

Feb 23, 2011

**81th Meeting of the Executive Committee of IMU
Perth, Australia
February 27-28, 2011**

**The meeting takes place in the conference room of Matilda Bay Restaurant & Bar
Wine Room, 3 Hackett Drive, Crawley, WA 6009**

Schedule

Time frame for the EC meeting:

Sunday, February 27

08:30 Cheryl Praeger picks EC up at hotel for walk to Matilda Bay Restaurant
09:00 – 12:00
12:00 – 13:00 Lunch
13:00 – 18:00
Morning and afternoon tea and lunch provided in Matilda Bay Restaurant
Carlos Kenig, will join at 13:00
Nalini Joshi will join at 16:00
19:00 BBQ at Cheryl Praeger's home (38 Kanimbla Road Nedlands)

Monday, February 28

09:00 – 13:00
11:00 Prof Owens, UWA Deputy Vice-Chancellor, will meet the IMU EC during
the coffee/tea break
13:00 – 14:00 Lunch
14:00 – 17:00
Morning and afternoon tea and lunch provided in Matilda Bay Restaurant
16:00 Members of the NCMS will join
17:30 Sunset (6.53 pm) and dinner (pizzas) at Cottesloe beach (swim suits!)

Every EC member will get a USB flash drive containing the meeting schedule, agenda and all supporting material (appendices).

Please remember to bring any electrical connections you need to plug your equipment into Australian powerpoints. Internet access (WLAN) will be available in the conference room at Mathilda Bay Restaurant and Trinity Hotel.

Tuesday - Saturday, March 1- 5

- [Appendix: 001. IMUSchedule March 1-4](#)

MathWest Workshop 2011

http://www.maths.uwa.edu.au/community/year-of-maths/mathwest-workshop-2011/_nocache

Cheryl's contact numbers: mobile +61 412389677 home +61 8 93868407

Cheryl at work: +61 8 64883344

Tania Blackwell at work: +61 8 64883342 mathwest@maths.uwa.edu.au

Feb 23, 2011

- [Appendix: 00. UWA map](#)

Hotel information:

Trinity Conference and Accommodation Centre
230 Hampden Road, Crawley WA 6009
Phone: +61 (08) 9423 9423 Fax: +61 (08) 9423 9422
E-mail: admin@trinity.uwa.edu.au
<http://www.trinity.uwa.edu.au/>
See campus map at: http://www.uwa.edu.au/campus_map

Meeting participants arriving at Trinity College after normal working hours please take the following steps – when you get to the main door at Trinity, to the left near the brick pillar there is a switch to open the doors, once you enter just inside the doorway there is an intercom system, instructions on how to contact the After Hours Duty Officer are posted next to the intercom, once contacted the After Hours Duty Officer will come to reception to check you in and show you to your rooms.

Some have already let Cheryl know their dietary requirements. Could anyone else please tell Tania of any special requirements.

From the airports, please take a taxi to Trinity. They are plentiful: Tell the taxi driver you are going to NEDLANDS [Cheryl: don't ask, I know the address says Crawley]
Trinity is across Stirling Highway from the University of Western Australia - corner of Stirling Highway and Hampden Road. Ask for a receipt when you pay.

There will be currency exchange at the international airport but not at the domestic airport. So if you need to change money please do that at the airport where you first arrive in Australia.

Leisure time

Some links work from <http://www.trinity.uwa.edu.au/conf/conference/location.html>
Perth International Arts Festival: <http://www.uwa.edu.au/piaf>
A possibility - if you're not too jetlagged is a picnic under the pines followed by outdoor film: <http://perthfestival.com.au/events/lotterywest-festival-films/certified-copy/>

Agenda









































1. Introduction and welcome to EC Members (ID), welcome to Perth (CP)
2. Approval of the agenda of this EC meeting (ID)
3. Minutes and Bulletins (LL, MG)
 - 3.1. Minutes of the 80th EC Meeting (August 2010, Bangalore)
 - 3.1.1. Appendix: [minutes](#), just provided for information
 - 3.2. Approval of the General Assembly Report (LL, MG)
 - 3.2.1. Appendix: [draft GA report](#)
 - 3.3. Overview of the Actions resulting from the EC minutes and from the GA Report. What about ballot sheets of GA 2006 (and in general)? (MG)
 - 3.4. Post-congress Bulletin, 2010 Bulletin
4. Finances of IMU (MG)
 - 4.1. Election of an IMU Treasurer
 - 4.2. Financial report 2010
 - 4.2.1. Appendix: [Independent Auditors' Report 2010](#)
 - 4.3. Dues and countries in arrears
 - 4.3.1. Appendix: [Dues and countries in arrears](#)
 - 4.4. Budget (IMU and IMU-WIAS Budget), Future budget structure (MG, AM)
 - 4.4.1. Appendix: [GA approved budget 2011-2014](#)
 - 4.5. Reimbursement policy, investment strategy, change of bank, 2011 invoices (MG)
 - 4.5.1. Appendix: [CL 17/07](#)
5. Prize Committees (ID)
 - 5.1. General discussion of prizes and related issues
 - 5.1.1. Former prize committee members, <http://www.mathunion.org/general/prizes/prize-committee-chairs/2006-1936/>, Appendix: [Former Prize Selection Committees](#)
 - 5.1.2. Prize committee rules, Appendix: [Prize committee rules](#)
 - 5.1.3. Prize committee guidelines (LL), Appendix: [E-mail LL](#)
 - 5.2. [Fields Medal](#)
 - 5.2.1. Fields Medal symposia in Toronto, Appendix: [Bierstone letter](#)
 - 5.3. [Nevanlinna Prize](#)
 - 5.4. [Gauss Prize](#), Appendix: [Statutes](#)
 - 5.5. [Chern Medal](#), Appendix: [Chern Medal Agreement](#)
 - 5.6. Leelavati Prize, Appendix: [Raghunathan letter](#)
6. Niels Henrik Abel Memorial Fund
 - 6.1. Agreement with the Abel Fund, Appendix: [IMU-DNVA \(new proposal\)](#)
 - 6.2. Ramanujan Prize, Appendices: [06.2.a Memorandum of Understanding concerning the Ramanujan Prize](#); [06.2.b IMU-ICTP rev. Lovasz](#); [06.2.c Ramanujan Prize Regulations \(new proposal\)](#)
 - 6.3. Ramanujan Prize Committee, Liaison Person
 - 6.4. Abel Prize Committee (we nominate 2), Appendix: [DNVA letter of Feb 9, 2011](#)
7. IMU representation at meetings, IMU Representatives and Liaison Persons, Appendix: [Current list of liaison persons](#)
 - 7.1. IMU at the EMS EC meeting (March 19-20, 2011 in Berlin), booth at 6ECM (July 2-7, 2012)?
 - 7.2. IMU at ICIAM Board meeting in Vancouver, July 23, 2011
 - 7.3. IMU at ICSU General Assembly in Rome (September 26-30, 2011)
 - 7.4. Various ICSU representations and nominations (see item 17)

- 7.5. Cosmology Prize Advisory Board (of the Peter and Patricia Gruber Foundation, currently Roger Penrose, 2009-2011, his second term)
- 7.6. IMU-Net Editor and IMU-Net EC correspondent
- 7.7. Curator of the IMU archive (currently Guillermo Curbera, interested in continuing)
- 7.8. Ramanujan Prize (see item 6)
- 7.9. UNESCO Liaison Person (see item 13)
- 7.10. EC member of CEIC (see item 15)
- 7.11. ICMI liaison (see item 16)
- 7.12. Other liaison persons
- 8.** after lunch (about 13:00)
ICM 2014 (ID, MG, CK)
 - 8.1. ICM 2010: Afterthoughts
 - 8.2. Introduction of the PC Chair
 - 8.3. PC/OC Guidelines
 - 8.3.1. Appendix: [PC/OC Guidelines](#)
 - 8.4. Laudator and plenary speaker guidelines
 - 8.5. Program Committee selection
 - 8.5.1. Appendix: [PCs of the last 3 ICMs](#). Program Committees and Sectional Panels of former ICMs are at <http://www.mathunion.org/activities/icm/pc/>
 - 8.6. Reorganization of sections
 - 8.6.1. Appendix: [Section lists 2010, 2006, 2002, 1998](#)
 - 8.7. Regional and gender balance
 - 8.8. Report about the meetings with the Local Organizing Committee in Hyderabad and Berlin
 - 8.9. Developing countries
 - 8.10. Public outreach (e.g. Gardner gathering)
 - 8.11. GA and GA guidelines
 - 8.12. Copyright issues, proceedings, abstracts, videos (to be discussed with CEIC)
- 9.** ICM 2018 Site selection (MG)
 - 9.1. Timing and call for bids
 - 9.2. Site selection committee
 - 9.3. Decision process, expected report of the site selection committee
- 10.** 16:00
Working Group on Journal Ranking and Pricing (Nalini Joshi)
 - 10.1. Appendices: [10.1.a Report by N. Joshi](#); 10.1.b Terms of Reference; and see <http://www.maths.usyd.edu.au/u/nalini/hidden0WG/> for more
- 11.** Permanent IMU Office in Berlin
 - 11.1. Report about the inauguration), Appendix: [Inauguration publicity \(directory 11.1\)](#), see also <http://www.wias-berlin.de/imu/fotos/>
 - 11.2. Organization
 - 11.3. Staff
 - 11.4. Archive
 - 11.5. A guided tour of the groupware system for the EC, available files and data, electronic voting
 - 11.6. IMU server, doodle, secure e-mail, e-mail distribution lists, electronic voting for Adhering Organizations
 - 11.7. Archiving e-mail correspondence, electronic archiving (EC, CDC, CEIC, prize committees)
 - 11.8. Skype and teleconferences
 - 11.9. News handling

12. Friends of IMU (FIMU)
 - 12.1. Board membership and terms of appointment
 - 12.1.1. Appendix: [AMS FIMU Services Agreement](#)
 - 12.1.2. Appendix: [Statutes](#)
 - 12.2. Web page
 - 12.3. Board meetings (face to face, electronic)
 - 12.4. Fund raising (book royalties, auctions, donors, ...)
 - 12.5. FIMU administration
13. Other activities
 - 13.1. Planet Earth 2013 (MPE2013) (CR), possible partnerships: IMU, ICSU, other scientific unions, Appendices: [13.1.a MPE2013](#); [13.1.b Partnership](#)
 - 13.2. Request of the U.S. National Academies' Committee on Women in Science, Engineering, and Medicine (CWSEM) for its project "The Status of Women in International Chemistry, Computer Science, and Mathematics: What We Know and Need to Know to Increase the Advancement of Women"
 - 13.3. Proposal to UNESCO (LL), see <http://www.mathunion.org/fileadmin/IMU/Report/IMU-UNESCO-project.pdf>
 - 13.4. "FORWARD LOOK: Mathematics and Industry" of the European Science Foundation (MdL), Appendix: [Final report](#)
 - 13.5. Outreach and popularization
14. Developing countries (ID, MG)
 - 14.1. Report about the CDC meeting in Berlin
 - 14.2. Donors' conference, GA Resolution 6, see GA report 3.2.1.
 - 14.3. [CDC Grants Committee](#)
 - 14.4. CDC finances
 - 14.5. Support from Abel Fund and PGS (Petroleum Geo-Services)
 - 14.6. Move from Columbus, Ohio to Berlin, Germany
 - 14.7. Support from Einstein Stiftung, see <http://www.math-berlin.de/imu-esb/>
 - 14.8. Funding from other institutions (McArthur Foundation, ...)
 - 14.9. Donation of royalties to FIMU for projects in developing countries, auctions of mathematical objects, and other funding ideas
15. Committee on Electronic Information and Communication CEIC (ID, LL, MG)
 - 15.1. EC representative and CEIC membership, Appendix: [CEIC membership](#)
 - 15.2. Joint activity with CDC: Electronic infrastructure (Internet connections, used computers), open access, agreements with publishers, collection of true stories on the impact of the Internet on mathematical practice and development, World Digital Mathematics Library, see <http://www.wdml.org/> (ID)
 - 15.3. Terms of Reference and future CEIC activities (facebook, twitter, blogs, ...), Appendix: [Terms of Reference](#)
 - 15.4. Software repository, promotion of ArXive and similar servers
 - 15.5. CEIC Web page
16. International Commission on Mathematical Instruction ICMI (CP, ID, MG)
 - 16.1. Appointment of an ICMI liaison officer
 - 16.2. Report on the ICMI EC meeting in Beijing(CP)
 - 16.3. Report on the ICME IPC meeting in Korea (CP)
 - 16.4. Move of ICMI's administrative business and financial operations
 - 16.5. [ICMI Nominating Committee](#) (ID, CP)
17. International Council for Science ICSU
 - 17.1. General information about ICSU, report about ICSU related activities (MdL)

- 17.1.1. [Appendix: Manuel's report](#)
- 17.2. Appointment of an ICSU liaison officer (ID)
- 17.3. IMU Representative in COSPAR ICSU's Committee on Space Research (Alain Bensoussan up to 2010) (MG)
- 17.4. Nominations for ICSU offices and ICSU Executive Board (ID)
- 17.5. ICSU Regional Office for Africa (MG)
- 17.6. ICSU Regional Office for Latin America and the Caribbean (MV)
- 17.7. ICSU Regional Office for Asia and the Pacific (CP)
- 17.8. Nomination for the Steering Committee for Earth System Research for Sustainable Development (CR)
- 17.9. ICSU principle of Universality (MG)
- 17.10. ICSU Draft Report on Science Education (CP)
- 17.11. ICSU Science Plan: Health and Wellbeing in the changing urban Environment (MdL), Appendix: [ICSU document](#)
- 17.12. ICSU Strategic Plan for Comments - Deadline 18 March 2011, Appendix: [ICSU document](#)
- 17.13. CODATA and WDS (MG)
- 17.14. ICSU Foresight Analysis, Appendix: [ICSU document](#)
- 18.** IMU membership (MG)
 - 18.1. General information
 - 18.2. Potential new members (The Gambia, Costa Rica, South Pacific, ...)
- 19.** Functioning of the EC (MG)
 - 19.1. Number and timing of meetings
 - 19.2. Next and further meetings
- 20.** Miscellaneous (ID)
- 21.** 16:00
Meeting with the Australian National Committee of Mathematical Sciences

List of Appendices

 11.1. Inauguration publicity	23.02.2011 18:11	Dateiordner	
 00. UWA Map.pdf	18.02.2011 17:13	Adobe Acrobat-D...	1.227 KB
 001. IMUSchedule March 1-4.docx	23.02.2011 12:32	Microsoft Office ...	13 KB
 03.1.1. 80 EC Minutes final 100815 Bangalore.pdf	03.12.2010 16:59	Adobe Acrobat-D...	123 KB
 03.2.1. 11-01-10 Draft report IMU GA 100816.pdf	10.01.2011 14:18	Adobe Acrobat-D...	1.631 KB
 04.2.1. IMU_Jahresrechnung_2010.pdf	23.02.2011 12:04	Adobe Acrobat-D...	227 KB
 04.3.1. ArrearsFeb2011.pdf	17.02.2011 16:53	Adobe Acrobat-D...	15 KB
 04.4.1. Budget 2011_2014-Final.pdf	06.01.2011 23:45	Adobe Acrobat-D...	19 KB
 04.5.1. IMU_EC_CL_17_07_reimbursement_policy_&_ICMI.pdf	05.03.2010 16:25	Adobe Acrobat-D...	107 KB
 05.1.1. Former Prize Selection Committees.docx	18.02.2011 18:00	Microsoft Office ...	19 KB
 05.1.2. IMU prize committee rules.docx	18.02.2011 16:22	Microsoft Office ...	17 KB
 05.1.3. Fields Committee_LL.txt	18.02.2011 16:50	Textdokument	10 KB
 05.2.1. Bierstone letter.pdf	17.02.2011 17:18	Adobe Acrobat-D...	44 KB
 05.4. gauss-statutes.pdf	17.02.2011 17:22	Adobe Acrobat-D...	31 KB
 05.5. Chern Medal Grant Agreement final (2).pdf	06.04.2009 15:23	Adobe Acrobat-D...	72 KB
 05.6. Raghunathan letter 110205.pdf	17.02.2011 17:38	Adobe Acrobat-D...	39 KB
 06.1. IMU-DNVA.pdf	23.02.2011 16:03	Adobe Acrobat-D...	69 KB
 06.2.a Memorandum of Understandi_Ball.doc	16.01.2008 19:46	Microsoft Office ...	30 KB
 06.2.b ICTP-IMU rev_Lovasz.pdf	17.02.2011 22:45	Adobe Acrobat-D...	1.010 KB
 06.2.c The Ramanujan_Prize_regulations.pdf	23.02.2011 16:05	Adobe Acrobat-D...	45 KB
 06.4. IMU 2011DNVA letter.pdf	17.02.2011 23:03	Adobe Acrobat-D...	318 KB
 07. IMU Representatives 110218.doc	18.02.2011 14:42	Microsoft Office ...	40 KB
 08.3.1. PC-OC Guidelines 071121.pdf	21.11.2007 19:47	Adobe Acrobat-D...	58 KB
 08.5.1. The last 3 PCs.docx	23.02.2011 16:25	Microsoft Office ...	14 KB
 08.6.1. Section lists 2010, 2006, 2002, 1998.docx	18.02.2011 14:45	Microsoft Office ...	13 KB
 10.1.a summary_19Feb11.pdf	23.02.2011 16:33	Adobe Acrobat-D...	105 KB
 10.1.b WG-JRP-Terms-of-Reference.pdf	18.02.2011 15:05	Adobe Acrobat-D...	51 KB
 12.1.1. 090910 AMS FIMU Services Agreement_Clean.pdf	18.02.2011 15:22	Adobe Acrobat-D...	20 KB
 12.1.2. By-laws.pdf	11.09.2009 21:55	Adobe Acrobat-D...	2.249 KB
 13.1.a PlanetEarth2013_Institutes_societies.doc	23.02.2011 17:09	Microsoft Office ...	279 KB
 13.1.b IMU_MPE_ICSU.DOC	23.02.2011 17:09	Microsoft Office ...	28 KB
 13.4. MathIndustry_FinalReport.pdf&#t=1298568625&#hash=6aaad319...	23.02.2011 17:33	Adobe Acrobat-D...	3.316 KB
 14.3. CDC Grants Committee complete.pdf	23.02.2011 17:45	Adobe Acrobat-D...	43 KB
 15.1. Term of CEIC membership.txt	06.01.2011 21:35	Textdokument	1 KB
 15.3. CEIC-Terms-of-Reference2010.pdf	03.01.2011 20:46	Adobe Acrobat-D...	10 KB
 16.3. ICMI Nominating Committee.txt	18.02.2011 16:35	Textdokument	4 KB
 17.1.1. IMU in ICSU 2011.pdf	18.02.2011 15:47	Adobe Acrobat-D...	154 KB
 17.11. FILE_Health_PG_ToR_12-7-07.pdf	18.02.2011 16:43	Adobe Acrobat-D...	97 KB
 17.12. SPdrIcs15-2-2011.doc	18.02.2011 16:38	Microsoft Office ...	478 KB
 17.14. ICSU Foresight Analysis.pdf	18.02.2011 18:35	Adobe Acrobat-D...	883 KB



CRAWLEY CAMPUS

VISITORS - All visitors must report to reception areas of buildings and must not enter restricted areas unaccompanied.
SMOKING - Permitted only in open areas away from buildings, courtyards and pathways.
 maps@uwa.edu.auy



THE UNIVERSITY OF WESTERN AUSTRALIA



**Minutes of the 80th Meeting of the Executive Committee of IMU
Chancery Pavilion Hotel – Bangalore - India
August 15, 2010**

Attendees:

László Lovász
Martin Grötschel
Zhi-Ming Ma
Claudio Procesi
Manuel de León
Ragni Piene
Cheryl E. Praeger
Marcelo Viana
John Ball

Excused

M. Salah Baouendi
Victor A. Vassiliev

Invited guests:

GA 2010 EOC Gadadhar Misra
(GA issues)

Sylwia Markwardt (minutes)

AGENDA

1. Introduction and Welcome, Approval of the Agenda
2. Approval of Rome EC meeting minutes, report about the activities
3. Report by President and Secretary

GA Issues (the pointer [GA x.y.](#) refers to the corresponding item of the GA Agenda)

4. Review of the GA Agenda
5. Change of Procedures for Election ([GA 2.1.](#))
6. Statute changes ([GA 4.1.](#), [GA 9.](#))
7. Appointment of the General Assembly Committees ([GA 2.](#))
8. Overview of the activities of the Union ([GA 3.1](#))
9. Stable IMU Office ([GA 4.](#), [GA 5.](#))
10. CEIC, including: membership, terms of reference, Best Practice for Journals document, IMU-net blog, D. Arnold's "Nefarious Numbers" ([GA 6.1.](#))
11. Financial Matters: Dues in arrears, dues increase, current version of 2011-2014 budget, resolution concerning update and structure of the future budget ([GA 6.4.](#), [GA 11.](#))
12. Presentation of the Slates ([GA 8.](#))
13. CDC: New terms ([GA 10.2.](#))
14. ICMI issues ([GA 6.2.](#))
15. Resolutions (e.g., Resolution on Conference Funding (MG), Noether Lecture (ChP), Budget 2011-2014 (MG)) ([GA 14.](#))
16. ICM 2014, GA 2014 ([GA 15.](#))
17. Group Changes, New IMU (Associate) Members ([GA 16.](#))
18. Preparation of the GA: Equipment, seating, secretarial assistance, preparation of the votes
19. GA Guidelines, Bulletin Quadrennial Report Guidelines, and all other GA items

ICM 2010 Issues

20. ICM Opening Ceremony
21. ICM: Booth and Merchandise
22. EC representation at receptions
23. ICM Dinner for the Local Organizers (Thank You Dinner)
24. ICM 2010 media exposure
25. PC/OC Guidelines and all other ICM Items

Other Issues

26. IMU/ICMI and UNESCO
27. Ramanujan Prize
28. Archive rules (E-mail exchange with Guillermo)
29. Further membership drives (in particular in Africa)
30. FIMU and funding drives
31. Miscellaneous
32. Closing (Thanks to all members leaving the EC)

1. Introduction and Welcome, Approval of the Agenda

L. Lovász welcomed everybody and opened the 80th meeting of the IMU Executive Committee in Bangalore. The agenda was approved without additions or amendments.

2. Approval of Rome EC meeting minutes, report about the activities

The minutes of the Rome EC meeting were approved. M. Grötschel referred to his update on the actions he sent to the EC on May 3, mention was made as follows:

- Bulletins 57, 58: are ready
- ICSU: item 26. of this agenda
- Budget: item 11. of this agenda
- New potential members: item 17. of this agenda
- US resolution: item 15. of this agenda
- ICMI: item 26. of this agenda
- CEIC issues: item 10. of this agenda
- Filming project (Curbera, Dalitz): under way
- ICIAM: IMU's support for ICSU membership application

3. Report by President and Secretary

There was nothing special to be reported by the President and the Secretary.

GA Issues

4. Review of the GA Agenda

M. Grötschel has made a PowerPoint presentation in preparation of conducting the General Assembly. It was decided to show it at the end of the meeting after all GA items have been reviewed.

5. Change of Procedures for Election (GA 2.1.)

M. Grötschel explained why the Procedures for Election have been revised. There are 3 major changes and in addition a number of minor mostly editorial changes.

- D. Mumford, in his capacity as Chair of the IMU Nominating Committee, requested to add the aspect of geographical distribution of the members of the IMU Executive Committee to the Procedures for Election. A new paragraph (new item 2.b.) was included into the Procedures for Election which reads as follows: “The slates for the commissions are formed taking advice from the current officers of these commissions, but this advice is not binding on the IMU Nominating Committee. The Nominating Committee is asked to distribute its nominations for the EC geographically so as to represent as equally as possible the whole international community of mathematicians. The connections of individual candidates to the countries where they were born, educated, or have lived in the past may be considered in addition to the country in which they presently reside.”
- All CDE related terms and activities had to be adapted to “CDC” which starts working as of 2011. The CDC nomination process, which differs from that of the CDE, had to be introduced into the Procedures for Election.
- An Election Committee working at the 2010 General Assembly had to be introduced into the Procedures for Election. The new paragraphs 5.a. and 5.b. take care of this and read as follows:
“5.a. On the first day of the GA meeting, an Election Committee is formed which consists of all members of the Nominating Committee and all Past IMU Presidents present at the GA and, if necessary, further GA delegates elected to reach a membership of at least five. The election shall be from names either proposed by the President or proposed and seconded from the floor by show of hands, unless the meeting decides otherwise. The Election Committee is chaired by the Chair of the Nominating Committee, or if unavailable, by the IMU President. The Election Committee is responsible for handling the election process and deciding on all issues related to it that may arise.
5. b. The Chair of the Election Committee presents the EC, CDC, and ICHM slates to the General Assembly.”

(The General Assembly approved the proposed changes of the Procedures for Election.)

M. Grötschel mentioned that one task of the new Election Committee could possibly be a nomination from the floor from the Russian delegation, since Russia has informed the Secretary that it has forgotten to submit its nomination. (This did not happen at the GA because the Russian delegation refrained from submitting a nomination.)

6. Statute changes (GA 4.1., GA 9.)

M. Grötschel outlined that the Statutes need to be revised due to the (expected) establishment of the stable IMU office. Two crucial changes have to be implemented which concern paragraphs 28. and 29. that in their new version read as follows:

- “28. The Secretary of the Union shall act also as its Treasurer, unless the Executive Committee appoints another person for this position.
- 29. The legal domicile of the Union shall be located at the offices of the Union.”

In addition some other essentially editorial changes have been made. (The General Assembly approved the proposed change of the Statutes.)

7. Appointment of the General Assembly Committees (GA 2.)

- Credentials Committee (~3 persons), in charge: M. de León
- Tellers Committee (~6 persons), in charge: R. Piene
- Finance and Dues Committee (~6 persons), in charge: M. Grötschel
- Resolutions Committee (~6 persons), in charge: M. Viana
- Election Committee (≥ 5 persons), in charge: L. Lovász

M. Grötschel explained that the documentation provided to the GA participants contained information concerning the General Assembly committees, especially the duties of these committees. The first item of the General Assembly is the appointment of these committees. The persons in charge of the committees are supposed to explain at the GA in few words what “their” committee has to do and introduce the nominees of their committee (who have already been selected beforehand by the persons in charge).

The Secretary is supposed to explain at the GA the details of the voting process and how the Adhering Organizations exercise their voting rights, and make them aware that the heads of the AO delegations are responsible for casting the votes of their country. The vote on the location of the stable IMU office is expected to take place in 2 rounds, round 1 would eliminate the candidate with the least number of votes, round 2 would yield the final ballot (on the assumption that none of the candidates would get the absolute majority in round 1).

8. Overview of the activities of the Union (GA 3.1)

L. Lovász gave a brief summary of his report on the Unions activities according to item 3.1 of the GA agenda. Topics addressed are mathematics application and research, the Congress, prizes at the Congress, quantitative evaluation of research, digitization, education, developing world and membership drive, UNESCO, political issues, stable office, fund raising. (Lovász’s speech will be printed in Bulletin No. 59 and the report of the GA.)

9. Stable IMU Office (GA 4., GA 5.)

R. Piene said that she presents the proposal to install a Stable IMU Office including the resulting necessary changes of the Statutes, introduces the presentations of the three bidders, and presents the report of the Stable Office Committee (SOC). The SOC proposes 3 resolutions, the first resolution being on the Yes/No vote on the Stable IMU Office, the second on the Statutes changes, and the third expressing thanks to all institutions which made efforts to submit a bid. R. Piene also explains the voting procedure. She will also moderate the question time.

10. CEIC, including: membership, terms of reference, Best Practice for Journals document, IMU-net blog, D. Arnold's "Nefarious Numbers" (GA 6.1.)

J. Ball said that in his presentation to the GA on the CEIC he speaks on archiving, copyright, digitization, the CEIC Terms of Reference (amendment approved by the EC today), IMU-Net, the Round Table on "The Use of Metrics in Evaluating Research" to take place on August 26, the "Best Current Practices for Journals" document to be endorsed by the General Assembly through a resolution, the effort to establish a joint IMU/ICIAM working group on the ranking of journals, and CEIC membership as of 2011 (approved by the EC today: P. Olver (chair), T. Bouche, O. Caprotti, J. Davenport, C. Hutchins, L. Lovász, R. Vakil). There was agreement that the blog discussion is continued when the Stable IMU Office has been established.

11. Financial Matters: Dues in arrears, dues increase, current version of 2011-2014 budget, resolution concerning update and structure of the future budget (GA 6.4., GA 11.)

M. Grötschel reviewed IMU's financial status. It is in good shape. The amount of dues in arrears could be reduced considerably (CHF 5,086 by the end of 2009). In his view it is desirable to redesign the structure of the IMU budget in order to adapt it to the present-day income and expenditure structure. This needs a Statutes change and is to be voted on by the General Assembly through a resolution. The currently proposed budget 2011-2014 has been drafted along the lines of the preceding budgets and initially applies. Once the Stable IMU Office has been installed a restructured budget should be drawn up and put to vote by the Adhering Organizations. The GA should adopt a resolution to that effect. The EC approved that a dues increase of 2% per year during 2011-2014 is to be proposed to, and voted on by the General Assembly.

The Secretary spoke about how to invest the funds of IMU and explained that he favors the conservative way of interest earning even if the interest rate levels are very low (below annually 1% at present). This, however, protects IMU's limited means from losses due to speculative investments. The EC approved this approach and expressed its wish to continue this way.

12. Presentation of the Slates (GA 8.)

M. Grötschel mentioned that, according to item 5.b. of the Procedures for Election (if approved by the GA), D. Mumford, chair of the IMU Nominating Committee and also chair of the Election Committee, presents the slates for the IMU Commissions and Committees to be elected at the General Assembly.

13. CDC: New terms (GA 10.2.)

M. Viana said he gives a report of the work of CDE/DCSG at the General Assembly and presents the new CDC Terms of Reference to the GA delegates. His presentation also includes the proposal for a resolution requesting to study the feasibility of convening a donors' conference as a satellite to the ICM 2014 in order to seek funding for IMU activities in support of developing countries.

14. ICMI issues (GA 6.2.)

The EC took note that B. Barton, ICMI President, gives a presentation on ICMI at the General Assembly. M. Grötschel said that ICMI leadership changed as of 2010 and the internal ICMI EC structures still need time to develop. The interaction with Barton is excellent. The new ICMI Secretary General has not yet tread into the footsteps of his predecessor (B. Hodgson). Ch. Praeger reported on discussions in the ICME 2012 program committee concerning plenary speakers. The IMU EC insists that program committee members are not supposed to be invited as major speakers at a congress.

15. Resolutions (e.g., Resolution on Conference Funding (MG), Noether Lecture (ChP), Budget 2011-2014 (MG)) (GA 14.)

The EC agreed that M. Viana mentions at the GA the resolution submitted by the US with respect to studying the feasibility of convening a donor's conference as a satellite to ICM 2014. M. Grötschel, having discussed this resolution with H. Clemens and the ICM 2014 organizers, will also comment on it and explain the resolutions on the IMU dues and budget. Ch. Praeger will give an explanation on the Emmy Noether Lecture at ICMs.

16. ICM 2014, GA 2014 (GA 15.)

M. de León said he gives a report on the activity of the ICM Site Committee and presents to the GA delegates the decision of the EC to recommend Seoul as the site for the ICM 2014. M. Grötschel said he was informed by the Korean ICM 2014 organizers that, different from the two GA 2014 candidate sites which they had offered in their initial ICM 2014 bid (Busan and Jeju Island), they now intend to propose another option which is Gyeongju, an ancient capital city sheltering three UNESCO cultural heritages. The EC agreed that they refrain from recommending a site for the GA 2014 to the GA delegates but leave it up to vote by the GA delegates.

17. Group Changes, New IMU (Associate) Members (GA 16.)

M. Grötschel will report to the GA delegates the new members adhering to the IMU since 2007 as well as the group upgrades that took place during the last term. The applications for membership/associate membership are presented by representatives of the corresponding countries except for Moldova which has asked the Russian delegation to present the Moldovan application.

M. Grötschel also said that he has received a request from Mexico which was contemplating an upgrade from group II to III, but Mexico was not able to decide on this by now.

M. Grötschel reported that he has got an application for membership from the Youth Care Foundation (YCF), The Gambia. He has replied to YCF that they cannot become an IMU member. By the help of D. Makinde from the AMU, M. Grötschel got in contact with the university of The Gambia and suggested that The Gambia becomes an associate member of the IMU. M. Grötschel will pursue the possible IMU associate membership of The Gambia.

Action: *M. Grötschel will keep contact with The Gambia in the matter of their possible IMU associate membership.*

18. Preparation of the GA: Equipment, seating, secretarial assistance, preparation of the votes

The EC discussed the details of the organization with G. Misra from the Indian Executive Organizing Committee who was responsible for the organization of the General Assembly in Bangalore. The arrangements in the GA conference hall were inspected with the aim to find out whether the technical and other requirements are met or need improvement.

Voting slips had to be prepared for the election of the Stable IMU Office location and for the election of the IMU Executive Committee, the Commission for Developing Countries, and the International Commission on the History of Mathematics for the term 2011-2014. All other votes take place by show of hands.

19. GA Guidelines, Bulletin Quadrennial Report Guidelines, and all other GA items

The EC discussed that so far there are no guidelines concerning the organization of a General Assembly of the IMU. Considering that IMU's General Assemblies take place every four years at another place and are organized by different people (in different cultural and social environments) the EC agreed that General Assembly guidelines specifying rules for the organization of a General Assembly are drawn up. Further, it would be desirable to have guidelines for writing the quadrennial activity reports of the EC and IMU's commissions/committees CDC, ICMI, ICHM, CEIC that are published in the IMU bulletins, and guidelines for the press coverage of the IMU prizes.

Action: *M. Grötschel will draft IMU General Assembly guidelines.*

Action: *L. Lovász will draft bulletin quadrennial report guidelines and press coverage guidelines for IMU prizes.*

ICM 2010 Issues

20. ICM Opening Ceremony

M. Grötschel said that a joint dinner is scheduled for tonight, August 15, with Raghunathan where there is occasion to discuss problems concerning the Opening Ceremony.

On August 14, a last minute e-mail to all registered ICM participants was forwarded by the Indian event manager KW Conferences providing detailed information on arrival, hotel check-in, shuttle facilities to the congress venue, registration timing, and special instruction for the Opening Ceremony.

L. Lovász spoke of the minute-by-minute schedule of the Opening Ceremony distributed by the Indian organizers and his e-mail reply to this where he has pointed out that this schedule gives no room for the IMU President to inform the Congress participants of the decisions of the IMU General Assembly and other important issues (information on the Program Committee, on other prizes like the Ramanujan Prize, the Leelavati Award that has been newly instituted for outstanding contributions to public outreach in mathematics by an individual, and the Kenneth O. May Prize for the History of Mathematics both to be awarded at the Closing Ceremony) and urged that a more IMU oriented session be scheduled after a short break when the Indian President has left the Opening Ceremony.

Other essential issues were online accessibility for the presenters during the Opening Ceremony (enabling PowerPoint presentations) and the absolute necessity to rehearse the Opening Ceremony the evening before. Many issues concerning the Opening Ceremony are still open and urgently need clarification (no bags and cameras allowed, timing, ...).

21. ICM: Booth and Merchandise

M. Grötschel said the preparations for the ICM booth were finalized. According to KW Conferences, the booth is ready in time, all IMU merchandise has arrived on site. A booth committee has been appointed, chaired by R. Piene who prepares schedules for manning the booth. The booth is not open on the day of the Opening Ceremony.

22. EC representation at receptions

During the time of the ICM, receptions are organized by the embassies or mathematical societies, by the Indian organizing committee, or there are cultural and other performances. The EC agreed to try to attend as many events as possible even if these take place in parallel (“reception hopping”).

- Aug 19 Receptions by the Norwegian embassy and the US delegation (in parallel);
Reception of the prize winners and invited speakers by the Indian organizing Committee afterwards;
- Aug 20 Cultural performance and banquet by the Indian organizing committee;
- Aug 21 Informal gathering by the German Science Foundation and funding agencies;
Receptions by the Korean math society and the Canadian math society (in parallel);
Meeting of the FIMU board of directors afterwards;
- Aug 22 Reception by Math Reviews;
Theater performance;
Reception by the French embassy;
- Aug 24 Chess contest;
Reception by the German embassy;
- Aug 25 Reception by the UK math society;
Cultural performance;
- Aug 27 IMU Thank You Dinner.

23. ICM Dinner for the Local Organizers (Thank You Dinner)

M. Grötschel reported on the Thank You Dinner for the Indian local organizers. The dinner takes place on August 27 after the Closing Ceremony. M. Grötschel has sent out invitations to a list of persons communicated to him by R. Tandon, the secretary of the Indian organizing committee. The dinner is in Siasa Restaurant in Hyderabad, about 50 persons including EC members are expected to come. Ch. Praeger volunteered to organize the details of the food and service and is assisted by Sedhar Ball, Cecilia Kulscar, and Ms. R. Tandon.

24. ICM 2010 media exposure

M. Grötschel said that in the evening of August 16, the first popular announcements of the ICM are launched, so far there were only technical announcements. A press conference is scheduled for August 19, 1:00 p.m., after the ICM Opening Ceremony. It was not clear up to now whether there will be a press office at the Congress. (There was no such office.) M. Grötschel reported that he got to know that secret press activities concerning prize winners are going on in Israel and Vietnam. The EC was unhappy of the ICM 2010 media activities.

25. PC/OC Guidelines and all other ICM Items

M. Grötschel said that considering the experience of the Program Committee and the report of the Program Committee chair H. Lenstra the PC/OC Guidelines need revision.

M. Grötschel reported that the invited talk of A. Erschler who has cancelled her participation in the ICM for personal reasons is read by A. Eskin.

Action: *M. Grötschel will revise the PC/OC Guidelines and submit it to the EC for approval.*

Other Issues

26. IMU/ICMI and UNESCO

L. Lovász reported that he and M. de León took part in the ICSU presidents' meeting in Paris on April 7/8. They both had a meeting with the director of the Promotion of the Basic Education division and L. Lovász also met the director of the Basic and Engineering Sciences Division. Both directors were favorable towards IMU's/ICMI's proposal. They also had said that they plan to install a committee on math education with the function to act as advisor to UNESCO. IMU should make efforts to be represented in such a committee. L. Lovász also said that he got a message from M. Artigue saying that she met M. Alarcon from UNESCO. Alarcon has sent a letter with a proposal for a program with a reasonable content but low budget. IMU should look for ideas and people in order to implement its ICSU/UNESCO proposal.

27. Ramanujan Prize

L. Lovász reported that he attended the Ramanujan Prize ceremony at ICTP on July 13, and that he had a discussion with ICTP director Quevedo and with the mathematics department head Ramadas Ramakrishnan about the Ramanujan Prize. The initial IMU-ICTP memorandum of understanding covers five awards, i.e. until the 2009 award. ICTP, however, had already announced the 2010 award. Together with Quevedo, L. Lovász signed on July 14 a new IMU-ICTP memorandum of understanding that can be terminated on a one year notice basis. Now, a new agreement needs to be concluded between IMU and the Niels Henrik Abel Memorial Fund which is funding the Ramanujan prize. IMU, ICTP, and the Abel Fund have to mutually agree on the time and place of the Ramanujan award. With regard to the Ramanujan prize selection committee the EC agreed that Gang Tian from China be appointed to the selection committee on behalf of the IMU EC. M. Viana will stay on the committee. With respect to other committee members the EC would be in favor of H. Holden, R. Ramakrishnan (chair), and J. Banasiak (South Africa).

Action: *Z. Ma will (informally) approach Gang Tian and ask him whether he is willing to join the Ramanujan Prize selection committee. (Tian has agreed.)*

Action: *L. Lovász will communicate the name of Gang Tian to ICTP.*

Action: *Conclusion of an agreement IMU – Niels Henrik Abel Memorial Fund about the continuation of the Ramanujan prize.*

28. Archive rules (E-mail exchange with Guillermo)

The EC argued that there is still no clarity or agreement concerning rules for electronic archiving. The EC members were aware that there is a danger of loss of data/information since the practical issues of electronic archiving are not solved. Further discussion of this issue was postponed to until the Stable IMU Office has been established.

M. Grötschel said that he has received at the Berlin IMU secretariat documentation from the 2010 Chern and the 2010 Gauss Medal committees. He did not examine what he has received but sealed it for further storage.

29. Further membership drives (in particular in Africa)

M. Grötschel reported that the activities of EC members to attract new IMU members had some success (membership applications from Cambodia, Moldova, Montenegro, Nepal, Oman, that are for ballot at the GA), special interest could be observed from Africa, where D. Makinde from the African Mathematical Union is very active.

Action: *Ch. Praeger will get in contact with D. Makinde/AMU. Ch. Praeger will also keep an eye on Asia.*

Action: *M. Viana will approach Mexico, and also Costa Rica (together with Ch. Praeger).*

30. FIMU and funding drives

The EC members agreed that there is a FIMU board of directors' meeting during the time of the Congress to discuss matters of interest because J. Arthur, D. Mumford, L. Lovász, M. Grötschel (4 of the 5 board members), and D. McClure who administers the FIMU fund are attending the ICM. Date envisaged: August 21.

31. Miscellaneous

The EC agreed to organize a get-together with the newly elected EC members during the ICM in Hyderabad. Informal lunch envisaged for: August 21.

L. Lovász has got an invitation from the Swiss Mathematical Society for their 100th anniversary on Oct 1 and 2 but is prevented. C. Procesi is willing to attend. The EC agreed that IMU cannot be present at all such anniversaries but has to decide ad hoc at which event IMU should be represented.

M. Grötschel reported that he had rejected an application to IMU for the conference "Complex Analysis, Operator Theory, and Approximation (CAOTA)" to take place in July 2011 at Johannes Kepler University in Linz on the ground that the IMU EC has decided, at its EC meeting in April 2008, that its scarce funds should go primarily to supporting mathematicians from developing countries and high quality international conferences that take place in developing countries. The EC reaffirmed its decision and approved the policy to distribute the funds to conferences that satisfy both requirements.

M. Grötschel reported that he has got an invitation from the Union of International Associations (UIA) to attend the UIA's 100th anniversary in November 2010. The UIA is seated in Brussels and looks serious, but it is unheard-of. It does not seem to be an active institution of science. The EC agreed to take no action.

See Agenda item 4.

M. Grötschel showed a Power Point presentation that he has prepared for the agenda and guidance of the General Assembly.

32. Closing (Thanks to all members leaving the EC)

L. Lovász said that this was the last meeting of this term's executive committee. He thanked the EC, especially the members leaving the EC, for the good cooperation and particularly showed appreciation to J. Ball.

**Report of the 16th General Assembly
of the International Mathematical Union (IMU)**

**Bangalore, India
August 16-17, 2010**

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1. Opening

The IMU President L. Lovász opened the 16th General Assembly (GA) of the IMU and cordially welcomed the participants of the meeting. He introduced the members of the IMU Executive Committee (EC) to the audience. The GA agenda was approved.

2. Appointment of Subcommittees

2.1. Procedures for Election (vote on changes)

The IMU Secretary M. Grötschel gave a survey on the changes of the Procedures for Election that were proposed to the General Assembly. The major changes concerned the introduction of the aspect of geographical distribution of the members of the IMU Executive Committee, the change to “CDC” of all CDE related terms and activities as well as the introduction of the

CDC nomination process, and the institution of an Election Committee working at the 2010 General Assembly. Further a number of minor mostly editorial changes were proposed.

The proposed changes were approved and the new Procedures for Election adopted by the 16th General Assembly.

See: <http://www.mathunion.org/organization/ec/procedures-for-election/>.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

2.2. Credentials Committee

M. de León explained the duties of the Credentials Committee and presented the proposed committee to the General Assembly.

Duties of the Credentials Committee:

- *Review the list of delegates that have registered at the General Assembly and verify each delegation is correctly constituted and present the list to the President of IMU*
- *Ensure that voting procedures are understood*

The General Assembly approved the following committee.

Credentials Committee:

Marta Sanz-Solé, *Chair* (Spain)
Ruth Kellerhals (Switzerland)
Qiman Shao (Hong-Kong)

VOTE (by show of hands): IN FAVOUR = 134, ABSTENTION = 1

2.3. Tellers Committee

R. Piene introduced the persons proposed for the Tellers Committee and explained the duties of the committee.

Duties of the Tellers Committee:

- *Distribute ballots*
- *Collect ballots*
- *Verify ballots and discard invalid ballots*
- *Count the votes*
- *Report the outcome to the President of IMU*

The General Assembly approved the following committee.

Tellers Committee:

François Loeser, *Chair* (France)
Rajendra Bhatia (India)
Etienne Desquith (Ivory Coast)
Yboon Victoria Garcia Ramos (Peru)
Takashi Tsuboi (Japan)
Karen Vogtmann (USA)

VOTE (by show of hands): IN FAVOR = UNANIMOUS

2.4. Finance and Dues Committee

M. Grötschel presented the proposed committee and explained its duties to the General Assembly.

Duties of the Finance and Dues Committee:

- *Review the proposed 2011-2014 budget*
- *Make recommendations to the General Assembly concerning dues unit increase*
- *Make recommendation to the General Assembly concerning action to be taken regarding dues in arrears*

The General Assembly approved the following committee.

Finance and Dues Committee:

Christiane Rousseau, *Chair* (Canada)
Erwin Albert Karl Brüning (South Africa)
Hernán Cendra (Argentina)
Dohan Kim (Republic of Korea)
Jaroslav Nesetril (Czech Republic)
Ragnar Winther (Norway)
Ex officio: Martin Grötschel, Sylwia Markwardt

VOTE (by show of hands): IN FAVOUR = 134, ABSTENTION = 1

2.5. Resolutions Committee

M. Viana explained the duties of the Resolutions Committee and presented the proposed members.

Duties of the Resolutions Committee:

- *Accept resolutions put forth by delegations prior to the close of the first day's sessions of the General Assembly (August 16)*
- *Review and edit resolutions received from the delegations*
- *Formulate resolutions*
- *Present the resolutions to the General Assembly with recommendations*

The General Assembly approved the following committee.

Resolutions Committee:

Freddy Dumortier, *Chair* (Belgium)
Ramachandran Balasubramanian (India)
Nalini Joshi (Australia)
Roberto Markarian (Uruguay)
Mitsuhiro Shishikura (Japan)
John Francis Toland (United Kingdom)

VOTE (by show of hands): IN FAVOUR = 134, ABSTENTION = 1

2.6. Election Committee

L. Lovász explained the duties of the Election Committee and presented the proposed members.

Duties of the Election Committee:

- *Settle all issues coming up during the election process, in particular*
 - *to oversee the form of the ballot papers*
 - *and to clarify all matters coming up when suggestions from the floor are made.*

The General Assembly approved the following committee.

Election Committee:

David Mumford, *Chair* (USA)
John Ball (United Kingdom)
Masaki Kashiwara (Japan)
László Lovász (Hungary)
Jacob Palis (Brazil)

VOTE (by show of hands): IN FAVOR = UNANIMOUS

3. Review of the activities of the Union (part 1)

3.1. Overview on Union activities

President's address to the delegates, László Lovász

Introduction: goals of the IMU

At the beginning of this General Assembly, I would like to give you an overview of the main achievements, challenges, and problems of our Union, as I have experienced over the last four years. I hope that against this background you will be able to better appreciate the specific problems we will discuss later.

Life connected with mathematics has many aspects: besides research in pure math, it includes math education (at many levels, from Kindergarten to doctoral programs), applications of mathematics (in industry, finance, sciences and humanities), and popularization (in media, books, and schools). The main focus of the IMU is research, but we have always felt responsibility for the other aspects. Applied mathematics has several organizations, and our international Commission of Mathematical Instruction has a large degree of autonomy. We don't want to monopolize mathematics in any sense, but we feel that close cooperation with organizations and individuals engaged in all these activities is vitally important. Many of these connections will be agenda items of our Assembly.

I will group my thoughts around these aspects of mathematical life, and then talk a bit about some very important issues concerning the administration of the Union.

1 Research

1.1 Congress

The main event in the life of the IMU is our Congress. Often one can hear scepticism about having such congresses in general. One of the points people make is the large size of it (at least for a mathematics meeting). Indeed, a single participant will only know a small fraction of the other participants and one can walk around for a long time without seeing a familiar face. A participant will be able to follow only a small fraction of the section talks. A lot of effort has been made, especially at recent congresses, to make the invited talks, especially the plenary talks, accessible to a general mathematical audience; but it is still difficult to follow so many ideas from different parts of mathematics within such a short time.

However, talking to scientists working in physics, computer science or other branches of science, they are envious of the fact that we mathematicians have such an event, where the

latest developments are described, most of the most important prizes are awarded and the recipients describe their work, and much more.

There are many proposals to change the format of the Congress: some propose new sections, others suggest to make it shorter, etc. I believe that substantial change in the duration or format would do more harm than good. Details of the program are decided by the Program Committee for each Congress, and cautious adjustments are made as our science develops.

1.2 Prizes

Prizes are the most visible and perhaps also emotionally charged elements of our activities. They are important to motivate researchers, and also to draw attention to the most important developments in our field, both among mathematicians and the broader public.

Four major Prizes of the Union will be awarded at the opening ceremony: the Fields Medals (typically four of them), the Nevanlinna Prize, the Gauss Prize, and the new Chern Medal Award, financed by the Chern Foundation, named after the outstanding mathematician S.S.Chern.

The new *Leelavati Prize* for popularization of mathematics, named after a 12th century Indian mathematical text, will be awarded at the closing ceremony. This prize is funded by the Indian Government, and at this time it is not clear whether it will be awarded again at the next Congress, although we feel that it is an excellent cause and we are grateful to the Indian Government and to the local organizers for establishing it.

The IMU recommends or appoints committee members for a number of other prizes: the Abel Prize, the Ramanujan Prize (for young researchers from developing countries), and the Gruber Foundation's Cosmology Prize. ICMI sponsors the Felix Klein and Hans Freudenthal Awards.

On the other hand, IMU does not *nominate* people to receive prizes of other organizations; we feel this would be improper.

There have been other suggestions concerning the prizes, mainly the Fields medals: for example, to raise the age limit of 40. I am very much in favor of not changing the scope of a prize: I believe that it is very important that the meaning of a Prize remain the same over the years.

One exception here is the level of the financial award, which is inadequate for all our prizes except the Chern Medal. Of course, a Fields medal or Nevanlinna Prize in itself brings the recipient well-deserved recognition, and probably in most cases even financial benefits through promotions, job offers etc. But there is a danger that with almost 2 magnitudes of difference between, say, the Fields Medals and the Abel prize, the significance of the Fields medals erodes in the eye of the media, then in the eye of the general public, then even in the mathematical community. We have been working on this problem, but we insisted that the name of the Prize and the rules of awarding it must remain unchanged, and our attempts have failed so far.

1.3 Quantitative evaluation of research

The Union tries to follow those disputes and trends that influence the everyday life of mathematicians around the world. One of these is the quantitative evaluation of research, which often centers around the notion of “impact factor”, but is in fact a much more general issue. Jointly with ICIAM and IMS, we appointed a committee to look into the problems of quantitative evaluation of research, which published a very well received document, available on our web site, which gives a very balanced analysis of when impact factor and similar methods can and cannot be applied.

However, we don't consider the issue closed.

– First, it is not enough to explain why the use of impact factor is not proper in certain decisions; it is also necessary to make recommendations to departments and funding agencies what methods we consider justified.

– Second, very disturbing information about cheating with impact factors has come to light. We intend to continue our work on this issue, and as a preparation, we organize a panel discussion at the ICM where all participants will have the possibility to learn about these issues and express their concerns and recommendations.

1.4 Digitalization, internet

IMU has stated the ambitious goal that all mathematical material be accessible over the internet, and whenever possible, for free. Progress in this direction is slow but steady. We are happy to report:

- All Proceedings of previous ICM-s and ICME-s are available for free.
- The American Mathematical Society (AMS) just a few days ago completed a complete digital archive of its mathematical research journals, and made it freely available to all mathematicians through the generosity of an anonymous donor.

Commercial publishers have also digitalized their publications, but the cost of downloading is often prohibitive in many countries. An additional new development is bulk subscription to journals from large publishers, by consortia of universities, sometimes whole countries, which effectively takes out the decision subscriptions from our hands.

IMU remains concerned with this problem, but complicated issues of international copyright make it difficult to propose a uniform system. Nevertheless, we mathematicians can do a lot ourselves to reduce the problem:

- We can post preprints of our papers on the Arxiv (let's hope it remains in place for a long time) or simply on our home pages, and we can encourage our colleagues to do so. We can favor those Journals for our publications which do not object to this.
- Many of our younger colleagues are afraid of publishing in free electronic journals, since they may not be valued equally in tenure or grant procedures. This may be so, but many of us here are senior people who have an influence on university authorities and grant agencies, and we should fight for evaluation based on quality and not on the publisher of the journal.

IMU could play an even larger role in this, by providing means for a just ranking of journals. We will have a round table discussion about these problems during the Congress.

1.5 Research projects

Unlike many other scientific Unions, the IMU does not have research programs or projects targeting specific goals. Such programs would clearly be incompatible with pure research, but even in applied math they would be counterproductive: We believe that one of the strengths of mathematics is its broad applicability, and also the variety of mathematical areas that have applications. To favor any of these could hinder research in other, potentially equally important areas.

This does not mean that the IMU is not open to be part of interdisciplinary projects, and in general to cooperation with other scientific unions and communities. We made substantial efforts to improve our relations with ICSU and UNESCO.

2 Education

We believe that mathematics education is a crucial element in improving mathematical literacy of society as well as in raising the next generation of math researchers. At the same time, we realize that mathematical education has different goals, problems, and different ways of measuring results. The IMU has a Commission, the ICMI, to deal with math education. The General Assembly in 2006 gave a larger degree of autonomy to this Commission, including separate elections for their officials. I would say that this did not loosen the connections between IMU and ICMI, to the contrary, I feel that we have developed an excellent working relationship.

3 Developing world

The main body of the IMU dealing with the developing world is our Commission for Developing Countries (CDC). In this form, this is a new Commission, whose creation was approved by postal ballot by the members of the IMU. Its charge is a combination of the charges of the former Commission for Development and Exchanges (CDE) and the Developing Countries Strategy Group. We hope that having a single commission to deal with all issues in connection with developing countries makes the work more efficient and decreases the possibility of important issues falling between the cracks.

One aspect of our relationship with the developing world is by far not satisfactory: this is IMU membership of developing countries. We have made efforts to increase the number of our members. The main point here is not to collect more membership fee; in fact, IMU has introduced Associate Membership through which countries with a developing mathematical life can participate in the activities of the Union (except voting) without paying membership fees. To have more application for membership from certain regions I appeal to all of you: if you know of non-member countries where you have professional connections, please see if you can help our colleagues there to form an organization and apply for (at least) Associate Membership in IMU.

4 Popularization

This area is becoming more and more important, and the IMU has to pay a lot of attention. There are excellent examples of successful popularization programs. However, due to language and cultural differences, methods in popularization are not as easily adaptable to other countries as, say, research programs. I will get back to this question a bit later.

5 Politics

5.1 UNESCO

Last Summer I met Dr Szollosi-Nagy, a Program Director at UNESCO, an engineer who recognizes the significance of mathematics, who suggested that the IMU propose an international program in mathematics to UNESCO. To work out the details, we organized a workshop last November, during the World Science Forum in Budapest, where besides our EC and UNESCO, also ICMI, ICIAM, ICTP and CIMPA were represented. This workshop produced two documents: a short call for action and a more detailed proposal. The first document points out that while mathematics plays a rapidly increasing role as a universal language for science, mathematical illiteracy is growing and interest in the study of mathematics is declining. We asked UNESCO to take the lead in improving mathematical education and awareness.

Our detailed proposal, in a nutshell, envisions a Program that could act as a “broker” of programs in mathematical research, education and popularization, developed and tested by local communities. It would facilitate translations of educational and popular material, and provide a “certificate of authority” to programs that are serious. All countries would be targets of these activities, but the main beneficiary would be the developing world, where it should contribute to capacity building in mathematics.

UNESCO is interested, but the timing of our proposal was not good, since the Director General and many UNESCO officers have changed shortly after. Nevertheless, we are talking with them, and appointed Michelle Artigue as our liaison person. The experience of ICMI is very important here. I hope to establish some level of cooperation better than before.

I feel whether or not UNESCO will take an action, thinking about these issues together had the result that we all see the possibilities better. The next EC should think about how much of this can we ourselves realize and thereby make UNESCO support more likely.

5.2 Political issues

There are some events which bring the IMU in contact with politics. The most dramatic ones are when a mathematician is kidnapped or unjustly imprisoned. Needless to say, we do our best to help, but this is not always straightforward. For example, when a mathematician was

kidnapped, we made confidential contact with our local colleagues, and were advised not to make any public move, because this would make hostage negotiations more difficult by increasing the stakes for the kidnappers. Luckily, our colleague was eventually freed. In another case, when massive protest seemed the best route, we joined this protest (unfortunately, our colleague was probably murdered by that time).

IMU does not have the resources and local knowledge to interfere in labor disputes, unless there is some expressed discrimination against mathematics. For example, we intervened (successfully) when a government wanted to close a mathematics department.

Visas for scientists and treatment of foreigners is becoming, unfortunately, an increasing concern. Under threats of terrorism, governments are often tightening their visa policies to irrational levels. IMU stands firmly by the principle that no scientist should be punished for actions of his or her government. The EC has joined the protest of ICSU against US visa policies by moving our EC meeting from the US to another country. Unfortunately, unexpected events like terrorist attacks can create difficult situations like we experienced with Indian visas for this meeting. It took enormous efforts on the part of the Indian organizers to make sure that the delegates and Congress participants get visas, for which I would like to express our gratitude.

6 Administration

6.1 Stable office

The last General Assembly (Santiago de Compostela, 2006) charged the EC with looking into the possibility of setting up a permanent office. It is natural to be skeptical about this: after all, the IMU has functioned very well over many years while staying as informal and un-bureaucratic as possible, just having a small office wherever the Secretary was located. But looking deeper into the issue made it clear that the charge by the GA was justified. With stricter and stricter legislation targeting money laundering and terrorism, it becomes more and more difficult to move the office from one continent to another any time a new Secretary is elected. There was also a pressing need to solve the problem of secretarial help for CDC and ICMI.

Looking deeper into the issue also revealed that, unfortunately, the finances of the Union do not allow the rental and staffing of a new office. Therefore we turned to the community for help: we thought that providing some office space and secretarial help may be within the possibilities of some larger research institute or university department.

The response was overwhelming, and this is how we are now in the position of having the decision about the stable office on the agenda of this meeting. You will hear more about this very soon; right now I just want to express my most sincere thanks to all the organizations who followed up on our call and explored how they can help the IMU within their resources.

6.2 Fund raising

Another aspect of modern life is that virtually no organization can exist without fund raising. IMU cannot operate from the budget based on membership fees alone: We need resources for our prizes, and also for our programs in the developing world, just to name the two most important goals. To facilitate fund raising, we created an organization called "Friends of IMU", registered as a not-for-profit organization in the United States. This organization handles, among others, the financial aspects of the new Chern Medal Award mentioned before, and also donations from members of the American Mathematical Society to the Special Development Fund, which this way are tax-deductible. We have thought of setting up fund raising organizations in other countries, but this is a difficult and costly process, and we can only afford it if substantial donations can be expected.

3.2. CDE/DCSG presentation, including vote on new CDC Terms of Reference

Presentation by Marcelo Viana, Chair of the Committee for Developing Countries

Commission for Developing Countries of the IMU

Commission on Development and Exchanges

Since 1978, *IMU's Commission on Development and Exchanges* has supported mathematicians in the developing world, through

- research travel support
- conference support

Total Budget 2006 – 2009 USD 212,541.35

Year	Applications Received	Applications Circulated	Awards Made	Conferences in Developing Countries	Conferences in Developed Countries	Individual Research Travel Support
2006	83	70	43	31	2	10
2007	60	54	53	31	2	20
2008	58	55	45	27	5	13
2009	56	56	55	30	10	15
Total	257	235	196			

Members (2007-2010)

Shrikrishna G. Dani (India, President)
 Gérard Gonzalez-Sprinberg (France, Secretary)
 Graciela L. Boente (Argentina)
 Paulo Cordaro (Brazil)
 Jean-Pierre Gossez (Belgium)
 Mary Teuw Niane (Senegal)
 Marta Sanz-Solé (Spain)
 Jiping Zhang (China)
 László Lovász (President of IMU)
 Martin Grötschel (Secretary of IMU)

Developing Countries Strategy Group

In 2002, the IMU General Assembly in Shanghai resolved to expand IMU's commitment to mathematics in the developing world.

This led to the establishment, in 2003, of the *Developing Countries Strategy Group*.

Mandate: Increase and coordinate IMU's activities in support of mathematics and mathematics education in the developing world.

DCSG acts as a "clearinghouse" and coordinating agent for activities of IMU itself, national agencies, professional societies and foundations, in support of mathematics and mathematics education in the developing world.

Total Budget 2006 – 2009 USD 287,701.57

- Administered the IMU program of travel awards for developing country mathematicians to attend ICM2006 in Madrid and ICM2010 in Hyderabad.
- Helped the London Mathematical Society establish and gain funding for the program Mentoring African Research in Mathematics (more information at ICM2010 MARM panel).
- Advised ICTP on the establishment and awarding of the Ramanujan Prize.
- Worked with the French *Centre International de Mathématique Pures et Appliquées* and with French, U.S. and Japanese mathematicians to establish and sustain a Masters degree program in mathematics at the Royal University of Phnom Penh, Cambodia.
- Collaborated with the U.S./IMU Adhering Body (USNCM) to establish the Volunteer Lecturer Program. IMU has so far sponsored 5 Volunteer Lecturers: 1 to Tanzania, 2 to Nigeria, 2 to Laos. CIMPA and USNCM have sponsored over 20 lecturers to Cambodia, plus one recent lecturer to El Salvador. (But 40 other mathematicians have offered their services!)

- Prepared the report "Mathematics in Africa: Challenges and Opportunities" requested and financed by the John Templeton Foundation. (Report available on IMU website.)
- Provides continuing support to the African Mathematics Millennium Science Initiative (scholarship program for African graduate students, conference support).
- Vets applications of developing country mathematicians to participate in programs of the world's leading mathematics research institutes.
- Supports the participation by developing world mathematicians in workshops and panels of International Council of Industrial and Applied Mathematics.
- Supports workshops and mathematics expositions of the International Commission on Mathematics Instruction in the developing world.
- Backs up CDE, easing CDE budget limitations and supplementing CDE grants in cases of extraordinary need and importance.
- Advises the IMU President, Secretary, and Executive Committee on matters related to mathematics in the developing world.

Members (2007-2010)

Herbert Clemens (US, Chair)
Jill Adler (South Africa)
Hajer Bahouri (Tunisia)
John M. Ball (United Kingdom)
Shrikrishna G. Dani (India)
Jean-Pierre Gossez (Belgium)
Andreas Griewank (Germany)
Lê Dung Trang (Italy)
Jacob Palis (Brazil)
Peter Pang Yu Hin (Singapore)
Ragni Piene (Norway)
Michel Jambu (France)
Sheung Tsun Tsou (United Kingdom)
László Lovász (President of IMU)

IMU work for Developing Countries

Funding:

- A continuing grant of USD 45,000 per year from Norway's Abel Fund.
- IMU's funds as derived from Adhering Body dues and other sources.
- Contributions from National Societies (Japan, Switzerland) and other institutions.

The resources available fall way short of the challenges before us!

Commission for Developing Countries

2006 General Assembly Recommendation:

Merge CDE and DCSG into

Commission for Developing Countries (CDC)

Merger approved by postal ballot in 2009.

Vote on the CDC Terms of Reference to be taken at this GA.

Mandate:

- Manage, strengthen, and promote the programs of the IMU in developing and economically disadvantaged countries.
- Search for funding to support the corresponding activities.
- Establish institutional partnerships with scientific organizations with common goals.

What's keeping CDC busy at the moment:

Manage ICM 2010 Travel Grants Program:

Travel grant awards to mathematicians from developing countries to attend ICM 2010.

- A little under 800 Applications
- 120 Awards:
- 57 Senior Mathematicians
- 63 Young Mathematicians

Panel: Herbert Clemens, Shrikrishna G. Dani, Wilfrid Gangbo, Zhiming Ma, Anatoly Vershik, Marcelo Viana

CDC plans for the next four years:

Continue and strengthen current activities:

- research travel grants and conference grants
- Volunteer Lecturer Program
- regional studies and projects
- articulation and mutual leveraging of mathematical initiatives of governments, agencies and individuals
- stop-gap funding for programs in crisis
- support of mathematics education
- attention to new regions of the world and their mathematical communities

But IMU does not have the resources to even begin to meet the needs of our colleagues in the developing world

- to develop and sustain their own mathematical research
- to form and guide a new generation of university and (post)-graduate students of mathematics
- to strengthen stature, norms and professionalism of academic institutions in their countries
- to network with other centers to gain critical mass through mutual reinforcement of programs and lecturer and student exchanges
- to establish sustained links with outside mathematical centers and resources

The needs...

- student support while studying for advanced degrees
- access to advanced training in both core and applied mathematics
- re-conceptualizing teaching and administrative workloads to allow time and energy for continuing research
- networking with other centers to gain critical mass through mutual reinforcement of programs
- nourishing links with outside mathematical centers and resources
- employment opportunities for mathematics professionals in their own countries

...exceed the resources available by many orders of magnitude.

The current problem is not so much lack of human resources:

Wise leadership by home country colleagues is everyday more manifest throughout the developing world.

Our professional colleagues in the developed world are ready to help: the abundance of professional generosity, as manifest in such initiatives as the Volunteer Lecturer Program, provides compelling evidence.

Efforts to make use of the regionally existing resources are also increasingly consistent in some parts of the world (e.g. EMALCA courses in Latin America).

There is an abundance of untapped mathematical talent in the developing world, and the desire of students to learn mathematics, and to become mathematics-based professionals, is perhaps nowhere stronger than among the students we encounter in our outreach to developing countries.

A major bottleneck at this point is financial in nature:

There are simply not the economic resources available for those who want to study advanced mathematics and who have the capacity to excel.

Unlike physical hunger, or disease control, or even economic development, the crucial importance of quality mathematics and mathematics education in the developing world is often not given its due by governments, international agencies or, in many cases, in what we ourselves say and do.

And so we welcome all initiatives to enhance support for mathematical activities in the developing world.

A resolution before this General Assembly:

“The U.S., French, British and Norwegian Adhering Bodies respectfully request the IMU Executive Committee to study the feasibility of convening a Donor’s Conference as a satellite to ICM 2014.

Preliminary conference planning during 2011-12 would involve identifying long-term success stories and their agents, potential donor foundations, agencies and governments, and professionals capable of organizing such a conference and of framing a persuasive case for the benefit to the profession, and to mankind, of mathematical development in the emerging world.”

Sources:

Herbert Clemens
Shrikrishna G. Dani
Janhavi Joshi (CDC Secretariat at Ohio State)

Vote on the CDC Terms of Reference 2010

The proposal of new CDC Terms of Reference was already approved by postal ballot in 2009. After some editorial revision, the GA was requested to vote on the revised version of the Terms.

The General Assembly approved the CDC Terms of Reference.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

4. Future IMU Stable Office

**4.1. Presentation of the proposal to install a stable office,
including proposal of the resulting changes of the Statutes (paragraphs 28, 29)**

Presentation by Ragni Piene, Chair of the Stable Office Committee

GA 2006 Resolution 11:

The General Assembly recommends that the incoming Executive Committee of the IMU studies the establishment of stable administrative structure and funding mechanisms, including possible fund-raising, for the support of the expanding IMU activities, and report to the 2010 General Assembly with concrete proposals.

IMU EC actions:

- October 2007: the EC launched a bid to host the Stable Office
- Ten institutions showed their interest
- By end of 2008, six serious proposals
- January 2009: the Stable Office Committee (SOC) formed, with members John Ball, Salah Baouendi, László Lovász, Ragni Piene (chair)
- Selected three finalists: Fields Institute (Toronto), IMPA (Rio de Janeiro), WIAS (Berlin)
- The SOC and the EC found that each of these would provide IMU with an excellent office
- The EC resolved that the GA should decide matters according to the following procedures:

Proposed Resolution I:

The General Assembly endorses the establishment of a Stable Office for the International Mathematical Union.

Proposed Resolution II:

The General Assembly endorses the following changes in the Statutes of the Union.

28. The Secretary of the Union shall act also as its Treasurer, unless the Executive Committee appoints ~~one of its Members at Large for that purpose.~~ another person for this position.

29. The legal domicile of the Union shall be located at the offices of the ~~Secretary.~~ Union.

(With the new wording of paragraph 28, the Executive Committee will have the option to appoint the Office Manager of the Stable Office or another mathematician from the (or a neighboring) institution as a Treasurer.)

Proposed Resolution III:

The General Assembly expresses its gratitude to all institutions which showed their support for IMU by putting in a bid or otherwise considering the possibility of hosting our Stable Office.

The procedure

- Presentations from each of the three institutions
- Report from the SOC's site visits and its assessment of the bids
- Time for discussion and questions
- Vote on Proposed Resolution I
- If favorable vote, then vote on Proposed Resolution II
- Vote on Proposed Resolution III
- After lunch, (eventual) vote to decide on the location of the Stable Office. (The vote will be by written ballots, and in two rounds unless one site gets more than 50% of the cast votes.)

4.2. Presentations of the IMU Stable Office candidates

4.2.1. Fields Institute, Toronto

Presentation by Edward Bierstone

“I think that the IMU would find its perfect home at the Fields Institute. I know no other institution where I feel more at home”

—*Stevo Todorovic (Paris VII and Toronto)*

WHY A STABLE OFFICE?

Institutional memory

- promotion of international cooperation
- celebration of great research achievements

Outreach

- to young people in the developing world
- to governments and scientific organizations

The Fields Institute is in a unique position to advance both aspects of the IMU's mission. The Institute combines tradition and experience with openness and diversity.

“I love the architecture with light-filled lecture halls, afternoon tea next to the fireplace, Coxeter's piano, and the beautiful spiral stairs”

—*Balint Virag (Toronto)*

“Of all places where mathematicians enjoy quality time to be creative, Fields is one of the best”

—*David Brydges (Past-President, International Assoc. Math. Physics)*

RECENT DISTINGUISHED LECTURERS

Lai-Sang Young, (Courant); David Cox, (Oxford); Persi Diaconis, (Stanford); Eva Tardos, (Cornell); Alain Connes, (Collège de France); Timothy Gowers, (Cambridge); Hendrik Lenstra, (Leiden); Shafi Goldwasser, (MIT, Weizmann Inst.); Jean-Christophe Yoccoz, (Collège de France); Yum-Tong Siu, (Harvard).

SOME RECENT PROGRAMS

Arithmetic and Hyperbolic Geometry, Foundations of Computational Mathematics, Mathematics in Quantum Information, Dynamics and Transport in Disordered Systems, Mathematics of Drug Resistance in Infectious Diseases

“What is most impressive about the Fields Institute is the diversity of activities, spanning all mathematically based research”

—Allan Borodin (Toronto)

FIELDS INSTITUTE PARTNERS

CRM, Perimeter Institute, PIMS, MITACS, Carleton University, McMaster University, U Ottawa, University of Toronto, University of Waterloo, Western, York University.

SOME FACULTY AT PARTNER UNIVERSITIES

Henry Kim, Nancy Reid, Jeremy Quastel, Yael Karshon, Jim Arthur, Walter Craig, Stephen Cook, Larry Guth, Robert McCann, Lisa Jeffrey

FIELDS FUNDING

Annual budget \$4.5 million: Ontario, NSERC/CRSNG, NSF

Additional funding: University of Toronto, CMS/SMC, Toronto

No other city better represents the world’s population in a single place.

“...we all enjoyed the atmosphere inside the institute and at cafes and restaurants nearby”

—Andrew Granville (U. Montréal)

Canadian Prime Minister Harper announces \$20 million funding for mathematics institutes in Africa.

FIELDS INSTITUTE OFFER

- 1 Administrative Positions
- 2 Space and Facilities
- 3 Archive
- 4 Fields-IMU-Perimeter Fellowship

1 THREE STAFF POSITIONS

- General administrator
- Joint administrator of ICMI and CDC
- Two half-time positions (financial administration and IT support)

2 OFFICE AND MEETING SPACE

3 ARCHIVE

The University of Toronto has one of the world’s largest university libraries with top-notch archiving and digitizing services

Michael Doob, (University of Manitoba)

ORIGINAL BRONZE CAST OF FIELDS MEDAL

4 FIELDS-IMU-PERIMETER FELLOWSHIP

Neil Turok (Director, Perimeter Inst. and founder, African Inst. Math. Sci.)

Eric-Martial Takougang (AIMS graduate, current Ph.D. student)

“I was a graduate student when the Fields Institute was founded...

it became a tremendous positive force in my career and those of my colleagues”

—Izabella Laba (UBC)

OFFICE MANAGER

Kumar Murty (University of Toronto, Chennai and Tata Institutes)

IMU VP NOMINEE

Christiane Rousseau (Université de Montréal)

“I am proud of what the Fields Institute has contributed to mathematics, here at Toronto, in Canada, and internationally”

—*Jim Arthur, Past-President, Amer. Math. Soc.*

Experience, global outreach, openness and diversity

www.fields.utoronto.ca/IMU/gainfo.pdf

4.2.2. IMPA, Rio de Janeiro

Presentation by Cesar Camacho

IMU @ IMPA

Choosing a permanent seat for the IMU is a momentous decision that must be made with the long term future of the Union at heart

Why IMPA as a seat for the IMU

- IMU aims to promote the development of Mathematics and the dissemination of mathematical knowledge in all parts of the globe
- Mathematical talent is uniformly distributed among the world population but Mathematics is not developed uniformly
- The presence of the developing world in the IMU remains unsatisfactory
- IMPA is committed to the development of Mathematics across Brazil and the whole Latin American region
- As the host of the IMU permanent office, IMPA will be uniquely placed to expand its action from the regional to the world stage

What we are

- A center for excellence located in a developing country
- A research center and graduate school with strong scientific links around the world
- Located in Rio de Janeiro, the heart of academic and cultural Brazil
- Committed to the development of Mathematics across the country and the whole region
- Part of IMPA's mission is to recruit young talented people to Mathematics
- IMPA sponsors an annual Mathematical Olympiad for schools in Brazil involving 20 million students, the largest in the world

What we offer

- Stable substantial funding: USD 800,000 per year
- All physical and human resources needed: office space, staff, equipment, archives, computers, websites
- Support for the mobility of IMU officials
- Broad plan of activities that will greatly enhance the Union's presence around the world

Plan of Activities:

IMU Annual World Conferences

IMU/IMPA Visitors Program

IMU activities in developing countries

IMU Archive Project

IMU Annual World Conferences *in the developing world:*

Northern Africa & Middle East
Central & Southern Africa
Indian Subcontinent
Central Asia
Far East & Pacific
Latin America

IMU Annual World Conferences

IMU/IMPA Visitors Program

*for mathematicians from both developed and developing countries to visit Rio de Janeiro
USD 250,000 per year*

IMU Annual World Conferences

IMU/IMPA Visitors Program

IMU activities in developing countries

*in collaboration with CDC
USD 200,000 per year*

IMU Annual World Conferences

IMU/IMPA Visitors Program

IMU activities in developing countries

IMU Archive Project

4.2.3. WIAS, Berlin

Presentation by Alexander Mielke, Jürgen Sprekels, Günter Ziegler

The stable IMU Office in Berlin: the German bid

“Wind of Change” in Berlin (since 1989):

Fall of the Berlin Wall 1989

ICM 1998

German Year of Mathematics 2008

WIAS, DMV, FU, HU, TU, U Potsdam, ZIB, MATHEON, BMS

Location:

- Central Europe – good flight connections
- In the heart of the German capital
- Close to governmental buildings, scientific organisations, funding agencies, etc.

Berlin-Brandenburg Academy of Sciences, WIAS main building, WIAS second location

The Offer:

- Sufficient space: 370 sqm
- Fully equipped, ready to use
- Up-to-date IT facilities

Office 1-5, Meeting Room, Reading Room, Archive

Head of Office, IMU Treasurer: A. Mielke

General Administration, Adm.Supp. ICMI/CDC, Financial Administration, IT Support/
Librarian/Archive

Full back-up for all positions by permanent WIAS staff

Financed by special grant of German government (appr. 0.5 Mio. €per year)

Commitments:

1. Core Funding:
City of Berlin, Federal Ministry of Education and Research
Dr. Angela Merkel, Chancellor of Germany
Prof. Annette Schavan, German Minister of Education and Research
2. Additional funding and further support
 - Einstein Foundation (1 Mio. €grant)
 - German Research Foundation (DFG)
 - Alexander von Humboldt Foundation
 - Deutsche Telekom Foundation
 - Stifterverband für die Deutsche Wissenschaft
 - Berlin-Brandenburg Academy of Sciences and Humanities (support for IMU archive)

Backbone:

- WIAS is part of a research organisation with more than 1,350 employees
 - Experienced administration (75 persons)
 - Access to further services such as lawyers, project management, public relations services, etc.
- DMV Head Office at WIAS
 - DMV Media and Public Relations Office

Players:

We are looking forward to serving the IMU !

C. Bär (DMV, U Potsdam), H. Baum (HU), P. Deuflhard (ZIB, FU), H. Föllmer (HU), M. Grötschel (ZIB, TU), D. Knees (WIAS), J. Kramer (HU, BMS, DMV) G. Huisken (AEI, FU), B. Lutz-Westphal (FU), V. Mehrmann (TU, MATHEON), K. Polthier (FU, BMS), C. Schütte (FU, MATHEON), B. Wagner (WIAS), H. Yserentant(TU)

4.3. Report of Stable Office Committee (SOC)

Report by Ragni Piene

SOC was formed in January 2009, with members Ball, Baouendi, Lovász, Piene. For impartiality reasons, IMU Secretary Martin Grötschel (Berlin) and EC Member Marcelo Viana (Rio) were excluded from all EC dealings with SO matters.

SOC considered the six proposals from

- ICTP (Trieste, Italy)
- AIM (Morgan Hill, USA)
- EPLF (Lausanne, Switzerland)
- Fields Institute (Toronto, Canada)
- IMPA (Rio de Janeiro, Brazil)
- WIAS (Berlin, Germany)

and found that three were better suited than the others: Fields, IMPA, WIAS.

The site visits (2009)

- WIAS May 8 (Ball, Lovász, Piene)
- IMPA October 6–7 (Ball, Piene)
- Fields October 8–9 (Ball, Piene)

At each site we met with the director, academic and administrative staff, members from surrounding mathematical community, politicians, etc. We were shown the proposed site of

the office spaces and explained how the office would be run. We were given relevant information concerning finances and formal setup.

Our main concerns:

Firstly

- the commitment of the people and the finances — especially with respect to long term stability.

Also

- legal issues and the functioning of the office
- development of work for the commissions ICMI and CDC
- accessibility (visa issues)
- possibilities for expansion and fundraising

Assessment: An oral summary of the views of the Stable Office Committee was given, under the headings:

1. The people
2. Finances
3. Office functions
4. CDC, ICMI, Archives

The Stable Office Committee was convinced that all three sites would be able to fulfill the needs of IMU, and that the small differences in details were in favor of different bidders.

Conclusions:

The SOC and the EC found that all three bids are very generous and impressive, and that therefore the choice of the site should be made by the General Assembly.

Finally, we hope that, regardless of the outcome of the vote, the bidding institutions will continue to offer their support to IMU.

4.4. Question time

The participants of the General Assembly were invited to ask questions concerning the three bids, R. Piene moderated the question time, the presenters of the stable office bids and R. Piene and the President and Secretary answered the questions. The discussion was about the longevity and stability of financial support, the immediate connection and communication between the secretary and the office, balanced distribution of meeting places on the continents, the archive and presence of IMU on the Internet, visa problems, the constitutional position of the staff in the stable office, the desirability of establishing a permanent office, a possibly more distributed system of different functions. The French delegation declared that they were not convinced of the need of establishing the stable office. Also the UK and Indian delegations were doubtful to some extent. The EMS representative strongly recommended to install a permanent office, the representatives of ICIAM and of the former IMU secretariat in Brazil also supported the proposal. The Australian delegation suggested to review the performance of the stable office in 2018 and to add this to the motions to be passed by the GA.

4.5. Vote on Stable Office (Yes or No) + Vote on Statutes change para 28 and 29

The General Assembly agreed to the suggested amendment (*review the arrangements in 2018*) of proposed resolution I.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

The General Assembly approved the amended *Resolution I*.

The General Assembly endorses the establishment of a Stable Office for the International Mathematical Union. The arrangement will be reviewed by the General Assembly in 2018.

VOTE (by show of hands): IN FAVOUR = 119, OBJECTIONS = 9, ABSTENTIONS = 4

The General Assembly approved *Resolution II* of the Stable Office Committee.

The General Assembly endorses the following changes in the Statutes of the Union.
28. The Secretary of the Union shall act also as its Treasurer, unless the Executive Committee appoints one of its Members-at-Large for that purpose, another person for this position.
29. The legal domicile of the Union shall be located at the offices of the Secretary, Union.

VOTE (by show of hands): IN FAVOUR = 131, OBJECTIONS = 1

The General Assembly approved *Resolution III* of the Stable Office Committee.

The General Assembly expresses its gratitude to all institutions which showed their support for IMU by putting in a bid or otherwise considering the possibility of hosting our Stable Office.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

The 3 resolutions were passed on to the GA Resolutions Committee.

5. Vote on the IMU Stable Office candidate institutions

The GA delegates proceeded to the vote on the IMU Stable Office candidate institutions on written ballots.

6. Review of the activities of the Union (part 2)

6.1. CEIC and electronic IMU, vote on Best Practices document

Presentation by John Ball, Chair of CEIC

Membership: John Ball (Chair and EC rep), Olga Caprotti, James Davenport, Michael Doob, Carol Hutchins, Peter Olver, Ulf Rehmann.

2011-14: Peter Olver (Chair), Thierry Bouche, Olga Caprotti, James Davenport, Carol Hutchins, László Lovász (EC rep), Ravi Vakil.

Members who retired in 2007, 2008: Jonathan Borwein (Chair), David Eisenbud, John Ewing, Alf van der Poorten.

The committee met in Providence 2007, Budapest and Oxford 2008, Minneapolis 2010.

Terms of reference:

- (a) Reporting regularly to the EC, advising it on aspects of IMU operations related to information and communication, including financial implications, and keeping it informed of new developments.
 - (b) Reviewing the development of electronic information, communication, publication, and archiving so as to keep the EC abreast of current and emerging issues. Publicising relevant developments to the wider community via IMU on the Web and other methods.
 - (c) Advising the EC about potential opportunities to endorse standards ('best practice recommendations') on issues related to publication and communication, including such matters as the use of software and data repositories.
 - (d) Advising the EC about potential opportunities to foster the growth of electronic infrastructure, and selectively creating tools for this purpose.
- (As amended by IMU Executive Committee, Bangalore, 2010.)

Some issues addressed by CEIC

- **Archiving of the IMU records (paper and electronic).** The IMU archivist Guillermo Curbera manages the paper records, currently in Helsinki, which will be transferred to the stable office. Most business is now done electronically, and so the archiving of the electronic records, for both historical and current access reasons, is important and raises difficult issues being faced by many organizations. An augmented subcommittee of CEIC reported to the EC. Implementation awaits the decisions on the stable office. The immediate priority is to ensure that no electronic material is lost. Curbera will also interview past IMU officers at the ICM as a historical record.
- **Copyright agreements for ICM 2010** (including for videoing) were drafted and adopted.
- **Digitization of ICM Proceedings.** Remarkable work has been done by Keith Dennis and Ulf Rehmann to digitize all proceedings of the International Congress of Mathematicians from 1893-2006 (after which the Proceedings were born digital), and to obtain the copyright where possible. This will be announced at the ICM.
- **IMU-Net.** This is the electronic newsletter of IMU (you are encouraged to subscribe if you do not already). It is proposed that in future it becomes a blog as well. There is a section *IMU on the Web* on CEIC matters (currently moderated by Carol Hutchins).

Round Table on *The Use of Metrics in Evaluating Research*

26 August 18.00-20.00

Panellists: László Lovász (Chair), Douglas Arnold, Frank Pacard, José-Antonio de la Peña, Malcolm MacCallum.

Follow-up to IMU/ICIAM/IMS *Citation Statistics* report.

- Are impact factors and other such indices good measures of journal quality, and should they be used to evaluate research and individuals?
- What can be done about unethical practices like impact factor manipulation? (See *Nefarious Numbers*, D. Arnold & K. Fowler.)
- Is there a role for metrics in evaluating research?
- Are there better alternatives?

Best Current Practices for Journals

Document written by CEIC and Doug Arnold.

First Draft February 2010

Considered by EC late February 2010

Revised version widely circulated to editors, publishers, individuals for comment, leading to substantial further revision.

Final draft approved by EC July 2010.

Presented to GA for endorsement.

How should a good mathematics journal be organized and managed?

- Journals remain an important tool of mathematical research through quality control, improving content and presentation, dissemination and archiving.
- Basic principles of transparency, integrity and professionalism.
- Rights and responsibilities of authors, referees, editors and editorial boards, and publishers (e.g. openly available description of peer review and publication process, transmission of referee reports in full to authors, need for procedures for handling unethical behaviour.)

The GA discussed the document on best practices. There was controversy about the sentence on page 3 “We believe that in best practice such comments should be used exceptionally, rather than as a general procedure.” The majority of delegates voted in favor of not deleting this sentence and make no changes to the document.

The General Assembly endorsed the Best Current Practices for Journals subject to changes that might be made by CEIC and endorsed by the EC.

J. Ball reported that IMU and ICIAM are proposing setting up a working group on ranking journals. This was commented by the ICIAM president R. Jeltsch and extensively explained by D. Arnold on the basis of his paper “Nefarious Numbers”. The GA was in favour of the proposal.

6.2. ICMI presentation

Presentation by Bill Barton, President of ICMI

Present Representing ICMI

Bill Barton (NZ)

President of ICMI

Jaime Carvalho e Silva (Portugal)

Secretary-General of ICMI

Mathematics Education in the International World of Mathematics

- Special section at ICM’s
 - Teaching and history of mathematics (1900)
 - Mathematics Education and Popularization of Mathematics (≥ 2002)
- Founding of ICMI @ ICM-Roma, 1908
 - Felix Klein, 1st President;
 - International (6-year) study of secondary education in 18 countries.
- IMU re-formed in 1952, with ICMI as a sub-commission
- ICMEs, – ICME-1, Lyon, 1969 ...to ... – ICME-12, Seoul, Korea, 2012

Organization & Governance of ICMI

- Executive Committee
 - President, two Vice Presidents, Secretary-General, five members-at-large, IMU representatives. The EC meets face-to-face once annually.
- Members (85)
 - The 68 member countries of IMU, plus 4 more associate member countries, plus 13 non-IMU affiliated countries.

- Finances - Modest! IMU gives ICMI a subvention, as a sub-commission of IMU. Individual and institutional participants in ICMI programs contribute much (>50%) *pro bono* effort and financial support.

Relations with IMU

- Representation:
 - (a) IMU liaison member on ICMI EC, plus ex officio members;
 - (b) ICMI representation at parts of IMU EC meetings, and at GA;
 - (c) Consultation with ICMI regarding the Mathematics Education and Popularization Section of the ICMs.
- Elections: This is the first Executive elected by the ICMI General Assembly from a slate constructed by a nominating committee with strong representation from IMU. Process went very well.
- Collaboration: Administration, Development activities, Special Projects (Pipeline Project, Klein Project).

Affiliated Study Groups

In chronological order of affiliation

- HPM – History and Pedagogy of Mathematics (1976)
- PME – Psychology of Mathematics Education (1976)
- IOWME – International Organization of Women and Mathematics Education (1987)
- WFNMC – World Federation of National Mathematics Competitions (1994)
- ICTMA – International Study Group for Mathematical Modeling and Applications (2003)

Affiliated Societies

In chronological order of affiliation

- CIAEM – Inter-American Committee on Mathematics Education (2009)
- ERME – European Society for Research in Mathematics Education (2010)
- CIEAEM – International Commission for the Study and Improvement of Mathematics Teaching (2010)

Core Activities of ICMI

1. ICME Conferences
2. ICMI Regional Conferences
3. ICMI Studies
4. Development Activities
5. ICMI Awards

1. International Congresses on Mathematical Education (ICMEs)

- ICME-11, Monterrey, Mexico, July, 2008
2526 Participants, 88 countries. Proceedings due at the end of this year
- ICME-12, Seoul, Korea, 8-15 July, 2012
- ICME-13, Bidding in process, decision by 2011

2. ICMI Regional Conferences

- EARCOME: China, 2005; Malaysia, 2007; Tokyo 2010
- CIAEM: Brazil, 2003; Mexico, 2007; Brazil 2012

- EMF: Tunisia, 2003; Canada, 2006; Dakar 2009
- AFRICME: S. Africa, 2005; Kenya, 2007; Botswana, 2010

3. *ICMI Studies*

- #18 Statistics Education in School Mathematics
- #19 Proof and Proving in Mathematics Education
- #20 Educational Interfaces between Mathematics and Industry (EIMI) (joint with ICIAM)
- #21 Mathematics Education & Language Diversity
- #22 (Task Design)
- #23 (In the area of Primary Mathematics)

4. *Development Activities*

- Solidarity Program – founded by Miguel de Guzman
- Solidarity Taxes – 10% of registration at ICMEs
- CDC Collaboration
- UNESCO Activities – “Experiencing Mathematics” Exhibition,
– Capacity Development Project

5. *ICMI Awards*

- Launched in 2003
- Awarded in odd numbered years and presented at ICMEs
 - Felix Klein Award: For lifetime achievement: Guy Brousseau, France, 2003; Ubiratan d’Ambrosio, Brazil, 2005; Jeremy Kilpatrick, USA, 2007; Gilah Leder, Australia, 2009
 - Hans Freudenthal Award: For a major program of research in mathematics education during the past decade: Celia Hoyles, UK, 2003; Paul Cobb, USA, 2005; Anna Sfard, Israel, 2007; Yves Chevallard, France, 2009

Pipeline Project

- Final report now available.
- Serious data collection and analysis issues.
- Globally, there are no serious concerns except, possibly, with respect to teachers.
- Nationally, there are some countries that have problems. Government policy and economic factors are the main determinants.
- Recommendations:
 - National structures for data be put in place.
 - ICMI maintains a website for international comparisons.
 - Possible follow-up on the quality of the Pipeline (especially changes over time).

Klein Project <<http://kleinproject.org>>

- Design Group has met three times.
- Klein meetings have been held in Portugal, Spain, UK, Brazil, USA.
- Book design decided, authoring under way.
- Website established, contributions sought.
- Considerable interest and excellent discussion between mathematicians, mathematics educators, and teachers.

ICMI thanks IMU for its considerable support and excellent relations. We look forward to continued work together.

6.3. ICHM presentation

The President referred to IMU Bulletin No. 58 concerning the report of activities of the International Commission on the History of Mathematics.

6.4. IMU finances/dues

Presentation by Martin Grötschel, IMU Secretary

IMU finances 2009 (as an example)

Statement of income and expenditure 2009

	A	F	G	H	I
1	INTERNATIONAL MATHEMATICAL UNION				
2					
3	Statement of Income and Expenditure*– 2009				
4	for the year ended December 31, 2009				
5					
6		Budget 2009	Actual 2009	Budget 2009	Actual 2009
7		CHF (Swiss Franc)		EUR (Euro)	
8	Expenses				
9	Schedule A:				
10	Secretarial help, IMU office	22.660	0	15.234	0
11	Secretarial help, President	5.150	1.968	3.462	1.323
12	Accountant	9.270	0	6.232	0
13	ICMI	15.450	15.378	10.387	10.337
14	CDE	6.180	2.391	4.155	1.607
15	Office expenses (including postage)	16.480	4.527	11.079	3.043
16	Travel expenses of the EC	30.900	24.407	20.773	16.406
17	President's and Secretary's expenses	4.120	4.279	2.770	2.876
18	Contribution to ICSU	9.785	9.844	6.578	6.617
19	IMU Bulletin	1.500	3.541	1.008	2.380
20	Audit fee	8.755	15.182	5.886	10.205
21	General Assembly	4.120	0	2.770	0
22	World Directory of Mathematicians	0	0	0	0
23	Contingencies	2.060	22.708	1.385	15.264
24					
25	Subtotal of Schedule A	136.430	104.225	91.718	70.057

Statement of Income and Expenditure*– 2009				
for the year ended December 31, 2009				
	Budget 2009	Actual 2009	Budget 2009	Actual 2009
	CHF (Swiss Franc)		EUR (Euro)	
8	Expenses			
9	Schedule A:			
10	22.660	0	15.234	0
11	5.150	1.968	3.462	1.323
12	9.270	0	6.232	0
13	15.450	15.378	10.387	10.337
14	6.180	2.391	4.155	1.607
15	16.480	4.527	11.079	3.043
16	30.900	24.407	20.773	16.406
17	4.120	4.279	2.770	2.876
18	9.785	9.844	6.578	6.617
19	1.500	3.541	1.008	2.380
20	8.755	15.182	5.886	10.205
21	4.120	0	2.770	0
22	0	0	0	0
23	2.060	22.708	1.385	15.264
24				
25	136.430	104.225	91.718	70.057

Statement of Income and Expenditure*– 2009				
for the year ended December 31, 2009				
	Budget 2009	Actual 2009	Budget 2009	Actual 2009
	CHF (Swiss Franc)		EUR (Euro)	
8	Expenses			
9	Schedule A:			
10	22.660	0	15.234	0
11	5.150	1.968	3.462	1.323
12	9.270	0	6.232	0
13	15.450	15.378	10.387	10.337
14	6.180	2.391	4.155	1.607
15	16.480	4.527	11.079	3.043
16	30.900	24.407	20.773	16.406
17	4.120	4.279	2.770	2.876
18	9.785	9.844	6.578	6.617
19	1.500	3.541	1.008	2.380
20	8.755	15.182	5.886	10.205
21	4.120	0	2.770	0
22	0	0	0	0
23	2.060	22.708	1.385	15.264
24				
25	136.430	104.225	91.718	70.057

	Budget 2009	Actual 2009	Budget 2009	Actual 2009	
	CHF (Swiss Franc)		EUR (Euro)		
25	Subtotal of Schedule A	136.430	104.225	91.718	70.057
26					
27	Schedule B:				
28	IMU non-CDE conference support	20.000	0	13.445	0
29	ICMI scientific activities	27.810	27.682	18.696	18.607
30	CDE scientific activities	115.000	128.918	77.311	86.656
31	CDE support staff	56.000	86.029	37.647	57.827
32	CEIC scientific activities	25.000	1.535	16.807	1.032
33	Website support	6.253	2.150	4.204	1.445
34	ICM Site Committee	2.000	4.496	1.345	3.022
35	Program Committee for ICM	8.240	19.995	5.540	13.440
36	Subvention to ICM	28.840	87.313	19.388	58.690
37	Prize Committees (subvention)	11.100	7.709	7.462	5.182
38	Awards	0	15.621	0	10.500
39	Travel grants (young & senior)	61.000	0	41.008	0
40	Media Relations	3.500	0	2.353	0
41	Subtotal of Schedule B	364.743	381.448	245.206	256.402
42					
43	Total Expenses (A & B)	501.173	485.673	336.924	326.460

	Budget 2009	Actual 2009	Budget 2009	Actual 2009	
	CHF (Swiss Franc)		EUR (Euro)		
45	Income				
46	Membership dues	371.304	398.360	249.617	267.769
47	ICSU Grant	0	0	0	0
48	Special Development Fund	32.000	36.175	21.513	24.316
49	Interest on bank accounts	16.000	7.015	10.756	4.715
50	Donations	59.220	60.039	39.812	40.357
51	Other income	0	45.039	0	30.377
52	Draw from Reserves	22.649	0	15.226	0
53	Return to Reserves	0	0	0	0
54	Total Income	501.173	546.628	336.924	367.535
55					
56	Income less Expenses	0	60.955	0	41.075
57					
58	Transition to P&L Statement:	Transfer to liabilities from donations not yet spent		-24.316	
63		Excess (deficit) of income over expenditure:		16.759	
64					
65	Actual Euro Income and Expenses converted to Swiss Franc, using the December 31, 2009 rate				
66	of 1 Euro = 1,4877 Swiss Franc				
67					
68	*Based on the corrected version of the Budget for 2007-2010, published in IMU Bulletin No. 55, 2007				

IMU finances/dues

Some significant CHF expense changes 2009:

- Audit fee: budget 8.755, truth 17.000
- Contingencies: budget 2.060, truth 22.708

Some significant CHF income changes 2009:

- Almost all countries paid their dues (positive)
- Interest: budget 16.000, truth 7.009

Development of IMU net assets

Net assets	31.12. 2005:	562.289 \$
Transfer	01.01. 2007:	307.465 €
Net assets	31.12. 2009:	499.543 €

International Mathematical Union							
Proposed Budget for 2007-2010 (Swiss Francs)							
Expenses	Approved Budgeted for 2003-2006			5% Dues increase	5% Dues increase	5% Dues increase	5% Dues increase
	1995-1998	1999-2002	2003-2006	2007	2008	2009	2010
Draw from Reserves				45,545	28,778	11,039	0
Return to Reserves							-7,672

Positive financial development only because of:

- Self exploitation of all IMU representatives
- Travel costs often paid from other sources (economy air fair)
- Significant contributions of all institutions that have hosted IMU activities (e.g., EC meetings)
- Almost no IMU expenditure for the IMU office in Berlin (DFG grant not represented in IMU budget ~ 200.000€ for 4 years)
- Secretarial help for IMU officers provided by local institutions (e. g., ICMI: Hodgson, Barton,...)

In kind contributions by many volunteers

Excel Table of IMU budget plan 2011-2014,
see Bulletin 58

Exchange rate development during the last 3½ years:
1 € ~ 1.21 US\$ – 1.58 US\$ (contingencies problem)

IMU finances/dues

2010 Base Unit Contribution: 1605 CHF ~ 1080 € ~ 1550 US\$

1 € ~ 1,4877 CHF (31.12.2009)

Proposal: 2% increase annually

2% increase	No. of Unit Contributions	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
Unit Contribution		1637	1670	1703	1737
Group I	1	1637	1670	1703	1737
Group II	2	3274	3340	3406	3474
Group III	4	6548	6680	6812	6948
Group IV	8	13096	13360	13624	13896
Group V	12	19644	20040	20436	20844

7. Ballot result of vote on IMU Stable Office

The IMU President L. Lovász announced the result of the vote on the location of the IMU Stable Office.

VOTES for

WIAS, Berlin	75
IMPA, Rio de Janeiro	37
Fields Institute, Toronto	23

The General Assembly decided that WIAS, Berlin, will get the right to host the Stable Office of the IMU.

The President congratulated the WIAS and thanked the three institutions for their tremendous efforts. The WIAS Director J. Sprekels thanked the GA in a short speech for their vote.

8. Nominating Committee

8.1. Introduction of the Nominating Committee and explanation of the nominating process

8.2. Presentation of slates proposed by the Nominating Committee

8.2.1. IMU President

8.2.2. IMU Secretary

8.2.3. IMU Vice Presidents and IMU EC Members-at-Large

8.2.4. President, Secretaries and Members-at-Large of CDC

8.2.5. IMU Representatives to ICHM

Presentation by David Mumford, Chair of the Nominating Committee

D. Mumford presented the members of the IMU Nominating Committee (NC), he explained the process of the NC nomination and the work of the NC to put forward the slates. He introduced to the GA the slates that the Nominating Committee has put together from all the nominations received and outlined the motivation behind.

8.3. Nominations from the floor

There were no nominations from the floor.

9. Further Statutes changes, explanation and votes

M. Grötschel reported about the successful use of electronic voting within the EC and asked whether it would be an option to try to extend electronic voting to the Adhering Organizations. The GA was in favor of this proposal.

M. Grötschel introduced the proposed changes in the Statutes. Most changes were editorial, some naming schemes were corrected, but no substantial changes were made

The General Assembly approved the proposed Statutes changes.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

10. Presentation of the Election Committee's proposals and Elections

D. Mumford presented the proposals of candidates to the General Assembly. The candidates who were present at the meeting introduced themselves to the audience, those who were not at the meeting were introduced by the EC, D. Mumford or some colleagues.

10.1. Executive Committee (EC) of IMU

IMU Executive Committee (EC)

IMU President	Ingrid Daubechies (USA)
IMU Secretary	Martin Grötschel (Germany)
IMU Vice Presidents	Christiane Rousseau (Canada) Marcelo Viana (Brazil)
EC Members-at-Large (<i>8 candidates for 6 posts</i>)	Manuel de León (Spain) Yiming Long (China) Tetsuji Miwa (Japan) Cheryl E. Praeger (Australia) Claudio Procesi (Italy) Vasudevan Srinivas (India) John Francis Toland (United Kingdom) Wendelin Werner (France)

10.2. Commission for Developing Countries (CDC)

Commission for Developing Countries (CDC)

CDC President	José-Antonio de la Peña (Mexico)
CDC Secr. Policy	C. Herbert Clemens (USA)
CDC Secr. Grants	Srinivasan Kesavan (India)
CDC Asian Member (<i>2 candidates for 1 post</i>)	Hoang Xuan Phu (Vietnam) Jiping Zhang (China)
CDC African Member (<i>2 candidates for 1 post</i>)	Oluwole Daniel Makinde (South Africa) Wandera Ogana (Kenya)
CDC Latin Am. Member (<i>3 candidates for 1 post</i>)	Carlos Cabrelli (Argentina) Rafael Labarca (Chile) Márcio G. Soares (Brazil)

10.3. International Commission on the History of Mathematics (ICHM)

International Commission on the History of Mathematics (ICHM)

ICHM Representatives (<i>5 candidates for 2 posts</i>)	P. P. Divakaran (India) Wenlin Li (China) Jesper Lützen (Denmark) Peter M. Neumann (UK) Kim Plofker (USA)
--	---

10.4. Election of the 2011-2014 EC, CDC, and ICHM officers

The GA delegates proceeded to the vote on the IMU EC, the CDC, and the ICHM on written ballots which were then counted by the Tellers Committee.

11. Finance and Dues Committee

11.1. Recommendation

Report by Christiane Rousseau

Ch. Rousseau explained that the Finance and Dues Committee has looked into the report on finances and dues and the proposed dues increase and the budget proposal for the term 2011-2014. One difficulty of the financial planning has been the uncertainty about the stable office, however, the Committee recommended a 2% increase over the next four years. The Committee also recommended to adopt the proposed budget which has been established along the lines of previous years, but which should be restructured after 1 year in order to adapt it to current necessities. Then also the separation into Schedule A and B should be reviewed.

11.2. Balloting

The General Assembly approved the three motions proposed by the Finance and Dues Committee, that were to be included in the GA Resolutions.

Motion 1

That the increase of dues be 2% per year for the years 2011-2014, not to be revisited before the next meeting of the GA.

VOTE (by show of hands): IN FAVOR = 133, ABSTENTIONS = 2

Motion 2

That we operate in 2011 under the proposed budget, and that a new budget for 2012-2014 be submitted to vote to the Adhering Organizations by the end of 2011, under the constraints of resolution 1.

VOTE (by show of hands): IN FAVOR = 134, ABSTENTION = 1

Motion 3

That the EC be invited to revise the statutes concerning the distinction between general expenses (Schedule A) and special expenses (Schedule B).

VOTE (by show of hands): IN FAVOR = 133, ABSTENTIONS = 2

	No. of Unit Contributions	2011	2012	2013	2014
Unit Contribution		1,637	1,670	1,703	1,737
Group I	1	1,637	1,670	1,703	1737
Group II	2	3,274	3,340	3,406	3,474
Group III	4	6,548	6,680	6,812	6,948
Group IV	8	13,096	13,360	13,624	13,896
Group V	12	19,644	20,040	20,436	20,844

International Mathematical Union					
Proposed Budget for 2011-2014 (Swiss Francs)					
EXPENSES	Approved Budgeted for	2% Dues increase	2% Dues increase	2% Dues increase	2% Dues increase
Schedule A:	2007-2010	2011	2012	2013	2014
Secretarial help, IMU Secretary	22.660	20.000	20.000	20.000	20.000
Secretarial help, IMU President	5.150	8.000	8.000	8.000	8.000
Accountant	9.270	9.500	9.500	9.500	9.500
ICMI	15.450	16.000	16.000	16.000	16.000
CDC	6.180	6.300	6.300	6.300	6.300
Office expenses (including postage)	16.480	16.800	16.800	16.800	16.800
Travel expenses of the EC	30.900	32.000	32.000	32.000	32.000
President's and Secretary's expenses	4.120	5.000	5.000	5.000	5.000
Contribution to ICSU	9.785	9.785	9.785	9.785	9.785
IMU Bulletin	1.500	2.200	2.200	2.200	2.200
Audit fee	8.755	17.000	17.000	17.000	17.000
General Assembly	4.120	5.000	5.000	5.000	5.000
IMU office transfer		17.500	17.500	17.500	17.500
Contingencies	2.060	50.000	50.000	50.000	50.000
Subtotal of Schedule A	136.430	215.085	215.085	215.085	215.085
Schedule B:					
IMU non-CDC conference support	20.000	3.750	3.750	3.750	3.750
ICMI scientific activities	27.810	40.000	40.000	40.000	40.000
CDC scientific activities	115.000	120.000	120.000	120.000	120.000
CDC support staff	56.000	7.500	7.500	7.500	7.500
CEIC scientific activities	25.000	21.000	21.000	21.000	21.000
Website support	6.253	8.000	8.000	8.000	8.000
ICM Site Committee	2.000	3.000	3.000	3.000	3.000
Program Committee for ICM	8.240	10.000	10.000	10.000	10.000
Subvention to ICM	28.840	29.420	29.420	29.420	29.420
Prize Committees (subvention)	11.100	12.000	12.000	12.000	12.000
Travel grants (young & senior)	61.000	62.220	62.220	62.220	62.220
Media Relations	3.500	4.000	4.000	4.000	4.000
Subtotal of Schedule B	364.743	320.890	320.890	320.890	320.890
Total Expenses (A & B)	501.173	535.975	535.975	535.975	535.975
INCOME					
Membership dues	390.015	435.442	444.220	452.998	462.042
ICSU Grant	0	0	0	0	0
Special Development Fund	32.000	30.000	30.000	30.000	30.000
Interest on bank accounts	16.000	1.000	1.000	1.000	1.000
Donations (Abel Fund)	59.220	56.000	56.000	56.000	56.000
Draw from Reserves (here in 2010)	3.938	13.533	4.755	0	0
Return to Reserves (here in 2010)	0	0	0	4.023	13.067
TOTAL INCOME	501.173	535.975	535.975	535.975	535.975
INCOME LESS EXPENSES		0	0	0	0

12. Review of the activities of the Union (part 3)

12.1. ICSU

Presentation by Deliang Chen, ICSU Executive Director

Recent ICSU Activities

Outline

- ICSU and its vision
- Strategic themes & ICSU's role
- Key priorities 2006-2011
- Engaging in ICSU: focusing on strategic planning

ICSU

- Founded in 1931, based on two earlier bodies known as the **International Association of Academies** (IAA; 1899-1914) and the **International Research Council** (IRC; 1919-1931)
- 121 **National Members** (representing 141 countries/regions), and 30 International Scientific **Union Members such as IMU**
- 19 **Interdisciplinary Bodies (e.g. WCRP, IGBP)**
- Unique **worldwide** access to intellectual resources



The ICSU Vision

“A world where science is used for the benefit of all, excellence in science is valued and scientific knowledge is effectively linked to policy-making. In such a world, universal and equitable access to scientific data and information is a reality and all countries have the scientific capacity to use these”

Strategic themes

Three inter-related themes:

International Research Collaboration ; Science and Policy ; Universality of Science

Key Priorities: 2009-2011

Consolidating/refocusing existing activities:

- Visioning process for Earth system research
- New World Data System (WDS) and Strategic Coordinating Committee for Information and Data (SCCID)
- Reviews of Regional Offices
- Science for policy

Implementing new programmes:

- Integrated Research on Disaster Risk (IRDR)
- Ecosystem Change and Society (PECS)
- [Health and Wellbeing in the changing Urban Environment]

Foresight and strategic planning:

- Strategic Planning for 2012-17 (incl. foresight analysis)
- Rio+20

ICSU Regional Offices

	Located	Inauguration date	Host Institution
Regional Office for Africa (ROA)	Pretoria, South Africa	September, 2005	National Research Foundation (NRF)
Regional Office for Asia and Pacific (ROAP)	Kuala Lumpur, Malaysia	September, 2006	Academy of Sciences Malaysia (ASM)
Regional Office for Latin America and the Caribbean (ROLAC)	Rio de Janeiro, Brazil	April, 2007	Brazilian Academy of Sciences (ABC)

Each RO has a Regional Director and receives strategic scientific guidance from a Regional Committee (RC)

Science for Policy

Regular UN engagement

- UN Commission for Sustainable Development
- UNEP and IPBES (Biodiversity and Ecosystems)
- UNESCO
- WMO

Policy oriented science programmes; Education and outreach e.g. IPY

Universality of Science

Strengthening national base

- Establishment of three Regional Offices with Regional Committees
- Expansion of National Membership from 103 in 2005 to 119 in 2010 covering 133 countries

Strengthen disciplinary base

- Process of strengthening social sciences input
- Efforts to further involve technology and engineering
- Closer contact with Unions (e.g. participation in Union GA)

Support partnerships within ICSU

- Grants programme

Freedom and responsibility (CFRS)

Union Engagement in ICSU

- Executive Board
- CSPR, CFRS
- Panels
- Consultations
- Linked initiatives
- Grants programme
- Regional Offices
- Interdisciplinary bodies

Strategic Planning



12.2. ICIAM

Presentation by Rolf Jeltsch, President of ICIAM

History and Facts

- World Organisation
- Society of Societies
- Full members are applied
- Associate members are general

Members

Continent	Full	Associate	Total
Europe	9	8	17
North America	2	2	4
Latin America	1	0	1
Asia	6	4	10
Australia & Oceania	1	0	1
World	1	0	1
Total:	19	13	34

Activities

- ICIAM Congresses, every 4 years, 1987,...
Paris, Hamburg, Edinburgh, Washington, Sydney,
2007 Zurich more than 3000 delegates
2011 Vancouver 18 – 22 July www.iciam2011.com
- ICIAM Prizes, since 1999
- Olga Taussky-Todd Lecture
- Support for Developing Countries, 3 – 4 conferences each year
- Projects: Quantitative assessment with IMU, IMS; EIMI with ICMI; Working group: ranking journals with IMU

ICSU - Application for Associate Membership

Why? Get involved in projects before these are defined

Need: Support of at least 9 ICSU members (at least 3 unions, 3 academies)

Motivate your academy to support application

New Members: Motivate societies in your country to become an ICIAM member

12.3. Friends of IMU, Itô Fund, and Fundraising

L. Lovász reported that the Friends of IMU (FIMU) was created recently and registered in the US as a 501(c)(3) organization, it is a charitable tax free organization with the goal to collect donations and use it for the purposes of IMU. At the moment there were two donations, one concerned the Chern Medal Award, the other one the donations by AMS members to support IMU activities in the developing world.

Board of Directors: David Mumford (chair), Jim Arthur, M. Salah Baouendi, Martin Grötschel (ex officio), László Lovász (ex officio).

L. Lovász expressed his thanks to the Chern Medal Foundation that financed the prize itself as well as basically covered the expenses of establishing this organization. L. Lovász also thanked the AMS which provided a lot of help during this process.

Y. Miyaoka reported that in 2006 K. Itô was awarded the Gauss prize which he donated to the IMU as a fund to support young researchers. In order to celebrate Itô's achievement the Japan Mathematical Society established its own fund, the Itô fund, with the aim to support young Japanese researchers as well as international research exchange programs. The fund has raised about 200000 \$ but this amount is not enough to support programs. It is still trying to collect money but under the present circumstances this is very hard, however, they are still committed to such activities.

M. Grötschel reported that the EC spent some time on thinking on how to raise more funds for IMU activities. There was some success with respect to raising money for work in the developing world. M. Grötschel mentioned contributions from the Norwegian Niels Henrik Abel Memorial Fund, the support from the Liverholme and Nuffield Foundations. He invited the GA participants to help IMU and make suggestions on possibilities to raise funds.

12.4. ICM 2010

12.4.1. Report of the Program Committee

Report given by Hendrik Lenstra, Chair of the Program Committee

According to the PC guidelines it was the main task of the Program Committee to come up with the list of invited, plenary, and sectional speakers for the ICM. They had to take into account balance among subfields of mathematics, gender balance and geographical balance, in particular representation of developing countries. H. Lenstra explained how the committee attempted to achieve these goals. He suggested that for the next Program Committee one person particularly knowledgeable about developing countries (Committee for Developing Countries) should be appointed. H. Lenstra thanked all the people who helped the Program Committee putting together the speaker lists.

12.4.2. Report of the EOC

Presentation by M. S. Raghunathan, EOC Chairman

Registration

- All delegates have to register at HICC (the venue of the Congress).
- Registration starts at 10 am on 18/08/2010 at HICC and closes at 8pm.
- Registration at venue on 19th will start at 8 am and closes at 10 am. It will be continued after 2 pm.
- Those arriving too late for registration in the morning on 19th can collect invitations for the inaugural function at the venue. You need to give your registration ID number and show

your photo ID. Please note that entry to the inaugural function is possible only with the invitation card.

Inauguration

- The Honourable President of India Shrimati Pratibha Patil has kindly consented to inaugurate the Congress and give away the prizes.
- The inaugural function will take place on August 19, 2010 at 11 AM in the Hyderabad International Convention Centre (HICC), which is the venue for the entire Congress.
- Among the dignitaries who would be attending the function are:
 - Shri E S L Narasimhan, Honourable Governor of Andhra Pradesh.
 - Shri K Rosaiah, Honourable Chief Minister of Andhra Pradesh.
 - Professor Syed Hasnain, Vice Chancellor, Hyderabad University and Member, Scientific Advisory Committee to the Prime Minister.

The Venue

- The venue is the Hyderabad International Convention Centre.

Programme of the Inaugural Function

10:55 Arrival of the President of India

11:00 National Anthem

11:02 Lighting of the Lamp

11:05 Welcome by Organising Committee Chair, Prof M.S. Raghunathan

11:08 Address by IMU President, Prof L. Lovász

11:12 Chief Minister, Govt of Andhra Pradesh, Dr. K. Rosaiah

11:15 Awards Ceremony

11:45 Address by the President of India, Smt. Pratibha Devisingh Patil

11:55 Vote of Thanks by Secretary, EOC - ICM 2010, Prof Rajat Tandon

11:57 National Anthem

12:00 Departure of the President of India

Prizes

- The prizes to be given away are: Fields Medals, Nevanlinna Prize, Gauss Prize and Chern Prize.
- As all of you are aware, the Chern Prize is a new prize instituted last year.
- All the prize-winners as well as the laudators chosen for them have accepted our invitation to attend the Congress and the inaugural function.

Leelavati Prize

- The (Local) Executive Organising Committee (EOC) instituted a one-time international prize called 'Leelavati Prize', for outstanding work for public outreach for mathematics.
- Nominations were sought from mathematical societies as well as renowned university departments and research institutions from all over the world.
- The committee to choose the awardee consisted of : Professors M S Narasimhan (chair), John Ball, László Lovász, Jacob Palis and M S Raghunathan
- The committee has decided to give the prize to Dr Simon Singh.
- The EOC proposed that the prize be given away at the closing function and the EC has accepted the proposal.

Programme of Talks

- The Programme Committee (PC) had drawn up a list of 20 plenary and 169 sectional talks to all of whom the EOC sent out invitations.
- One plenary speaker and seven sectional speakers dropped out after initially accepting our invitation.

- The schedule of invited talks is put up on our website.
- As is the tradition, there is no other activity when a plenary talk is in session.
- The plenaries will be held in a hall with a capacity of more than 3000.
- Sectional talks will take place in six or seven parallel sessions in rooms with a capacity of hundred or two hundred.
- There will be two special talks: the Abel Lecture by S R S Varadhan and the Noether Lecture by Idun Reiten.
- Short communications and poster sessions will take place in parallel with sectional talks.
- A speaker preparation room has been setup for speakers to prepare and upload their talks.

Proceedings

- The Sectional speakers were requested to submit their contributions to the Proceedings (online) by March 15, a deadline that was extended to April 15. Plenary Speakers were requested to submit by May 15.
- We received 154 submissions of abstracts by sectional speakers and these are printed in the programme book.
- 151 submissions of full manuscripts were received by the extended deadline and these are printed in three volumes - Volumes 2, 3 and 4.
- All three volumes are ready in both DVD and hard copy form.
- The DVDs will be given to all the delegates and hard copies to those who have ordered them.
- A limited number of hard copies of these volumes will be available for sale at the venue; orders may also be placed there.
- The plenary talks, lectures by the prize-winners and their laudators will be printed in Volume 1.
- Volume 1 in DVD form will be sent later to all delegates and hard copies to those who have ordered them.

Public Outreach

- On a suggestion from Professor Martin Groetschel two talks, one addressed to high school students and one to undergraduates, are being organised at the Global Peace Auditorium. They are:
 - Bill Barton, '*Where is mathematics taking us - an exciting ride into the future*'; Date and time: 23/08/10, 11 AM
 - Gunter Ziegler, '*Proof of the book*'; Date and time: 23/08/10, 3 PM
- On August 25, Simon Singh will be giving a 1 hour talk titled '*Fermat's Last Theorem - the making of a documentary*' at HICC at 5 PM.

Chess

- World Champion Viswanathan Anand will play simultaneous chess against 40 opponents on 24/08/10 at HICC.
- From among the delegates (and accompanying persons) who applied to play, 35 were chosen on a first-come first-served basis. The names can be found in our website.

English Play

- Two performances of the much acclaimed play 'A disappearing number' by the renowned theatre company Complicite of London will be staged at the Global Peace Auditorium in Hyderabad on August 21 and 22 at 7 PM.
- The play has for its back-drop the Hardy-Ramanujan story.
- Tickets for purchase were made available online from 07/08/10 to delegates, 4 days before plans were opened for the public.

Dance-drama

- A Bharatha Natyam dance-drama by the troupe Nrityashree of C V Chandrashekar is one of the cultural offerings to the delegates.
- The performance is scheduled for 20/08/10 at HICC at 6PM.

Music Concert

- There will be a Hindustani vocal music concert by the leading artiste Ustad Rashid Khan on 25/08/10 at 7 PM (venue: HICC).
- Prior to the concert, on 21/08/10 and 24/08/10, there will be two one hour lectures both at 5 PM on Indian Music appreciation by Prof. Sunil Mukhi.

Leelavati Ballet

- There will be repeated screenings of the DVD of the ballet Leelavati conceived and choreographed by the brilliant dancer, the late Chandraleka, on two days: August 21 and 26.

Closing Ceremony

- Shri Prithviraj Chavan Honourable Minister of Science of Technology, Government of India will be the chief guest and will present the Leelavati Prize to Dr Simon Singh
- Announcements about new EC and next ICM

13. IMU leadership ballot results

The President announced the results of voting on the IMU leadership 2011 - 2014

IMU Executive Committee (EC) 2011 - 2014

IMU President	Ingrid Daubechies (USA)
IMU Secretary	Martin Grötschel (Germany)
IMU Vice Presidents	Christiane Rousseau (Canada) Marcelo Viana (Brazil)
EC Members-at-Large	Manuel de León (Spain) Yiming Long (China) Cheryl E. Praeger (Australia) Vasudevan Srinivas (India) John Francis Toland (UK) Wendelin Werner (France)
Ex-officio Member (Past President)	László Lovász (Hungary)

Commission for Developing Countries (CDC) 2011 - 2014

CDC President	José-Antonio de la Peña (Mexico)
CDC Secretary Policy	C. Herbert Clemens (USA)
CDC Secretary Grants	Srinivasan Kesavan (India)
CDC, Asian Member	Hoang Xuan Phu (Vietnam)
CDC, African Member	Wandera Ogana (Kenya)
CDC, Latin American Member	Carlos Cabrelli (Argentina)

International Commission on the History of Mathematics (ICHM) 2011 - 2014

ICHM Representatives

Jesper Lützen (Denmark)

Kim Plofker (USA)

After some controversy about whether or not the detailed results of the vote (number of votes for each candidate) shall be announced or whether the tradition of not making the detailed results public shall be continued, a motion was put forward.

Motion 4:

That the results of the vote on the IMU leadership be read before the General Assembly.

VOTE (by show of hands): IN FAVOR = 9, AGAINST = 126

The General Assembly decided not to make public the detailed results of the vote on the IMU leadership.

14. Resolutions

14.1. Presentation of Resolutions Committee

Presentation by Freddy Dumortier, Chair of the Resolutions Committee

Resolutions of the IMU General Assembly 2010

Resolution 1

The General Assembly of the IMU expresses its deep gratitude to the Organizing Committee of the ICM 2010 chaired by M.S.Raghunathan and to the Organizing Committee of the General Assembly chaired by G. Misra for their excellent organization, their special efforts in helping delegates in obtaining their visas and their warm welcome to delegates.

Resolution 2

The General Assembly of the IMU expresses its deep appreciation to the Executive Committee, especially to the IMU President László Lovász and to the IMU Secretary Martin Grötschel, as well as to the chair of the Program Committee Hendrik Lenstra, for their excellent work during the period 2007-2010.

Resolution 3

The General Assembly of the IMU expresses its gratitude to the Konrad-Zuse-Zentrum in Berlin for their generous support to the IMU.

Resolution 4

The General Assembly of the IMU thanks Mireille Chaleyat-Maurel, Cecilia Kulczár and Sylwia Markwardt for their multiple contributions to the IMU.

Resolution 5

The General Assembly of the IMU expresses its gratitude to those bodies that have contributed to the Special Development Fund in the past four years.

Resolution 6

The IMU Executive Committee is requested to study the feasibility of convening a Donors' Conference as a satellite to ICM 2014 in order to seek funding for IMU activities in support of developing countries. If found feasible, preliminary conference planning should begin in good time and should involve potential beneficiaries.

Resolution 7

The General Assembly of the IMU expresses its appreciation for all initiatives that have been taken to encourage the participation of women and of contributors from developing countries at the ICM 2010 and urges the EC to continue with efforts in this direction.

Resolution 8

The General Assembly of the IMU recommends continuing the tradition of holding an Emmy Noether lecture at each ICM, with selection of the speaker to be made by a committee appointed by the IMU Executive Committee.

Resolution 9

The General Assembly of the IMU proposes that at least one member of the Nominating Committee should be knowledgeable about CDC activities.

Resolution 10

The General Assembly of the IMU endorses the establishment of a Stable Office for the International Mathematical Union. The arrangement will be reviewed by the General Assembly of the IMU in 2018.

Resolution 11

The General Assembly of the IMU accepts following changes in the Statutes of the Union:
28. The Secretary of the Union shall act also as its Treasurer, unless the Executive Committee appoints another person for this position.
29. The legal domicile of the Union shall be located at the office of the Union.

Resolution 12

The General Assembly of the IMU expresses its gratitude to all institutions which showed their support for IMU by putting in a bid or otherwise considering the possibility of hosting IMU's Stable Office.

Resolution 13

The General Assembly of the IMU approves an increase of dues of 2% per year for the years 2011-2014, not to be revised before the next meeting of the GA.

Resolution 14

The General Assembly of the IMU agrees that the IMU will operate in 2011 under the proposed budget. Subject to the constraints of resolution 13, a new budget for 2012-2014 should be submitted to a vote of the Adhering Organizations by the end of 2011.

Resolution 15

The General Assembly of the IMU invites the EC to revise the Statutes concerning the distinction between general expenses (Schedule A) and special expenses (Schedule B).

Resolution 16

The General Assembly of the IMU requests the Secretary to explore the possibility of electronic voting by the IMU Adhering Organizations. When the necessary hardware and software are available and the Executive Committee is convinced of their functionality, the EC should empower the Secretary to make use of electronic voting where appropriate.

Resolution 17

The General Assembly of the IMU endorses the document "Best Current Practices for Journals" of its Committee on Electronic Information and Communication (CEIC). The General Assembly of the IMU requests the CEIC to review the document according to the

discussion during the GA and to continue their work on all aspects of this crucial issue so that the document reflects up-to-date best practices.

Resolution 18

The General Assembly of the IMU asks the EC to create, in cooperation with ICIAM, a Working Group that is charged with considering whether or not a joint ICIAM/IMU method of ranking mathematical journals should be instituted, and what other possible options there may be for protecting against the inappropriate use of impact factors and similar manipulable indices for evaluating research.

Resolution 19

The General Assembly of the IMU shares the concerns expressed by the World Science Forum organized in Budapest, November 2009, by IMU, ICMI, and ICIAM, and strongly endorses its call for an international effort to improve mathematical research, education and awareness in all countries, and asks UNESCO, together with the scientific community, to take the lead in launching such an initiative.

Resolution 20

The General Assembly of the IMU continues to endorse the principle of Universality of Science expressed in the International Council for Science (ICSU) ARTICLE 5 of the STATUTES, as adopted by the 1998 General Assembly, and endorses the additional ICSU Statement on the Universality of Science (2004). Notwithstanding heightened tensions, security concerns, etc., the General Assembly of the IMU urges free exchange of scientific ideas and free circulation of scientists and mathematicians across international borders. The IMU opposes actions by governments and other organizations to restrict contacts, interactions, access and travel in the international mathematical community, particularly when such restrictions penalize individual mathematicians for the actions of their governments.

Resolution 21

The General Assembly of the IMU resolves that the next meeting of the General Assembly be held at a time and place conveniently linked to the International Congress of Mathematicians in Seoul, Korea, in 2014.

14.2. Resolutions balloting

The General Assembly adopted Resolutions 1 to 21.

VOTE (by show of hands): IN FAVOR = 131, ABSTENTIONS = 4

Recommendation to the incoming EC or the next General Assembly: Look into the possibility of splitting the Nominating Committee into two committees (for the EC and for the CDC/ICHM)

15. ICM 2014

15.1. IMU EC Site Recommendation for ICM 2014

Presentation by Manuel de León, ICM 2014 Site Committee

Site Committee

Following the recommendation of the 1990 General Assembly in Kobe, Japan, the guidelines below have been in place for the operation of the Site Committee for the ICM2014:

1. The Site Committee shall consist of the members of the Executive Committee and the President of the Local Organizing Committee of the previous ICM.
2. All Adhering Organizations were formally invited to place bids to hold ICM 2014.
3. The Site Committee made its recommendation by May 31, 2009. The recommendation of the Site Committee was communicated to all Adhering Organizations.
4. The final decision will be taken by this General Assembly (16-17, 2010 in Bangalore).

Information Requested

Among other relevant information that each potential host country may want to supply, the Site Committee wishes to know about the following items:

I. Finances

II. Infrastructure

III. Accessibility

It is also expected that the local mathematical community gets involved in the preparations of the Congress, so as to create a nice ambiance during the meeting.

Information Requested: Finances

- A potential host country may consider a budget of about 1.5 million US dollars, of which about 0.5 or 0.6 million US dollars might be raised through registration fees
- Registration fees should be at most about 300 US dollars.
- Printing costs of the Proceedings and other material (posters, announcements, summary of invited lectures,...) as well as mailing, deserve special attention.
- The host country should be prepared to lodge freely about 120 young research mathematicians from developing countries, selected by IMU.
- In special cases, invited speakers are expected to receive some financial support.
- Registration fees are waived for invited speakers and the above young research mathematicians from developing countries.
- There is an IMU subvention to the ICM as well as some provision in its budget to defray costs of the General Assembly Meeting that takes place just before the Congress.

Information Requested: Infrastructure and Accessibility

Infrastructure

- It is important that good facilities to hold the Congress are available.
- All lectures should take place in sizable, well equipped, pleasant and audible rooms.
- Special attention should be given to the plenary talks.

Accessibility

- The city and site of the Congress should be easily accessible (flight connections transportation to the site of the Congress)
- Lodging facilities constitute an important item.

Site Committee 2014

- László Lovász
- Zhi-Ming Ma
- Martin Grötschel
- Manuel de León

IMU has received the following three bids for ICM 2014:

- Montreal (Canada)
- Rio de Janeiro (Brazil)
- Seoul (South Korea)

Visits

- The Site Committee has visited the three candidates
 - Seoul (Grötschel, Lovász, Ma)
 - Rio de Janeiro (de León, Grötschel)
 - Montreal (de León, Grötschel, Lovász)
- The Site Committee found the three bids really good, with an strong involvement of the local mathematical community, good financial provisions and convenient congress centers.
- The Site Committee reported his findings to the EC, and the EC decided to recommend Seoul as the site for the ICM2014.
- We thank Brazil and Canada for their excellent proposals and for graciously accepting the EC's decision

15.2. Presentation of the Committee for Seoul ICM 2014

Presentation by Hyungju Park, Chair of the OC ICM 2014

Executive Summary

The IMU Adhering Organization of the Republic of Korea, the Korean Mathematical Society (KMS), hereby submits its bid to host ICM 2014 in Korea.

Dreams and Hopes for Emerging Nations

The highlights of its proposal include:

Readiness

1. Korea, despite a relatively short history in modern mathematical research, has made significant progress in quality and quantity of research in mathematics. It is currently in IMU Group IV, and in terms of 2007 SCIE publications in mathematics, it was ranked 12th in the world, more than doubling its publications in less than 10 years.
2. The Korean government has shown tremendous interest in the pursuit of the KMS to host ICM 2014 in Korea. It has awarded a cash grant of US\$250,000 to aid its bidding efforts. Also, President Myung-bak Lee of Korea has written an enthusiastic letter of support to accompany this proposal.
3. The Korean government has made a formal decision to offer financial support to SEOUL ICM. Its support is expected to exceed US\$3,000,000.
4. With the strong support being mobilized from the government and corporations, SEOUL ICM is expected to be a turning point for mathematics in Korea; to reach out to the public and to be recognized by society.

Toward a Collaborative Math Community

1. The KMS considers its bidding efforts to have a positive symbolic impact on the IMU member countries whose mathematical research in modern standards has a relatively short history. This motivated the motto of this proposal: "Dreams and Hopes for Emerging Nations".
2. In order to realize the proposal's theme, the KMS offers to invite 1,000 mathematicians in developing countries (DC) to Korea during ICM 2014.
3. To invite 1,000 DC mathematicians to Korea, the KMS has set up a SEOUL ICM Travel Fellowship Fund. The fund has so far attracted commitments of US\$860,000, and is expected to receive over US\$2 million by 2014, mainly from global corporations.
4. The KMS has every intention to make SEOUL ICM 2014 the best-attended ICM, not only in terms of the number of participants, but also in terms of its cultural impacts on the countries that could benefit from such opportunities to attend an ICM.

Accessibility and Affordability

1. Korea has state-of-the-art convention facilities and services. The proposed venue has an auditorium large enough to house more than 7,000 people, and has 7,500 hotel rooms within 5km radius.
2. Korea has agreements with over 160 countries for no-visa entry. The Ministry of Foreign Affairs and Trade of Korea respects the IMU stance on the freedom of academic exchanges, and will make every effort to expedite the issuance of travel visas to bona-fide registered participants of SEOUL ICM.
3. Over 3,700 flights from 142 cities in 43 countries arrive in Korea every week. Coupled with easy access, a variety of accommodations will be made available to the participants of ICM 2014, ranging from university dormitories to five star hotels.
4. Seoul is one of the safest places in the world for foreign travelers, with low levels of crime, cutting-edge medical facilities and capable police and security authorities.
5. Korea, with a five-millennia-long history, is an attractive place to visit and has its own unique cultural heritage, distinct from that of other Asian countries. A visit to the country's numerous historical relics, seven of which are designated UNESCO World Cultural Heritage Sites, will make ICM participants' journey all the more special.

Conclusion

The KMS very much hopes to realize in Asia the exemplary positive impacts that the three ICMs in Europe achieved during 1994-2006. SEOUL ICM will make possible a significant and meaningful increase of interaction and cooperation among Asian countries. This will add to the momentum gained by previous ICMs in Asia. The 1,000 mathematicians to be invited to SEOUL ICM, many of whom would not have been able to visit an ICM otherwise, will bring the ICM excitement back home, further extending the positive impacts of SEOUL ICM to future generations in their respective countries. The KMS cordially requests the IMU Executive Committee to review and examine its proposal carefully and to consider its merits.

Respectfully submitted

Dohan Kim
President, The Korean Mathematical Society

Hyungju Park
Chair, The Committee for SEOUL ICM 2014

15.3. Location of ICM 2014 balloting

15.4. Meeting of the 17th IMU General Assembly

Gyeongju Ancient Capital City of 1,000 years(BC 57 ~ AD 935, Silla Dynasty)

- 2 hours by train, 4hours by bus, from SEOUL
- KTX train to open in 2013 >2 hours from Incheon Airport to Gyeongju
- Three UNESCO cultural heritages in the city of Gyeongju
- 4,000 Hotel rooms within 20 minutes in the historic area of Gyeongju
- Some of the SEOUL ICM Travel Grant will be allocated to cover the expenses of some delegates from developing countries.

The General Assembly voted to hold the ICM 2014 in Seoul, Korea, with the General Assembly to be held in Gyeongju, Korea prior to the ICM.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

15.5. Vote on establishment of the ICM Emmy Noether Lecture

Presentation by Cheryl Praeger, IMU EC

The IMU General Assembly, Shanghai 2002 had adopted the following in Resolution 5:
“The General Assembly recommends continuing the tradition of the 1994, 1998, 2002 ICMs, by holding an Emmy Noether lecture at the next two ICMs (2006 and 2010), with selection of the speakers to be made by an IMU appointed committee.”

ICM Emmy Noether Lectures:

“To honour women who have made fundamental and sustained contributions to the mathematical sciences”

- 1932 Emmy Noether
- 1990 Karen Uhlenbeck
- 1994 Olga Ladyzhenskaya
- 1998 Cathleen Synge Morawetz
- 2002 Hesheng Hu
- 2006 Yvonne Choquet-Bruhat
- 2010 Idun Reiten

The list of Resolutions adopted by the 2010 General Assembly includes in Resolution 8 the approval to hold an Emmy Noether Lecture at each ICM:

Resolution 8

The General Assembly of the IMU recommends continuing the tradition of holding an Emmy Noether lecture at each ICM, with selection of the speaker to be made by a committee appointed by the IMU Executive Committee.

16. IMU Membership

16.1. New Members

16.2. Group changes

Report by Martin Grötschel

M. Grötschel reported on the systematics of membership information on the IMU Web site. A content management system (Typo 3) has been introduced. For the next term, distributed data management is scheduled to be applied where the adhering organizations are responsible for their data management on the IMU Web site on their own.

IMU Membership Development 2007 – 2010

2007

Ecuador	Associate Member
Kyrgystan	Associate Member
Czech Republic	Group II -> Group III
Poland	Group III -> Group IV
Korea	Group II -> Group IV

Iran	Group II -> Group III
2008	
Kenya	Associate Member
Colombia	Member
Norway	Group II -> Group III
2009	
Thailand	Associate Member
2010	
Finland	Group II -> Group III
African Mathematical Union	Affiliate Member

Representatives of some new members (Ecuador - J.de los Reyes, Kenya – C. Procesi by proxy, Colombia - A. Onshuus, AMU – D. Makinde) gave short presentations on the activities of their mathematical societies.

16.3. Applications for Membership/Associate Membership Presentations of Cambodia, Moldova, Montenegro, Nepal, Oman

□ CAMBODIA, Chan Roath

Cambodian Mathematical Society
Request For Cambodia To Be Accepted as an
Associate Member of the International Mathematics Union

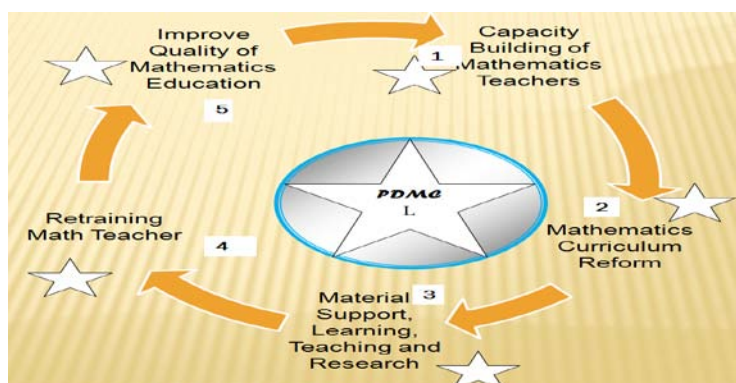
- Why Cambodian Mathematical Society would like to be as an Associate Member of the International Mathematics Union ?
- What benefits that Cambodian Mathematical Society will get from Associate Member of IMU?



Introduction

- | | |
|--------------------------------------|---|
| • Land area: 181,035 Km ² | • Literacy rate 73.6% |
| • Provinces/municip. 24 | • Gen. edu. Studts: 3,289,286 |
| • Population: 13.5 millions | • Higher edu. Studts: 110,090 |
| • Pop. Growth rate: 2.1% | • HE students per 100,000P: 656 |
| • Pop. Density: 76 | • HE non fee-paying students (2007-08): 13,620 (4,782F) |
| • Household size: 5.1 | • HE fee-paying students (2007-08): 96,470 (35,422F) |
| • GDP per capita: 513(2007) | • No. of public HEIs: 33 |
| • Occupation classification: | • No. of private HEIs:44 |
| - Agriculture 74.2% | • Teacher training institutions: 1 NIE, 6 RTTCs, and 18 PTTCs |
| - Industry 7.0% | |
| - Services 18.8% | |

Project Development Mathematics in Cambodia (PDMC)



1. Capacity Building
2. Curriculum Reform
3. Material Support learning, teaching and research mathematics
4. Improve the methodology of teaching mathematics
5. Using ICT in Mathematics Education
6. Encourage, Award and Incentive base competition.

23-25 February 2011, Cambodia

- The 4th International Conference on Science and Mathematics Education in Developing Countries
- Web-site: www.cambmathsociety.org/conf/HOME.html

Please come to joint with us !

□ **MOLDOVA**, Anatoly Vershik from the Russian delegation gave a short presentation on the mathematical society of Moldova because no representative from Moldova was at the GA

Moldova's application for Associate Membership

Moldova is one of (smaller) former SU republics, with a reliable mathematical activity, mainly in the areas of algebra, partial differential equations, general topology, optimal control and dynamical systems.

It has a few dozens of researchers with publications in good international journals, participation in international conferences, international research grants, etc. Many of them are absolvents of Moscow State University

Also:

Two universities with known mathematical departments; about 10 other universities teaching mathematics; a national research institute of Mathematics and Computer Science
Enthusiastic pedagogical community; good (for a small country) results in international school olympiads

A general mathematical journal edited by national Academy of Sciences; a specialized journal in algebra edited jointly with Polish colleagues

Mathematical community is represented by Mathematical Society with almost 200 fellows (a member of EMS and the current applicant for associate membership in IMU)

Specific features:

- A poor country; business not interested in advanced research
- Serious emigration; many remaining recognized researchers approach retirement age or are in it

- + Scientific success and integration into the international scientific community is one of few attractive living trajectories for youth ready to work
- + Traditional scientific relations with Russia, Ukraine, and Romania

□ MONTENEGRO

Application for full IMU membership

No representative of Montenegro was present at the GA, reference was made to the written application submitted to the IMU.

HISTORY AND REVIEW OF THE MAIN ACTIVITIES OF THE SOCIETY OF MATHEMATICIANS AND PHYSICISTS OF MONTENEGRO

The Society of Mathematicians and Physicist of Montenegro exists since 1947 when it was established the Society of Mathematicians, Physicists and Astronomers of Yugoslavia in which our Society was taking an active role. After the splitting of Yugoslavia and establishing the Federal Republic of Serbia and Montenegro our Society became an active member of the Society of Mathematicians, Physicists and Astronomers of Serbia and Montenegro.

When Montenegro became an independent state, it was organized the general assembly of all mathematicians of Montenegro in December 2006., where it was established the Society of Mathematicians and Physicists of Montenegro. It was officially registered as legitimate non-governmental organization of Montenegro. Accordinlgy to its full legitimate status the Society obtained its official stamp.

The President of the Society is Prof. dr Milojica Jacimovic and the vice presidents are Prof. dr Predrag Miranovic and Prof. dr Svjetlana Terzic.

In the framework of the Society the following sections are active: sections for teaching of mathematics, physics and programming, sections for young mathematicians, physicist and programmers and section for scientific research.

In the previos years the membership of our Society in the international organizations was realized through the societes it was the part of. In July 2008. the Society of Mathematicians and Physicists of Montenegro became a member of European mathematical society. In this way our Society has been enabled as a legitimate member to take part in all European educational and scientific activities.

The Society of Mathematicians and Physicists of Montenegro is jointly with Faculty for Natural Sciences and Mathematics of the University of Montenegro, founder of the research journal *Mathematica Montesnigri*.

Our Society was earlier very active member of ther Society of Mathematicians and Physicists of Yugoslavia, and after that of such Society of Serbia and Montenegro. Some of the activities performed by our Society are: Society organized Congress of Mathematicians, Physicists and Astronomist of Yugolavia in Becici, Montenegro; it also twiced organized, in 1995. and 2004., the Congress of Mathematicians and Congress of Physicists of Serbia and Montenegro in Petrovac, Montenegro. The Society organized also for several times state competitions in mathematics and physics for the pupils of elementary and secondary school in former Yugoslavia and later in Serbia and Montenegro.

The Society was till 2006., jointly with Faculty of Natural Sciences and Mathematics of the University of Montenegro, responsible for the organization of the competition for the pupils of elementary and secondary school in Montenegro at all levels.

In the last two years the Society also organized the participation of the young mathematicians and physicists from Montenegro in Balkan olympiads and International mathematical olympiads.

AN OVERVIEW OF EDUCATIONAL AND RESEARCH ACTIVITIES IN MATHEMATICS IN MONTENEGRO

- There are three universities where the mathematics is taught : University of Montenegro, University of Mediteran, University of Donja Gorica;
- The main research activities in mathematics are related to University of Montenegro;
- There is one Society of Mathematicians in Montenegro acting as the part of the Society of Mathematicians and Physicists of Montenegro;
- There is about 30 professors in mathematics, about 10 young mathematicians on doctoral studies and about 500 teachers in mathematics in secondary schools; formally, all they are the members of the Society;
- In Montenegro there is about 30 active researchers in the areas of Analysis (the greater part), Topology, Probability, Optimization, Discrete mathematics, Algebra. In the recent years some of their results were published in highly ranked mathematical journals: Commentari Mathematici Helvetici, Transaction of the American Mathematical Society, Journal of Mathematical Analysis and Applications, Nonlinear Analysis, Computational Mathematics and Mathematical Physics, Annales of Academie Scientiarium Fennicae Mathematica, Differential Equations
- In the recent years mathematicians living in Montenegro published 5-8 papers in respected mathematical journals and about 10 – 15 in other mathematical journals;
- Mathematical journals published in Montenegro: (1) Mathematica Montisnigri and (2) Proceedings of the Section of Natural Sciences of Montenegrin Academy of Sciences and Arts.

□ NEPAL, Bhadra Man Tuladhar

Application for Associate Membership of International Mathematical Union (IMU)



Higher Education

- | | |
|-------------------------------|----------------------|
| • Six universities | Offering mathematics |
| – Tribhuvan University | 1959 |
| – Nepal Sanskrit University | 1986 |
| – Kathmandu University | 1991 |
| – Purbanchal University | 1995 |
| – Pokhara University | 1997 |
| – Lumbini Buddhist University | 2004 |

Nepal Mathematical Society (NMS)

Nepal Mathematical Society was founded on January 19, 1979 with following objectives:

- To enhance the academic Excellency in studying, teaching, research and applications in Mathematics.

- To preserve and promote the professional ethics and rights and welfare of teachers and researchers of Mathematics.
- To work continuously for promoting Mathematics, maintaining good relations with the national and international educational and academic organizations.
- To work for increasing the popularity of Mathematics in local levels.

NMS has 13 Executive Members and 5 Advisory Board members:

Executive Members for NMS (2009-2012)

President: Prof. Dr. Bhadra Man Tuladhar, Vice President: Mrs. Sharada Shrestha, Secretary: Dr. Chet Raj Bhatta, Joint Secretary: Dr. Kanhaiya Jha, Treasurer: Mrs. Kabita Luitel

Members :8

Advisory Board Members

Prof. Dr. Hom Nath Bhattarai, Prof. Dr. Santosh Man Maskey, Prof. Dr. Shankar Raj Pant, Prof. Yadav Prasad Koirala, Prof. Prakash Shakya

Number of mathematics professors in Nepal and research activities

There are altogether 44 Ph. D. degree holders, 11 received Ph. D. degree in Nepal.

Nepali mathematics community consists of 23 Professors, 85 Associate Professors, and about 250 lecturers.

Events of 2009-2010: Held

- May 14, 2009 - Annual Convention of NMS and election of its new Executive Committee members for 2009-2012.
- October 17-19, 2009 -Workshop on Fuzzy Logic
- December 27, 2009 - January 5, 2010 - Winter School on Number Theory and Cryptography organized by Kathmandu University.
- January 17-19, 2010 - National Mathematics Conference held in Biratnagar, East Nepal: 80 participants, 38 papers presented.
- May 15, 2010 - Nepal Mathematics Day Celebration.

Recent Event

July19–31, 2010 - Number Theory in Cryptography and Its Applications, CIMPA– UNESCO–NEPAL RESEARCH SCHOOL, Kathmandu University, Nepal - A Satellite Conference of ICM 2010.

21 Foreign Participants: Pakistan, India, Sri Lanka, Thailand, Bangladesh, Czech, Italy, Spain & 26 Nepali participants.

11 Resource Persons - France, Italy, Canada, Spain, India, Japan and Nepal.

Upcoming Event

Dec 30, 2010 - Jan 7, 2011 - Third International Conference on Lie-Admissible Treatment of Irreversible Processes (ICLATIP-3), Kathmandu University, Nepal.

□ **OMAN**, Ibrahim Eltayeb

Application of Oman for Associate Membership of the IMU

Mathematics in the Sultanate of Oman

Plan of the talk

- The country
- Higher Education in Oman
 - Universities and colleges of higher education

- General Foundation Program
- Research in mathematics
 - Publications
 - Conferences attendance
 - Conference organization
 - Weekly seminars
 - Recognition
- Conclusion

Oman in world map



- Area of 309,500 Km²
- Population of 3 million
- Capital is Muscat
- Official language is Arabic but higher education science-based instruction is in English

Higher Education in Oman

- Higher Education introduced in 1986
- Students study for 12 years before they apply for Higher education after taking a national school certificate examination
- 5 Universities and 17 Colleges of higher education
- Total student intake of about 15 thousands
- Compulsory General Foundation Programme: English, Mathematics, Computer Literacy and Study Skills

Research in mathematics

- More than 80 active researchers.
- Promotion is largely based on research (quality assessed by anonymous external referees)
- Average production of papers is about 2/3 paper per year.
- Quality of research is essential.
- Attendance of international conferences is on average one conference for every two researchers per year.
- At Sultan Qaboos University of about 50 researchers, weekly seminars are scheduled.

Workshops and conferences are held with full international presence:

Title of activity	Time	Invited speakers	Attendance from outside
First SQU Workshop on Topology and its Applications	29 Dec 04-01 Jan 05	4	30
First workshop on Algebra and its applications	2 Dec 2006	8	8
International conference on Numerical Analysis and Optimization	6-8 April 2008	12	40
Second workshop on Algebra and its applications	14 Dec 08	8	8
International conference on mathematical modeling	23-26 Feb 2009	8	34
International Conference on Analysis and Applications	24 - 26 Jan 2010	14	110

Future conference activity:

Title of activity	Time	Planned invited speakers
Second International conference on Numerical Analysis and Optimization	3-6 January , 2011	12
International Conference on Radical Theory	January 2012	5
International Conference on Difference equations and Applications	2013	10
Second International conference on Mathematical Analysis & Applications	2014	14
Annual mathematics Day*	January	5

Recognition

- Membership of TWAS
- (Foreign) Membership of the Royal Astronomical Society of London
- TWAS mathematics prize for 1995
- COMSTECH (OIC) mathematics prize for 2007
- Young Affiliate of TWAS for 2009

Conclusion

- Need for infrastructure to support mathematics activity
- Associate membership will have a dramatic effect on promoting science activity in Oman.
- We want your support

□ Southeast Asian Mathematical Society (SEAMS), Fidel Nemenzo

Application from the floor (online application)
of the Southeast Asian Mathematical Society (SEAMS)
for IMU Affiliate Membership

The Southeast Asian Mathematical Society (SEAMS) would like to apply for affiliate membership in the International Mathematical Union.

SEAMS was founded in 1972, to facilitate mathematical exchange among mathematicians and mathematics educators in our region, and has since then contributed immensely to the development of mathematics in the countries of Southeast Asia, including the establishment of mathematical societies in some of these. Regional workshops and conferences organized by SEAMS have strengthened linkages and collaboration. Among the conference series initiated by SEAMS was the SEACME (Southeast Asian Conference on Mathematics Education), which ran for 9 conferences, until it merged with and metamorphosed into the EARCOME (East Asia Regional Conference on Mathematics Education). The 5th EARCOME will be held this week 18-22 August in Tokyo.

The main activity of SEAMS is the Asian Mathematical Conference (AMC), held every 4-5 years. SEAMS is the currently the only regional mathematical network in the Asian region, and thus was in a good position to launch this regional conference, which draws participation from all countries of Asia, as well as from other continents. The 6th AMC will be held in 2013 in Busan, Korea. This is the first time the AMC will be held outside Southeast Asia, part of our efforts to reach out to our counterparts in other Asian countries, with which our member societies have also established strong mathematical links.

SEAMS is composed of the members of the mathematical societies of Cambodia, Hongkong, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. It is in the process of contacting and inviting in other mathematical societies in the region.

The official journal of SEAMS is the Southeast Asian Bulletin of Mathematics
<<http://seams-bull-math.scnu.edu.cn>>.

The homepage of SEAMS is <<http://www.seams-math.org>>.

I hope the IMU considers SEAMS' application for affiliate membership favorably.

16.4. Membership applications balloting

The IMU Executive Committee has reviewed the applications of Cambodia, Moldova, Montenegro, Nepal, and Oman and recommended to accept the applications.

The General Assembly voted on the list of 5 membership applications and approved the applications of Cambodia, Moldova, Montenegro, Nepal, and Oman. As of September 2010 Montenegro is a full Member and Cambodia, Moldova, Nepal, and Oman are Associate Members of the International Mathematical Union.

VOTE (by show of hands): IN FAVOR = UNANIMOUS

The IMU Executive Committee has reviewed the application of SEAMS and was in favor of the application. The probable foundation of an Asian Mathematical Society was no obstacle for considering SEAMS to be an Affiliate Member of IMU. Once an Asian Mathematical Society is established IMU would encourage it to also join the IMU as an Affiliate Member.

The General Assembly approved the application of SEAMS. As of September 2010 the Southeast Asian Mathematical Society is an Affiliate Member of the International Mathematical Union.

VOTE (by show of hands): IN FAVOR = 117, AGAINST = 2, ABSTENTIONS = 16

17. Miscellaneous

Jacob Palis announced on behalf of the Brazilian delegation, the Brazilian Mathematical Society with full support of IMPA and all the main scientific institutions that perform good mathematical research that Brazil will present an application to host for the first time the ICM 2018.

Ari Laptev, current president of the European Mathematical Society (EMS), gave a short presentation of the EMS and announced the 6th European Congress of Mathematics to be held in Kraków, Poland, July 2-7, 2012 (www.6ecm.pl). Stefan Jackowski, President of the Polish Mathematical Society, gave more details on the EMS congress in Kraków. Marta Sanz-Solé, EMS President-elect expressed the invitation for input from other international societies in order to extend their network of cooperation by reciprocity agreements.

18. Any other item with the permission of the President

No request was put forward.

The President thanked G.Misra for the excellent organization of the meeting. G.Misra briefly addressed the audience and thanked his colleagues of the organizing committee for their cooperation. The President also thanked the colleagues who made the presentations and those who worked behind these presentations, the yet unknown members of the Program Committee, the members of CDC, ICMI, the prize committees, the CEIC, the members of the EC. The President thanked the Assembly for their work and patience. John Ball on behalf of the EC thanked the President for his dedicated work for IMU. The President declared the 16th General Assembly closed.

Dues in arrears on Feb 17, 2011					
<u>Country</u>	<u>CHF</u> <u>2010</u>	<u>CHF</u> <u>2009</u>	<u>CHF</u> <u>2008</u>	<u>CHF</u> <u>2007</u>	<u>total</u>
Argentina	3.210				3.210
Cameroon	1.605				1.605
Cuba	1.605				1.605
Hungary	6.420				6.420
Kazakhstan		1.528		1.386	2.914
Mexico	3.210				3.210
Montenegro	535				535
Nigeria	1.605				1.605
Peru	1.605		717		2.322
Uruguay	1.605				1.605
TOTALS	21.400	1.528	717	1.386	25.031 CHF 19.175 EUR

International Mathematical Union					
Proposed Budget for 2011-2014 (Swiss Francs)					
EXPENSES	Approved Budgeted for	2% Dues increase	2% Dues increase	2% Dues increase	2% Dues increase
Schedule A:	2007-2010	2011	2012	2013	2014
Secretarial help, IMU Secretary	22.660	20.000	20.000	20.000	20.000
Secretarial help, IMU President	5.150	8.000	8.000	8.000	8.000
Accountant	9.270	9.500	9.500	9.500	9.500
ICMI	15.450	16.000	16.000	16.000	16.000
CDC	6.180	6.300	6.300	6.300	6.300
Office expenses (including postage)	16.480	16.800	16.800	16.800	16.800
Travel expenses of the EC	30.900	32.000	32.000	32.000	32.000
President's and Secretary's expenses	4.120	5.000	5.000	5.000	5.000
Contribution to ICSU	9.785	9.785	9.785	9.785	9.785
IMU Bulletin	1.500	2.200	2.200	2.200	2.200
Audit fee	8.755	17.000	17.000	17.000	17.000
General Assembly	4.120	5.000	5.000	5.000	5.000
IMU office transfer		17.500	17.500	17.500	17.500
Contingencies	2.060	50.000	50.000	50.000	50.000
Subtotal of Schedule A	136.430	215.085	215.085	215.085	215.085
Schedule B:					
IMU non-CDC conference support	20.000	3.750	3.750	3.750	3.750
ICMI scientific activities	27.810	40.000	40.000	40.000	40.000
CDC scientific activities	115.000	120.000	120.000	120.000	120.000
CDC support staff	56.000	7.500	7.500	7.500	7.500
CEIC scientific activities	25.000	21.000	21.000	21.000	21.000
Website support	6.253	8.000	8.000	8.000	8.000
ICM Site Committee	2.000	3.000	3.000	3.000	3.000
Program Committee for ICM	8.240	10.000	10.000	10.000	10.000
Subvention to ICM	28.840	29.420	29.420	29.420	29.420
Prize Committees (subvention)	11.100	12.000	12.000	12.000	12.000
Travel grants (young & senior)	61.000	62.220	62.220	62.220	62.220
Media Relations	3.500	4.000	4.000	4.000	4.000
Subtotal of Schedule B	364.743	320.890	320.890	320.890	320.890
Total Expenses (A & B)	501.173	535.975	535.975	535.975	535.975
INCOME					
Membership dues	390.015	435.442	444.220	452.998	462.042
ICSU Grant	0	0	0	0	0
Special Development Fund	32.000	30.000	30.000	30.000	30.000
Interest on bank accounts	16.000	1.000	1.000	1.000	1.000
Donations (Abel Fund)	59.220	56.000	56.000	56.000	56.000
Draw from Reserves (here in 2010)	3.938	13.533	4.755	0	0
Return to Reserves (here in 2010)	0	0	0	4.023	13.067
TOTAL INCOME	501.173	535.975	535.975	535.975	535.975
INCOME LESS EXPENSES		0	0	0	0

Von: [IMU Secretary](#)
An: ec@mathunion.org;
CC:
Betreff: IMU EC CL 17/07: reimbursement policy & ICMI
Datum: Dienstag, 10. April 2007 22:43:45
Anlagen: [ICMI-BassHodgson_2004.pdf](#)

To the IMU 2007-2010
Executive Committee

Dear colleagues,

Below are two brief remarks on ICMI and the IMU reimbursement policy.

1. IMU reimbursement policy

Since EC members are starting to travel on behalf of IMU to participate in various IMU related activities I would like to say a few words on expense reimbursement.

IMU has no "official reimbursement policy". The secretaries have always covered all (reasonable) expenses. As you know IMU's budget situation you can easily infer that, if IMU would try to cover business class air fare, ruin would be immediate. All EC members organizing an EC meeting have spent a lot of effort to make local sources available in order to reduce the IMU expenses. (Ragni is doing a great job in this respect right now.) This unselfish behaviour has helped IMU to survive financially up to now. Local support of this type will in almost all other cases not be available, e.g., if EC members travel to ICSU, CEIC, CDE or other events. In such cases I will always try to be very non-bureaucratic concerning reimbursements. Just send me a list of items you would like to get reimbursed for, the bills, and your bank account data and we will transfer the money to your account.

I just ask everybody to be somewhat modest, and in case other sources are available, to utilize them.

If you think that a precise reimbursement policy is

necessary, I suggest that we discuss this issue at the Oslo EC meeting.

2. Article on ICMI

Since ICMI will be a permanent topic during our EC term I thought I should send you a copy of the article "The International Commission on Mathematical Instruction What? Why? For Whom?" by Hyman Bass and Bernard R. Hodgson that appeared in 2004 in the Notices of the AMS. Some of you may not have seen it. It provides good background material on the ICMI history and activities.

Note that ICMI will celebrate its 100th anniversary next year in Rome, March 5-8, 2008. The preliminary program and more details can be found at <http://www.unige.ch/math/EnsMath/Rome2008/>

Best regards

Martin

Former Prize Selection Committees

Year	Fields Medal Committee	Rolf Nevanlinna Prize Committee	Carl Friedrich Gauss Prize Committee	Chern Medal Award Committee
2010	László Lovász (chair) Corrado De Concini Yakov Eliashberg Peter Hall Timothy Gowers Ngaiming Mok Stefan Müller Peter Sarnak Karen Uhlenbeck	Ravindran Kannan (chair) Stanley Osher Olivier Pironneau Madhu Sudan Emo Welzl	Wolfgang Dahmen (chair) Rolf Jeltsch Servet Martinez Aguilera William R. Pulleyblank	Phillip A. Griffiths (chair) Robert Bryant Gerd Faltings Fanghua Lin Wendelin Werner
2006	John M Ball (chair) Enrico Arbarello Jeff Cheeger Donald Dawson Gerhard Huisken Curtis McMullen Alexey Parshin Tom Spencer Michèle Vergne	Margaret H. Wright (chair) Samson Abramsky Franco Brezzi Gert-Martin Greuel Johan Håstad	Martin Grötschel (chair) Robert E. Bixby Frank den Hollander Stephane Mallat Ian Sloan	
2002	Yakov Sinai (chair) James Arthur Spencer Bloch Jean Bourgain Helmut Hofer Yasutaka Ihara H. Blaine Lawson Sergei Novikov George Papanicolaou Efim Zelmanov	Michael Rabin (chair) Andrei Agrachev Ingrid Daubechies Wolfgang Hackbusch Alexander Schrijver	-	
1998	Yuri I. Manin (chair) John Ball John Coates J. J. Duistermaat Michael Freedman Jürg Fröhlich Robert MacPherson Kyoji Saito Steve Smale	David Mumford (chair) Bjorn Engquist F. Thomas Leighton Alexander Razborov	-	

1994	Mumford (chair) Caffarelli Kashiwara B. Mazur Schrivjer Sullivan Tits Varadhan	J.-L. Lions (chair) Lenstra Matiyasevic Tarjan Yamaguti	-	
1990	Faddeev (chair) Atiyah Bismut Bombieri Fefferman Iwasawa Lax Shafarevich	Lovász (chair) Chorin Rabin Strassen	-	
1986	Moser (chair) Deligne Glimm Hörmander Ito Milnor Novikov Seshadri	Faddeev (chair) Cook Winograd	-	
1982	Carleson (chair) Araki Malliavin Marchuk Mumford Nirenberg Schintzel C.T.C. Wall	J.-L. Lions (chair) Salomaa J. Schwartz	-	
1978	Montgomery (chair) Carleson Eichler I.M. James Moser Prohorov Szökefalvi-Nagy Tits	-	-	
1974	Chandrasekharan (chair) Adams Kodaira	-	-	

	Malgrange Mostowski Pontryagin Tate Zygmund			
1970	H. Cartan (chair) Doob Hirzebruch Hörmander Iyanaga Milnor Shafarevich Turán	-	-	
1966	de Rham (chair) Davenport Deuring Feller Lavrentiev Serre Spencer Thom	-	-	
1962	Nevanlinna (chair) P.S. Aleksandrov Artin Chern Chevalley Whitney Yosida	-	-	
1958	Hopf (chair) Chandrasekharan Friedrichs P. Hall Kolmogorov L. Schwartz Siegel Zariski	-	-	
1954	Weyl (chair) Bompiani Bureau H. Cartan Ostrowski Pleijel Szegő Titchmarsh	-	-	

1950	Bohr (chair) Ahlfors Borsuk Fréchet Hodge Kolmogorov Kosambi Morse	-	-	
1936	Severi (chair) Carathéodory G.D. Birkhoff E. Cartan Takagi	-	-	

IMU prize committee rules

Fields Medal

The Fields Medal recognizes outstanding mathematical achievement.

The Fields Medal Committee is chosen by the Executive Committee of the International Mathematical Union and is normally chaired by the IMU President. It is asked to choose at least two, with a strong preference for four, Fields Medallists, and to have regard in its choice to representing a diversity of mathematical fields. A candidate's 40th birthday must not occur before January 1st of the year of the Congress at which the Fields Medals are awarded.

The name of the Chair of the Committee is made public, but the names of other members of the Committee remain anonymous until the award of the prize at the Congress. If a former student (Ph.D. thesis only) of a Committee member is seriously considered, such a member shall not continue to serve on the Committee for its final decision.

Rolf Nevanlinna Prize

The Rolf Nevanlinna Prize honors distinguished achievements in mathematical aspects of information science, including

1. All mathematical aspects of computer science, including complexity theory, logic of programming languages, analysis of algorithms, cryptography, computer vision, pattern recognition, information processing and modelling of intelligence.
2. Scientific computing and numerical analysis. Computational aspects of optimization and control theory. Computer algebra.

The Rolf Nevanlinna Prize Committee is chosen by the Executive Committee of the International Mathematical Union. The name of the Chair of the Committee is made public, but the names of other members of the Committee remain anonymous until the award of the prize at the Congress. A candidate's 40th birthday must not occur before January 1st of the year of the Congress at which the Prize is awarded. If a former student (Ph.D. thesis only) of a Committee member is seriously considered, such a member shall not continue to serve on the Committee for its final decision.

Carl Friedrich Gauss Prize

The Carl Friedrich Gauss Prize is awarded for outstanding mathematical contributions that have found significant applications outside of mathematics, either in technology, in business, or simply in people's everyday lives.

The Gauss Prize is awarded jointly by the Deutsche Mathematiker-Vereinigung (DMV = German Mathematical Union) and the International Mathematical Union (IMU), and administered by the DMV. The prize consists of a medal and a monetary award. The source of the prize is a surplus from the International Congress of Mathematicians (ICM '98) held in Berlin.

With the Gauss Prize the IMU has broadened the range of its awards, now including the influence of mathematics to other disciplines. The award ceremony includes a brief overview of the achievements of the prize winner. The presentation of the mathematical work will be addressed to the general public as well as journalists, so that all may appreciate the importance of mathematics for everyday life.

Chern Medal

The Chern Medal is awarded to an individual whose accomplishments warrant the highest level of recognition for outstanding achievements in the field of mathematics. All living, natural persons, regardless of age or vocation, shall be eligible for the Medal. This prize is jointly awarded by IMU and the Chern Medal Foundation (CMF). CMF funds the Chern Medal Award. The Medalist receives a cash prize of US\$ 250,000. In addition, each Medalist may nominate one or more organizations to receive funding totaling US\$ 250,000, for the support of research, education, or other outreach programs in the field of mathematics (the “Organization Awards”). The details of the Chern Medal Award, the nomination process, and the selection criteria can be found in the [Chern Medal Program Guidelines](#)

About two years in advance of an award, the IMU Executive Committee appoints Selection Committees along the lines of the Prize Statutes and the IMU By-Laws. This includes specifications about the criteria of selection and instructions how to act in a conflict of interest.

Guidelines for handling conflicts of interest in an IMU prize selection committee

At its 78th meeting in April 2009, the IMU Executive Committee issued the following guidelines on “conflicts of interest” in IMU prize selection committees. The IMU EC urges the members of these committees to observe the guidelines below and requests the committee chairs to contact the IMU President in case there is dispute about how to judge or handle such a case.

Conflicts of interest occur in activities of the International Mathematical Union often and in many ways. IMU has always made sure that problems of this kind were handled properly. It is particularly important that potential conflicts of interest in IMU prize committees are identified as early as possible, that they are discussed openly, and that even the least indication thereof is avoided.

The IMU EC is aware that there can be no precise and exhaustive definition of a conflict of interest and therefore it wants to alert every committee chair and every committee member to review his or her scientific or personal involvement with a nominee. Appearance of conflicts of interest is different in the various committees and, thus, needs different handling.

In a previous decision, the IMU EC has ruled that, for the Fields Medal Committee, a committee member shall not continue to serve on the committee for its final decision when a former student (PhD thesis only) is considered, see <http://www.mathunion.org/general/prizes/fields/details/>.

This implies that a committee member who has a former or current PhD student on the candidate list can remain on the committee during the initial selection process leading to the list of finalists. However, a committee member with a PhD student on the list of nominees should not take part in any vote on this nominee.

The same rule also applies to the Nevanlinna Committee since, for the Nevanlinna Prize, similar selection criteria apply.

In the case of prizes for which there is no age limit, the situation is more subtle, and other forms of conflict of interest possibly appearing should be avoided, too.

Obviously, a member of a committee cannot be a nominee for the prize. (Members of the Fields and the Nevanlinna juries are (naturally) selected in such a way that they are not eligible for the prizes itself.)

The IMU EC makes out a possible conflict of interest if a committee member is a major coauthor of a nominee. What “a major coauthor” exactly means is not easy to define, and the EC hopes that a committee member reveals to the committee that he or she is a significant coauthor of a nominee.

A committee member, and this is valid for all prize committees, who has a special personal relation with a nominee (relative, spouse, partner, etc.) should also withdraw. If the relationship is more distant, it should be revealed to the committee chair and, if necessary, discussed in the committee.

In case the committee members disagree on whether there is a conflict of interest or not, the committee chair is asked to seek the IMU President’s authority to resolve the problem. The IMU EC has decided that the IMU President is empowered to make final decisions, for instance, to remove a person from a jury or to replace a committee member by another person.

The IMU EC has refrained from making rules that are too precise. It counts on the “common sense” of members of IMU prize committees.

Martin Grötschel
IMU Secretary

Von: lovasz@cs.elte.hu
Gesendet: Dienstag, 15. Februar 2011 20:48
An: Ingrid Daubechies
Cc: IMU Secretary
Betreff: Fields Committee

Dear Ingrid, dear Martin,

I put together in writing some points about the work of the Fields Medal Committee.

Some aspects of this could be discussed in Perth, or at our next meeting. I also

attach the text of the letter I wrote to the committee members. (John wrote a longer letter, so I guess it is up to the President what he/she wants to tell right away.)

Best,

Laci

Fields Committee recommendations

1. Timing. Spring of year -3: The EC appoints the Fields Committee at their first meeting. This is quite early, but it is necessary to avoid conflict with the Program Committee panels, which are being set up during the following months. During the same Spring, the President writes to the Committee members inviting them.

Fall of year -3: The Committee should be formed, with every member accepting, by mid-Fall.

Summer of year -2: Requests for nominations should be sent to adhering organizations, former medalists, former IMU officers, and posted on the web site. Deadline for nominations is December 15 of year -2, but the Committee may consider every reasonable nomination, including late nominations, except self-nominations.

Spring of year -1: First meeting of the Committee. If necessary, the Committee discusses the principles, then forms a first "long" list. (The Committee may come up with additional nominations.) The Committee groups the nominees by subject, and identifies experts who can be asked for evaluation and comparison.

Spring-Fall of year -1: The Chair writes to the experts, and distributes their replies. The Committee discusses the opinions of the experts by email, suggests the Chair to ask for further opinions, and reduces the list to about 10 nominees.

Early Spring of year 0: Second meeting of the Committee, decision. The Committee should also compose a list of 4-5 possible laudators for each prize winner. The prize winners can be asked to add names to the list.

Spring-Summer of year 0: The President informs the prize winners, the Secretary, and the local organizers. He/she invites the laudators, and makes sure the press coverage is organized. The Secretary makes sure the medals are minted, diplomas are written, prize money is ready.

3. Laudations. My experience was that it was difficult to find laudators. Most people's Summer plans were already made, and there may have been other factors we didn't know about. We did not make sufficiently long lists. The quality of the laudations was also a problem. If possible, the slides (ppt or pdf) of laudations should be checked by an expert for obvious problems (like portrait vs. landscape, large enough fonts).

4. Publicity. In the Spring of year 0, one or more journalists should be lined up to write articles for the general public about the work of the prize winners. Such articles should be written about the Fields and Nevanlinna winners, and perhaps also about the Gauss and Chern winners. This is the job of the Chair of the Prize Committee, since he/she is the one who knows the names of the prize winners. Once the prize winners and laudators are determined, the journalists should start working on these (with the help of the prize winners and their laudators). This costs money (2K-3K dollars per person), and the Secretary or the EC should be consulted whether the funds are available.

I was rather late in finding these journalists, and perhaps we could have gotten their services cheaper if we had more time to find them.

One also needs a local person, experienced in publicity of science, who arranges interviews, press conferences, and prepares a web page about the prizes which is made available after the opening ceremony.

5. Secrecy. The names of prize winners is only made public at the opening ceremony, but there are several people who necessarily will know about them: the committee; the winners and their families; laudators (also those who decline); the journalists; the Secretary of the IMU; the Chair of the local organizing committee, and some other local organizers (people arranging lodging, designing the program, constructing the web site, etc.). There is a guessing game going on on the internet! Some leaks seem to be inevitable, but hopefully no media will publish the list. Everybody must be warned about confidentiality, and the journalists should formally make a "non-disclosure" commitment. I accepted this by email, since time was short, but perhaps a hard copy should be requested, to emphasize it.

5. Conflict of interest. The guidelines say: "If a former student (Ph.D. thesis only) of a committee member is seriously considered, such a member shall not continue to serve on the Committee for its final decision."

This is important but tricky. Ph.D. advising is just one example of conflict of interest. It could happen, for example, that a committee member wrote many joint papers with a nominee when the nominee was a postdoc, or may be a relative of a candidate. On the other hand, having former students on the "long list" should not rule out committee members; this would jeopardize the whole work. When we formed our first list (about 30-40 people), three committee members had former students on it. Committee members who have former students or other closely associated candidates on the short list (10 or so), should not take part in the last meeting of the Committee.

There is another issue which can be labeled "Conflict of interest". Fields Committee members are instructed to decline invitation to program panels or to any other committee related to the IMU (without naming a specific reason). I declined participation in other, non-IMU Prize Committees during this period, since I thought it would mean too much influence by one person. I think Fields Committee members should not be committee

members for the Abel Prize, Shaw prize, or Wolf prize during their terms, but I don't think IMU has a policy to this effect. The EC did appoint Peter Sarnak, about whom we did not realize that he was serving on the Ramanujan Prize Committee at the time. After some correspondence, it was decided that since his Ramanujan appointment ended before the work of the Fields Committee started, he could stay.

6. Age. There is every now and then pressure coming from different persons or groups to change the age limit (usually to raise it). The main arguments are (a) this is age discrimination; (b) this is disadvantageous for women. Both the EC and the Prize Committee considered these arguments and did not accept them.

7. Chairing. Unless there are exceptional circumstances, the Fields Medal Committee should be chaired by the President.

8. Number of medalists. The guidelines say 2-4, with a strong preference for 4. I suggest that we make it four, period. It may happen that one or two medalists stand out; but mathematics is so broad that it is very unlikely that there are not sufficiently many excellent candidates.

[Invitation letter to Committee members]

> I am writing you as the Chair of the 2010 Fields Medal Committee. On
> behalf of the Executive Committee of the International Mathematical Union
> (IMU), I have the honor of inviting you to be a member of this
> Committee.
>
> The name of the Chair will be made public, but the names of the other
> members of the committee will remain confidential until the announcement of
> the Fields Medals at the International Congress of Mathematicians 2010
> (ICM 2010) in Hyderabad, India, August 19-27, 2010.
>
> The strictly confidential task of the Fields Medal Committee will be to
> choose at least two, with a strong preference for four, Fields Medalists.
> It is desirable for the choice to represent a diversity of
> mathematical fields. Candidates will be evaluated on "existing work and
> the promise of future achievement" and their 40th birthday must not occur
> before January 1, 2010.
>
> The EC believes that it is advantageous to hold two physical meetings of
> the committee (but not more than two), one at the onset of the committee's
> deliberation and one final meeting held as close as possible, but not less
> than two months, prior to the date of the Congress. If a former student
> (Ph.D. thesis only) of a committee member
> is seriously considered, such a member shall not continue to serve on the
> Committee for its final decision.
>
> In accepting this invitation to serve, it is understood that the
> committee member will make every effort to attend these meetings. The EC
> very much hopes that each committee member will be able to attend the ICM
> 2010.
>
> The work of the Fields Medal Committee will not start for another year
> or year and a half. The reason why we send this invitation so early is that
> members of the Fields Medal Committee should not take part in other
> activities in connection with the scientific program of the Congress (such
> as Program Committee panels). If (as I hope) you accept this invitation,
> and also receive an invitation to take part in such a work, we ask you to
> reject the latter without revealing the real reason, referring to some

> unspecified "other commitment" or "conflict of interest".
>
> I hope that you will accept this invitation to serve and I will be happy
> to discuss with you any concerns you may have.
>
> Sincerely yours,
>
> Laszlo Lovasz
> President of the
> International Mathematical Union

Sylwia Markwardt

Von: Edward Bierstone [bierston@fields.utoronto.ca]
Gesendet: Sonntag, 16. Januar 2011 20:39
An: IMU Secretary
Cc: president@mathunion.org; lovasz@cs.elte.hu; 'IMU Administrator'; Edward Bierstone
Betreff: Re: AW: Fields Medal Symposium

Dear Martin,

Thanks very much for your message. Of course it is fine that the EC discuss the proposal at its February meeting.

Our twentieth anniversary celebration is likely to be in the fall of 2012.

We are looking forward to hearing from you.

Best wishes,
Edward

On 15/01/11 12:00 PM, IMU Secretary wrote:

> Dear Edward,
>
> I personally think that what you suggest is a good idea.
>
> To get the "formal blessing" from IMU the EC should decide
> in what form it endorses the planned activities.
>
> I could try to handle the matter by e-mail. An easier way
> is to discuss your proposal at the EC meeting at the end
> of February in Perth, Australia. The main issue, I believe,
> is how fast you need a reaction. (I could not find out on
> your server when exactly the twentieth anniversary of the
> Fields Institute will be celebrated in 2012.) My personal
> feeling is that an answer in the beginning of March gives
> you sufficient lead time, so that the EC can handle the
> issue at its Perth meeting. Is that acceptable?
>
> Best regards,
>
> Martin

>> -----Ursprüngliche Nachricht-----

>> Von: Edward Bierstone [<mailto:bierston@fields.utoronto.ca>]

>> Gesendet: Freitag, 14. Januar 2011 15:45

>> An: IMU Secretary; groetschel@zib.de

>> Cc: president@mathunion.org; ingrid@math.duke.edu; 'Laci Lovasz'; Edward Bierstone

>> Betreff: Fields Medal Symposium

>>

>> Dear Martin,

>>

>> I am writing to follow up on our conversation in Hyderabad about the
>> possibility of a Fields Medal Symposium to be held at the Fields
>> Institute. We have advanced our plans for a Symposium, including
>> sponsorship for an initial period.

>>

>> We are proposing to establish a Fields Medal Symposium to take place
>> at the Fields Institute normally once a year, with an invited address
>> (or lecture series) by one of the Fields Medalists named at the
>> preceding ICM. (The frequency of the Symposium would depend on the
>> number of Fields Medals awarded.) The Symposium would provide a
>> substantial honorarium (e.g., \$15K--\$25K) to the Fields Medalist, partly
>> to enhance the monetary value of the Medal.

>>
>> We propose that the Fields Medal Symposium be organized as a three-day
>> meeting, centred around an address (or a series of lectures) by the
>> Fields Medalist, aimed at a general scientific audience. The Symposium
>> would include associated lectures and perhaps panel discussion by other
>> prominent scientists on themes related to the work of the Medalist. We
>> would also aim to have a public lecture, either by the Fields Medalist
>> or by another participant in the Symposium. We expect that the event
>> would attract large international participation.

>>
>> We would like to begin the Symposium in 2012 (on the occasion of the
>> twentieth anniversary of the Fields Institute). We have been seeking
>> sponsorship for an initial eight-year period, to cover the honorarium,
>> promotion and the expenses of the Medalist. The expenses of the other
>> scientific participants could be paid from our budget, as a regular
>> scientific event at the Institute. Our aim is to raise \$200K--\$400K for
>> the initial eight-year period. We currently have commitments of \$150K.

>>
>> The stature of the Symposium would of course be enhanced by official
>> association of the IMU, connected to the Fields Medal, as you suggested.
>> We would very much like to have your ideas -- I am looking forward to
>> hearing from you.

>>
>> With best wishes for a happy, healthy and productive year,
>> Edward

>>
>>

>> --

>> Edward Bierstone, Director
>> The Fields Institute
>> 222 College Street, 2nd Floor
>> Toronto ON Canada M5T 3J1

Phone 416 348 9710 ext. 2012
Fax 416 348 9714
bierston@fields.utoronto.ca
www.fields.utoronto.ca

**Statutes of the
IMU CARL FRIEDRICH GAUSS PRIZE FOR APPLICATIONS OF
MATHEMATICS**

The IMU *Carl Friedrich Gauss Prize* for applications of mathematics is to be awarded for outstanding

- mathematical contributions that have found significant practical applications outside of mathematics, or
- achievements that made the application of mathematical methods to areas outside of mathematics possible in an innovative way, e.g., via new modeling techniques or the design and implementation of algorithms.

The *Carl Friedrich Gauss Prize* is given, in particular, for the impact the work of the prize winner has had in practice.

Since the practical usefulness of mathematical results is often not immediately visible and since the applicability and importance for practice may only be realized after a long time lag, no age limit should restrict the choice of a prize winner.

The *Carl Friedrich Gauss Prize* may also be awarded to

- a group of individuals who have jointly made a contribution as specified above or to
- a group of persons whose individual contributions have jointly resulted in the impact that this prize is intended to honor.

The *Carl Friedrich Gauss Prize* is awarded every four years at an *International Congress of Mathematicians (ICM)*, for the first time at ICM'2006. The Prize consists of a Medal and a Cash Prize. For the first award, the cash prize will be Euro 10.000,-. In the case of a shared award each prize winner will receive a medal, the cash prize will be divided.

The International Mathematical Union appoints a Carl Friedrich Gauss Prize Committee in analogy to its other Prize Committees. The Carl Friedrich Gauss Prize Committee reports its choice to the IMU president who informs the prize winner(s), inviting him/her/them to the Award Ceremony at the forthcoming ICM.

The funds of the *Carl Friedrich Gauss Prize* (resulting from a positive balance of ICM'98 in Berlin) are administrated by the *Deutsche Mathematiker-Vereinigung (DMV)*.

The DMV treasurer stays in touch with the IMU president concerning the prize. The DMV treasurer is responsible for the production of the medal(s) and takes care that the medal(s) and check(s) are available at the Award Ceremony. The DMV appoints a representative handing out the *Carl Friedrich Gauss Prize*.

Chern Medal Grant Agreement

This Chern Medal Grant Agreement (this “Agreement”) is made between the Chern Medal Foundation, a Texas nonprofit corporation (“CMF”), and Friends of the International Mathematical Union, a Rhode Island nonprofit corporation (“FIMU”) as of the first day of March, 2009 (the “Effective Date”). CMF and FIMU may each be referred to herein as a “Party” and may collectively be referred to herein as “Parties.”

WHEREAS, CMF and FIMU, in furtherance of their shared purpose of promoting outstanding achievement in the field of mathematics, wish to cooperate in the promotion, administration and award of the Chern Medal and certain related awards to organizations, as further described herein (altogether, the “Program”);

WHEREAS, attached hereto and incorporated herein are guidelines regarding the purposes and administration of the Program (the “Program Guidelines”), as they may be amended by mutual written consent of the Parties from time to time; and

WHEREAS, the Parties wish to embark upon and conduct the Program pursuant to the terms and conditions set forth below and incorporated herein;

NOW, THEREFORE, in consideration of the mutual promises and undertakings set forth in this Agreement, and intending to be legally bound, the Parties hereby agree as follows.

I. **Funding**

A. CMF grants to FIMU \$600,000, to support the Program over each Term, as defined below (the “Grant”). The Grant includes the following components:

1. \$250,000 to be provided as a cash award to the Medalist;
2. \$250,000 to be provided as the Organization Awards (as defined in the Program Guidelines); and
3. \$100,000 to defray promotional, administrative, travel and other costs of the Program, and, to the extent that all such costs total less than \$100,000, any other exclusively charitable purposes concordant with the purposes of the Program in the discretion of FIMU.

B. CMF shall pay the Grant to FIMU during each Term in one or more payments, the timing and amount of which shall be as determined by CMF from time to time in reasonable accommodation of FIMU’s cash flow needs, CMF’s tax compliance obligations, and such other considerations as CMF shall deem relevant.

II. Program Guidelines; Further Agreements

A. FIMU shall ensure that the Program is carried out in keeping with the Program Guidelines, except as otherwise approved in writing by CMF. During the initial Term the Selection Committee (as defined in the Program Guidelines) may be seated less than two years in advance of the award ceremony.

B. If FIMU enters into any agreement with the International Mathematical Union (the “IMU”) or any other party regarding the Program, it shall do so subject to a written agreement (a “Program Agreement”). Any Program Agreement must incorporate, in any relevant part, elements of the Program Guidelines. CMF will not be party to any Program Agreement.

C. In the course of negotiating any Program Agreement, FIMU will consult with CMF regarding the terms and conditions under discussion, but FIMU ultimately controls those terms and conditions (except insofar as they must substantially conform to the Program Guidelines).

D. In the course of negotiating, amending or administering any Program Agreement, FIMU will ensure that CMF, as a third-party beneficiary of that agreement, receives and retains the rights to:

1. name a representative to each Selection Committee;
2. approve the chair of each Selection Committee; and
3. protect the names and marks associated with the Program.

III. Tax Compliance

A. FIMU will expend all grant funds exclusively:

1. in furtherance of grant purposes;
2. in furtherance of charitable purposes within the meaning of U.S. tax law; and
3. in a manner that is consistent with all other applicable U.S. laws.

B. In order to ensure that amounts paid by CMF may be treated as qualifying distributions under U.S. tax law, and that CMF may generally comply with U.S. tax law in regard to all distributions to FIMU, FIMU shall:

1. expend all grant funds received from CMF and any income therefrom by the end of the FIMU tax year following the FIMU tax year in which such funds were received;
2. provide such records or other evidence regarding FIMU expenditures and operations as CMF may reasonably require in connection with CMF’s tax-related obligations; and

3. cooperate in any other manner necessary, in CMF's reasonable discretion, to ensure that CMF may treat all distributions to FIMU as qualifying distributions within the meaning of federal tax law, and may otherwise comply with federal tax law.

IV. **Term and Termination**

A. Term. This Agreement remains in effect until August 31, 2010, and until all FIMU responsibilities have been discharged as to all Grant funds received by FIMU prior to that date, unless sooner terminated pursuant to C, D or E below (the initial "Term").

B. Renewal. This Agreement renews automatically at the end of each Term, for a renewal Term of four years and until all FIMU responsibilities have been discharged as to all Grant funds received by FIMU during that Term, unless previously terminated pursuant to C, D or E below.

C. Automatic Termination. This agreement shall terminate automatically if FIMU:

1. loses its recognition by the Internal Revenue Service as an organization described in § 501(c)(3) of the Internal Revenue Code;
2. dissolves or otherwise ceases operations;
3. becomes insolvent; or
4. aAmends its charitable or corporate purposes in a manner inconsistent with carrying out the Program.

D. Termination by CMF.

1. CMF may terminate this Agreement for cause, upon notice to FIMU that any action or omission of FIMU in connection with this Agreement either is injurious to CMF, or involves an expenditure by FIMU outside of the purposes of the Grant, and (in either case) the passage of 30 days during which FIMU fails to cure the situation to CMF's satisfaction.

2. CMF may terminate this Agreement at will, upon at least three years advance written notice of non-renewal prior to the end of any Term, provided that CMF shall not exercise this option during the first four Terms (including the initial Term).

E. Termination by FIMU. FIMU may terminate this Agreement at any time, upon determining in its sole discretion that it is impossible, impractical or not in furtherance of FIMU's charitable purposes to remain party to this Agreement.

F. Effect of Termination. Following any termination, FIMU shall remain bound by this Agreement until all Grant funds received by FIMU (and any income therefrom) have been expended in furtherance of Grant purposes or returned to CMF.

V. Reporting and Disclosure

A. Annual Reports. FIMU shall provide CMF with annual reports, of a form satisfactory to CMF, including FIMU's income, expenditures and activities related to the Program during each year of each Term.

B. Final Report. In connection with the conclusion of each Term, FIMU shall provide CMF with a final report, of a form satisfactory to CMF, including FIMU's income, expenditures and activities related to the Program over ~~the~~ that Term.

C. Further Inquiries. FIMU shall provide to CMF any further information, regarding any aspect of FIMU's financial or programmatic activities, as CMF may reasonably request from time to time.

VI. General Terms and Conditions.

A. Governing Law. The laws of the State of Texas shall govern the performance, interpretation and enforcement of this Agreement, and the courts of the State of Texas shall adjudicate any dispute regarding the interpretation of either Party's rights or the performance of either Party's responsibilities hereunder.

B. Entire Agreement. This Agreement, including the attachments and exhibits hereto, contains the entire agreement of the Parties concerning the subject matter hereof, and supersedes any prior written or oral agreements between the Parties concerning the subject matter hereof.

C. Amendment. This Agreement may be modified or amended only by a writing signed by both Parties.

D. No Inferred Waivers. The failure of either Party to enforce any provision of this Agreement shall not be construed as a waiver or limitation of that Party's right to subsequently enforce and compel strict compliance with each and every provision of this Agreement.

E. Assignment. Neither Party may assign any of its rights or responsibilities hereunder except with the written consent of the other Party.

[The remainder of this page is intentionally left blank; signature page follows]

IN WITNESS WHEREOF, CMF and FIMU have executed this Agreement as of the Effective Date set forth in the introductory clause above.

CHERN MEDAL FOUNDATION

By: _____
Name:
Title:

**FRIENDS OF THE INTERNATIONAL
MATHEMATICAL UNION**

By: _____
Name:
Title:

CHERN MEDAL PROGRAM GUIDELINES

I. Selection of Medalists

A. The Medal is to be awarded to an individual whose accomplishments warrant the highest level of recognition for outstanding achievements in the field of mathematics.

B. All living, natural persons, regardless of age or vocation, shall be eligible for the Medal. Additional qualifying or disqualifying criteria may be imposed consistent with IMU policies.

II. Selection Committee

A. Each Medalist shall be selected by a Selection Committee consisting of five members.

B. A new Selection Committee shall be formed at least two years in advance of each award ceremony, for the purpose of identifying that Medalist.

C. The IMU shall appoint four members of each Selection Committee, and CMF shall appoint the fifth.

D. At the outset of each award cycle, the IMU shall nominate one of the five members of the Selection Committee as Chair of the Committee, subject to approval by CMF.

III. The Awards

A. Each Medalist shall receive a cash prize of \$250,000.

B. In addition, each Medalist may nominate one or more organizations to receive funding totaling \$250,000, for the support of research, education or other outreach programs in the field of mathematics (the "Organization Awards").

C. Each Medalist's nominees for Organizational Awards are subject to approval by FIMU, which shall grant such approval so long as the proposed awards:

1. will be qualifying, charitable distributions within the meaning of U.S. tax law;
- and
2. will substantially further the purposes of CMF, FIMU and the Grant.

IV. Other Terms and Conditions

A. The identity of each Medalist will be kept strictly confidential until the time at which that Medalist is honored.

B. CMF retains the right to enjoin any ancillary usage of any name or mark associated with the Program if, in CMF's sole discretion, such use does not appropriately reflect on or advance the interests of the Program.

* * *

Sylwia Markwardt

Von: msr@math.tifr.res.in
Gesendet: Samstag, 5. Februar 2011 04:53
An: IMU Secretary
Cc: M. S. Raghunathan; rajattan@gmail.com; 'IMU President';
lovasz@cs.elte.hu; v.srinivas.imu@gmail.com; 'IMU Administrator'
Betreff: Re: Leelavati Prize

Dear Martin,

We are almost certain that we can secure the funds needed to make the Leelavati Prize a permanent prize to be given away at the ICMs. The matter will be finalised at a meeting of the ICM Executive Organising Committee to be held towards the end of March. Once we have the funding assured I will get back to you so that we can between the Indian authorities involved and the IMU EC work out the modalities.

May I therefore suggest that the IMU EC defer the matter to a future date.

Best regards, Raghunathan

> Dear Raghunathan,

>
>
>

> The IMU Executive Committee will discuss at its next meeting in
> Perth (February 27 and 28, 2011) the prizes to be awarded at
> the ICM 2014.

>
>
>

> The new prize awarded at the closing ceremony in Hyderabad, that
> you called Leelavati Prize, was originally intended as a "one-time
> only prize". I just would like to know whether this is still the
> case or whether you and your colleagues are intending to continue
> the prize and provide the associated funding.

>
>
>

> The IMU EC thinks that a prize for "mathematical outreach" is
> generally a good idea, and there are thoughts to establish such
> a prize (forever), although the plans are not very concrete yet.

>
>
>

> The EC gives, of course, priority to you and your Indian colleagues,
> since you had the idea and came up with the first mathematical
> prize of this type. Therefore, I would like to know whether you
> are pursuing a continuation of the Leelavati Prize or whether
> the statement that this is a one-time prize is final.

>
>
>

> I would appreciate an answer before the EC meeting.

>
>

>
>
>
> Best Regards
>
>
>
> Martin
>
>
>
>
>
>

This email was sent using SquirrelMail.
"Webmail for nuts!"
<http://squirrelmail.org/>

Agreement between The Norwegian Academy of Science and Letters and The International Mathematical Union

Introduction

This agreement covers the collaboration between the Norwegian Academy of Science and Letters (Academy) and the International Mathematical Union (IMU) to support and promote mathematical research and education in developing countries. This includes support to the Ramanujan Prize for Young Mathematicians from Developing Countries awarded by the International Center for Theoretical Physics (ICTP). There is a separate agreement concerning the Ramanujan prize.

Support

The total amount of financial support by the Academy per year is NOK 350.000,-

The support will be transferred to IMU early each year after the Academy has received a report from IMU concerning activities of the previous year. The deadline for the report is February 1. Together with the report IMU will send an invoice for the present year.

Report from the Activities

The report from IMU shall include:

- Details on how funds from the Academy are spent.
- A report from the Ramanujan Prize, including a list of nominees for the prize and the report from the Prize Committee.

Agreement duration

The duration of this agreement is 5 years starting from 2011, conditioned on the continuation of the Abel Prize past 2012. In the case that the Abel Prize is not extended past December 31, 2012, this agreement will be terminated without prior notice at the same time.

Partners

- the Norwegian Academy of Science and Letters (The Academy, residing at Drammensveien 78, N-0271 Oslo, Norway), and
- the International Mathematical Union (IMU, Markgrafenstr. 32 D-10117 Berlin Germany)

For the Norwegian Academy of Science and Letters

_____ Date _____

For the International Mathematical Union

Date _____

Memorandum of Understanding between ICTP and IMU

This memorandum of understanding summarizes the terms of the "Ramanujan Prize for Young Mathematicians from Developing Countries," to be established at the Abdus Salam International Centre for Theoretical Physics (ICTP), with the Prize money coming from the Abel Foundation through the funds it provides to the International Mathematics Union (IMU).

The Prize will be awarded once every year for the highest mathematical achievement by young researchers from developing countries (as defined by the United Nations), who conduct their research in a developing country. The recipient must be less than 45 years old (on December 31 of the year for which the award is given). The Selection Committee will take into account the environment in which the work was carried out. Work in any branch of the mathematical sciences is eligible for the prize.

The Prize amount will be \$10,000, to come entirely from monies granted to IMU from the Niels Henrik Abel Memorial Fund. ICTP will bear all costs related to the administration of the Prize, travel and accommodation costs for the Prize winners and selection committee to come to ICTP, all publicity matters, and so forth.

The prize will normally be awarded to one person, but in exceptional cases may be shared equally among recipients who have substantially contributed to the same body of work.

The initial period for this MOU shall cover five awards, or whatever part of that period is covered by Abel Fund grants to IMU, after which all parties may reexamine the issue.

The Prize will be administered by ICTP through a Selection Committee of five persons set up bi-annually under the watch of the ICTP Director. The committee should have an international representation from among distinguished mathematicians with one member of the committee appointed by ICTP, one member appointed by the Executive Committee of the IMU. Three additional members will be chosen jointly by ICTP and IMU. IMU's role in these appointments may be delegated to the IMU's Developing Country Strategy Group. The membership of the Selection Committee may be staggered to allow for both frequent rejuvenation and continuity.

The Prize nominations process shall be designed and administered by ICTP.
The Selection Committee shall have the right to make additional nominations.

The goal is to be able to make the selection of the first Prize winner in 2005.

.....
K.R. Sreenivasan
Director, ICTP

.....
J.M. Ball
President, IMU

Date:

Date:

Memorandum of Understanding between ICTP and IMU

This memorandum of understanding summarizes the terms of the "Ramanujan Prize for Young Mathematicians from Developing Countries," to be established at the Abdus Salam International Centre for Theoretical Physics (ICTP), with the Prize money coming from the Abel Foundation through the funds it provides to the International Mathematical Union (IMU).

The Prize will be awarded once every year for the highest mathematical achievement by young researchers from developing countries (as defined by the United Nations), who conduct their research in a developing country. The recipient must be less than 45 years old (on December 31 of the year for which the award is given). The Selection Committee will take into account the environment in which the work was carried out. Work in any branch of the mathematical sciences is eligible for the Prize.

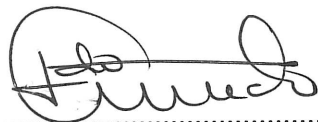
The Prize amount will be \$15,000, to come entirely from monies granted to IMU from the Niels Henrik Abel Memorial Fund. ICTP will bear all costs related to the administration of the Prize, travel and accommodation costs for the Prize winners and selection committee to come to ICTP, all publicity matters, and so forth.

The Prize will normally be awarded to one person, but in exceptional cases may be shared equally among recipients who have substantially contributed to the same body of work.

The Prize will be administered by ICTP through a Selection Committee of five persons set up bi-annually under the watch of the ICTP Director. The committee should have an international representation from among distinguished mathematicians with one member of the committee appointed by ICTP, one member appointed by the Executive Committee of the IMU. Three additional members will be chosen jointly by ICTP and IMU. IMU's role in these appointments may be delegated to the IMU's Commission for Developing Countries. The membership of the Selection Committee may be staggered to allow for both frequent rejuvenation and continuity.

The Prize nominations process shall be designed and administered by ICTP. The Selection Committee shall have the right to make additional nominations. IMU and ICTP will jointly advertise the Prize every year.

This MoU may be terminated by one of the parties on a one-year notice.



.....
F. Quevedo
Director, ICTP



.....
L. Lovász
President, IMU

Date: 14 July 2010

Date: July 14, 2010

The Ramanujan Prize

The Prize Committee

The winner of the Ramanujan Prize is chosen by a Prize Committee comprised of 5 members. After consultation with the other party, ICTP appoints two members (one of whom is the Chair) and IMU appoints two further members. One member is appointed by the Niels Henrik Abel Memorial Fund. The composition should reflect a geographic and scientific balance. The members of the committee, excluding the Chair and the member appointed by the Abel Fund, serve a non-renewable term of office of two years.

The Statutes

The purpose of the Ramanujan Prize is to recognize mathematical achievements made by young mathematicians working under less favorable conditions in developing countries.

The Prize will be awarded annually for the highest mathematical achievement by young researchers from developing countries (as defined by the United Nations), who conduct their research in a developing country. The recipient must be less than 45 years old (on December 31 of the year for which the award is given). It is an integral part of the committee's evaluation to take into account the environment in which the work was carried out. Work in any branch of the mathematical sciences is eligible for the Prize.

The Prize

The Prize amount will be USD 15,000, to come entirely from funds granted to IMU from the Niels Henrik Abel Memorial Fund. ICTP will bear all costs related to the administration of the Prize, travel and accommodation costs for the prizewinners and selection committee to come to ICTP, as well as all publicity expenses.

The Prize will normally be awarded to one person, but in exceptional cases may be shared equally by recipients who have substantially contributed to the same body of work.

The Call

The call for nominations is made jointly by the ICTP and IMU. The right to nominate is open to anyone, but self-nominations will not be considered. Nominations are valid for one year only. A nomination should include a CV and list of publications as well as a letter of recommendation. The nomination should explain in detail the working environment of the nominee. Additional letters of recommendation are encouraged.

The Announcement

The announcement of the Ramanujan Prize recipient is made jointly by the ICTP and the IMU.

Time schedule

The call is made in November (the year before), with deadline for nominations on February 1. The Prize Committee makes its selection by June 1, and the Prize ceremony is made in September at ICPT.

Duration

The duration of this agreement is 5 years starting from 2011, conditioned on the continuation of the Abel Prize past 2012. In the case that the Abel Prize is not extended past December 31, 2012, this agreement will be terminated without prior notice at the same time.

Berlin, Trieste, Oslo

IMU

ICTP

N. H. Abel Memorial Fund



DET NORSKE VIDENSKAPS-AKADEMI
THE NORWEGIAN ACADEMY OF SCIENCE AND LETTERS

President of the IMU
Ingrid Daubechies
Fine Hall
Washington Road
Princeton
NJ 08544-1000 USA

Copy: Martin Grötschel, Secretary

Oslo, February 9th 2011

Dear Ingrid Daubechies,

As you know, the Abel Prize will be awarded for the ninth time on May 24th this year by the board of The Norwegian Academy of Science and Letters following the advice given by the Abel Committee.

The five current members of the Abel Committee are Björn Engquist, Hendrik W. Lenstra, David Donoho, M.S. Raghunathan, and Ragni Piene, with the latter serving as chair of the Committee.

Two of the members, Björn Engquist and Hendrik W. Lenstra, were appointed for two years from 2009, and will accordingly resign from the Committee this year. The Norwegian Academy of Science and Letters therefore has to appoint two new members of the Abel Committee.

As we have done in previous years, we would like to ask the International Mathematical Union to kindly provide us with the names of two outstanding mathematicians who would be eligible for this important task, one of whom the Academy would choose as one of the two new members of the Committee. We would appreciate it if you could suggest at least one female mathematician. In the same manner as earlier, we will also ask the European Mathematical Society to propose the names of two mathematicians.

The board of the Norwegian Academy of Science and Letters will appoint the two new members of the Abel Committee at their board meeting in June 15th 2011.

Yours sincerely

Øivind Andersen
Secretary General

Representatives/Liaison persons on behalf of the International Mathematical Union

Body	Representative/ liaison person	(end of) Term
COSPAR	<i>Alain Bensoussan</i>	2010
Gruber Foundation Cosmology Prize	Roger Penrose	2011
ICMI	<i>Cheryl Praeger</i>	2010
CEIC	László Lovász	2014
IMU-Net editor	Mireille Chaleyat-Maurel	2014
IMU-Net EC correspondent	<i>Ragni Piene</i>	2010
Niels Henrik Abel Memorial Fund	<i>Ragni Piene</i>	2010
Ramanujan Prize	<i>Marcelo Viana</i>	2010
ICHM	Jesper Lützen Kim Plofker	2014 2014
Curator of the IMU archive	<i>Guillermo Curbera</i>	2010
UNESCO	<i>Michèle Artigue</i>	2010
ICSU	<i>Manuel de León</i>	2010
<i>ICSU Ad hoc Group on Weighted Voting</i>	Marcelo Viana	???
<i>ICSU Virtual Working Group on Publication Ethics</i>	John Ball	???
ICSU Regional office for Latin America and the Caribbean (ROLAC)	<i>Marcelo Viana</i>	2010
ICSU Regional office for Asia and the Pacific (ROAP)	<i>Manuel de León</i> <i>Zhiming Ma</i> <i>Cheryl Praeger</i>	2010 2010 2010
ICSU Committee on DATA for Science and Technology (CODATA), and ICSU World Data System (WDS)		

Scientific Program of the International Congress of Mathematicians (ICM)

Guidelines for the Program Committee (PC) and the Organizing Committee (OC)

Version endorsed by the IMU Executive Committee on November 21, 2007

1. General purpose of ICMs

International Congresses of Mathematicians are the most important IMU activity and need correspondingly careful preparation. Every ICM should reflect the current activity of mathematics in the world, present the best work being carried out in all mathematical subfields and different regions of the world, and thus, point to the future of mathematics. The invited speakers at an ICM should be mathematicians of the highest quality who are able to present current research to a broad mathematical audience.

2. Responsibilities of the Program Committee

2.1 The PC is responsible for the preparation of the Scientific Program of the ICM. It decides

- the structure of the program (e.g. the sections and their precise definition, the kind of lectures, their number, their purpose, and their arrangement, whether to have short communications and poster sessions);
- the list of invited plenary and sectional speakers.

It is understood that all decisions about the ICM structure use the programs of previous ICMs as rough guidelines, but that innovations are, of course, not ruled out.

2.2 In its decision making with respect to the selection of panel chairs and members, and in particular, with respect to the plenary and sectional speakers, the PC should take into account appropriate

- gender balance
- geographical/regional distribution (including smaller countries as appropriate)
- representation of developing countries
- representation of subfields of mathematics

as long as these considerations do not compromise mathematical quality. Here a person represents the country that he or she lives and works in.

2.3 The privilege of sending the invitations belongs to the Organizing Committee (OC) of the ICM. Recommendations about the quality of the presentation and the

expected audience of the lectures (see 3.1 for plenary lectures) are to be emphasized in the letters of invitation. The invited speakers should also be informed about technical equipment available in the lecture rooms and receive hints about making best use of these.

- 2.4 In addition to carrying out its task detailed in 2.1, the PC may make further recommendations to the OC and/or to the Executive Committee (EC) of the IMU, concerning the arrangement of the program, that will, in their opinion, enhance the prospects of success of the ICM as a continuing institution.
- 2.5 The IMU hopes that every PC member will make every effort to attend the Congress.

3. Plenary, sectional, special, and other lectures, further activities at the ICM

3.1 Plenary lectures

Plenary lectures are invited one-hour lectures to be held without other parallel activities. When choosing the speakers, the PC should take into account that diversity of themes is most desirable. If two lecturers are likely to have a partial overlap, it is the duty of the PC to make sure that the OC brings this to the attention of the lecturers concerned. The lectures should be broad surveys of recent major developments, aimed at the entire mathematical community. Plenary speakers should be outstanding mathematicians and good lecturers. It is the privilege of the PC to select the plenary speakers. The PC may ask the sectional panels for advice but is not bound by such suggestions.

3.2 Sectional lectures and sectional panels

Sectional lectures are invited 45-minute lectures. Several sectional lectures are scheduled in parallel. The number of parallel sections will depend on the number of sections and sectional speakers chosen. The PC appoints a sectional panel that provides a (possibly) ordered list of suggested speakers. The panel should propose about 50% more speakers than the number of speakers allotted to the section so that the PC has some flexibility, e.g., to meet the goals of 2.2. The PC is free to negotiate with a panel on its suggestions. In case of conflicts the PC has the final decision.

3.3 Lectures associated with the IMU prizes, media coverage

Since the names of the winners of the IMU prizes will only be made public at the opening ceremony of the ICM it is not possible to precisely schedule lectures of the prize winners in advance, and the number of such additional lectures needed will vary. For example, it may happen that a prize winner is already giving a plenary lecture. The OC should thus schedule five open one-hour slots for possible prize lectures (4 for Fields medalists, 1 for the Nevanlinna Prize winner),

some of which may not be needed. In addition, two more such slots are needed for the Gauss Prize and the Chern Medal lectures.

Reports on the work of the Fields medalists and Rolf Nevanlinna Prize winner are to be provided for at the beginning of the Congress, if possible on the first day. The speakers are appointed by the medals and prize committees and are not to be made public before the meeting.

An account of the work of the Gauss Prize winner will be provided in the Gauss Prize lecture. This lecture should aim at the general public. It is to be scheduled, if possible, on the second day of the meeting. The speaker of the Gauss Prize lecture will be determined by the Gauss Prize committee. The speaker's name should only be made public during the opening ceremony.

An account of the work of the Chern Medal winner will be provided in the Chern Medal lecture. This lecture should aim at the general public. It is to be scheduled, if possible, on the second day of the meeting. The speaker of the Chern Medal lecture will be determined by the Chern Medal committee. The speaker's name should only be made public during the opening ceremony.

The practical arrangements are the responsibility of the Organizing Committee.

Arrangements for media coverage are the joint responsibility of the OC and the IMU. The President of IMU will communicate the names of the prize winners, speakers, and prize committee members to the chair of the OC in sufficient time for necessary arrangements (for example, travel and accommodation, naming of committees in the printed programs, media coverage) to be made. This will in turn entail that a small number of OC members will also need to know confidential information, and it is the responsibility of the chair of the OC to do everything possible to ensure that there is no leakage of this information.

3.4 Short communications, poster sessions, unscheduled mathematical activities

It has become customary throughout the world that granting travel support often depends on the delivery of a lecture or presentation of a poster. The OC is requested to provide – depending on the available facilities – space and time for such presentations. It should discuss and possibly coordinate its activities in this direction with the PC. The contributed presentations need review to avoid the presentation of obviously wrong, or trivial, results. The review of contributed presentation is a demanding task and can only be done by the OC.

Unscheduled mathematical activity, by small groups of people acting on their own initiative by organizing small seminars or the like, should be encouraged. The OC should take into account that such requests may arise spontaneously during the Congress.

3.5 Emmy Noether lecture

The series of Emmy Noether lectures honours women who have made fundamental and sustained contributions to mathematics. The Emmy Noether lecturer shall be chosen by a committee appointed by the IMU EC. The committee

is advised to make its final choice after the PC has decided on the list of ICM speakers.

3.6 Other activities

The General Assembly has repeatedly recommended the scheduling of some less formal scientific events of broad interest during the Congress for ICM participants and/or the general public such as lectures for a broader audience, round tables, video or software demonstrations, exhibitions, etc. The PC may suggest such activities, but the responsibility for organizing them lies with the OC.

4. Dissemination and publication of ICM contributions

4.1 The OC is responsible for the collection of contributions and production of the proceedings of the Congress. All arrangements must be approved by the EC, and the PC can make recommendations about this part of the Congress.

4.2 The IMU must have a non-exclusive, irrevocable, and perpetual license to distribute the proceedings in print and electronic form, by all present and future means, possibly with a delay of up to two years following the Congress. The OC arranges for the initial publication of the Congress proceedings. The OC should obtain a suitable transfer of rights from all contributors whose work appears in the proceedings, as well as electronic files for each contribution. The OC is responsible for providing precise guidelines as to how abstracts and papers should be submitted. Abstracts of all plenary and sectional lectures should be made available at the Congress in printed form. The OC is requested to also provide an abstract booklet of the contributed presentations.

4.3 The following are recommended arrangements:

- If possible, the invited plenary and sectional lectures should be published before the Congress in printed and electronic form.
- It has become customary to print a daily ICM newsletter that informs the Congress participants of highlights of the day, special activities, and program changes. The OC is asked to consider the dissemination of such information.

5. Composition and appointment of the PC

5.1 It is the privilege of the IMU President to select the chair of the PC. The chair should be chosen before the EC meeting in Year 1 of the EC term. At this first EC meeting, all other PC members are appointed by the EC in consultation with the PC chair. It is desirable that PC members have ICM or IMU experience, e.g., as an invited speaker of a previous ICM.

- 5.2 The PC should have at most 12 members with at least one member nominated by the host country. The name of the PC chair will be made public upon appointment via IMU-Net. The names of all other PC members are to be kept secret until the Congress, when all names will be made public.
- 5.3 In choosing the membership of the PC the EC should ensure that there is appropriate subfield, gender and geographical balance, including membership from those working in developing countries.
- 5.4 The selection of the PC members needs coordination with the selection of the members of IMU prize committees. Members of prize committees should neither be PC members nor members of sectional panels. Prize committee members have to be informed about this side constraint in their letter of invitation.

6. Guidelines for the work of the PC

- 6.1 The PC chair should be invited to the EC meeting where the other PC members are chosen. In that meeting the PC chair and the EC should agree on general targets to be met concerning the number of sections, the number of plenary and sectional speakers, the composition of panels, and the issues mentioned under 2.
- 6.2 The PC should start its work in Year 1 of the EC term by defining the sections of the ICM. Next the PC should also appoint, for each section, the panel chairs and set up the sectional panels that will suggest plenary and sectional speakers. The PC chooses the panel chair and panel core members (usually 3-4). Then the core members plus the chair select the rest of the panel (total of about 6-8). The PC must complete the lists of plenary and sectional speakers one year before the beginning of the ICM. The PC has full responsibility for the decisions, but is advised to communicate with the IMU President before final decisions are made, in particular those concerning description of sections, panel composition, and lists of speakers, or where conflicts of interest occur.
- 6.3 The following rules should be applied:
- The composition of the panels should reflect gender balance and geographical spread.
 - No PC member should be a plenary or sectional speaker.
 - Members of the sectional panels should not be selected as speakers in their section, but may be chosen as invited speakers if proposed by another sectional panel.

The invitation letter to join the PC or a panel should contain these guidelines, and the rules of item 6.3 should be pointed out in particular.

- 6.4 A member of the OC may be a plenary or sectional speaker, unless he or she is a PC member. A member of the OC being a member of one sectional panel may be a plenary or sectional speaker if proposed by another sectional panel.
- 6.5 For the section on "Mathematics education; popularization of mathematics", the PC should consult with the ICMI president when choosing the panel chair. Two of the core members of the panel should be nominated by the ICMI EC. For the section on "History of mathematics", ICHM should be involved in the choice of panel members.
- 6.6 The final lists of plenary and invited speakers should be sent to the president of the OC, who has the privilege to send the invitation letters on behalf of IMU.
- 6.7 The PC's responsibility for the plenary and sectional lectures ends with the submission of the speaker list. Communication with the lecturers, requests for abstracts and the written texts belong to the task of the OC. If invited speakers reject the invitation and if the substitution process defined by the PC was not successful the OC has to contact the PC chair to decide on alternate invitations.

7. Suggested timeline for the work of the PC and OC

7.1 Year 1

PC chair's name is made public after appointment via IMU-Net by the Secretary.

After first EC meeting: IMU Secretary informs Adhering Organizations and mathematical societies that the PC has been appointed. Suggestions for ICM program structure are invited. The same is done electronically via IMU-Net. Coordination with the PC chair is necessary concerning the deadline for proposals.

September: Decide on the structure of the scientific program of the ICM (including revision and update of the description of the sections), decide on short communications and poster sessions, other sessions (e.g. mathematical software), decide on eventual modification of number of speakers.

September-December: First PC meeting should take place, suggest panel chairs and core panel members.

7.2 Year 2

January: Appoint panel chairs.

January-February: Appoint additional 2–4 core members of each sectional panel.

February-May: The panel chairs and core members appoint the remaining panel members in consultation with the PC chair (see 8.1 and 5.4). The PC chair informs the Secretary about the composition of all panels.

After ICM program structure has been fixed IMU Secretary invites proposals from Adhering Organizations and mathematical societies for invited plenary and sectional speakers. The same is done electronically via IMU-Net.

May-December: Collect suggestions for plenary and sectional speakers from the panels, from individuals and organizations considered suitable. The PC may steer interaction between some panels, in particular, if there are overlapping suggestions.

7.3 Year 3

January: All suggestions should be received.

January-March: Final PC meeting should take place, finalizing the choices in consultation with the IMU President (see 6.2).

April: Send final list of speakers and alternates to OC and President of IMU.

August: OC receive acceptance from all invited speakers (or alternates).

September: OC posts the list of speakers on the ICM web pages.

7.4 The deadlines of this timeline should be firmly kept. The PC chair is requested to remind and strongly encourage the colleagues involved to deliver the results in time.

8. Guidelines for the sectional panels

8.1 The panel chair and the core members choose the remaining panel members and subject to approval by the PC chair, in view of 5.4.

8.2 The following rules apply:

- No person should serve on two sectional panels.
- Experience and tradition need to be transported to panels. Therefore, at least one core member should have some IMU/ICM experience, e.g., former EC member, previous panel member, former plenary or sectional ICM speaker, or former PC member. However, the number of persons serving on a panel twice should be kept low in order to include in the decision-making process large parts of the scientific community and to avoid "closed shops".
- For some sections it may be advisable to seek nominations for panel members from international mathematical societies representing the areas covered. Examples could be the Bernoulli Society for stochastics and the Mathematical Programming Society for optimization and control theory.

8.3 The names of all panel chairs and members are to be kept secret until the Congress, when all names will be made public. The PC chair instructs all panel chairs that the panel work is to be kept confidential. In turn, the panel chairs let all panel members know their obligation not to disclose any details of their panel work.

9. Financial issues

- 9.1 IMU covers the expenses for meetings of the PC and the prize committees. Before making financial commitments the committee chairs have to contact the IMU Secretary concerning the budget available. All other financial matters are the responsibility of the Organizing Committee of the Congress.
- 9.2 A large-scale activity such as an ICM cannot be organized without the voluntary contribution of many individuals of the mathematical community. It is therefore understood that PC, panel members and invited speakers do not receive a honorarium. The OC is, however, asked to waive the registration fee for all invited speakers and the PC members.
- 9.3 The OC should be prepared to help some of the invited speakers and PC members if they have difficulties to receive financial support or to pay for their ICM attendance by covering part of the local and/or travel expenses.
- 9.4 It has become a tradition to make particular efforts that groups of mathematicians who have insufficient financial means, such as young mathematicians from developing countries, are partly supported to make their ICM attendance possible. Who is supported, in what way and how the selection is made depends on local circumstances, available funds, and the location of the ICM. The OC and IMU should negotiate on these issues and reach a consensus very early in the preparation phase so that application processes can be opened in time. The OC and IMU similarly negotiate how to handle the financial support (registration fee, local and/or travel expenses) for members of prize committees, prize winners, and persons delivering reports/lectures on their work.

10. Special issues/recommendations

- 10.1 The previous PC chair should be invited to the first meeting of the new PC.
- 10.2 The PC chair is supposed to prepare a final report to the EC on the work of the PC, pointing out, in particular, problems that were encountered and suggestions for improving the work of future PCs and for updating these guidelines.
- 10.3 All available final PC reports are to be made available (confidentially) to a newly appointed PC.
- 10.4 The IMU should keep a database of persons who have served on PCs or sectional panels, have been chairs of such committees, or have been plenary or invited speakers.
- 10.5 The Organizing Committee of the ICM host country has the right to appoint one additional plenary speaker and up to four additional sectional speakers. The PC

should negotiate with the president of the OC a mode for nominating the speakers from the host country so that the local choices can be taken into account when the final balancing is made. One possibility could be that the OC provides the PC with a list of nominees, not necessarily ordered, from which the PC can choose one plenary speaker and up to four sectional speakers. This will give the PC some flexibility with respect to the issues mentioned in 2.2.

- 10.6 Letters for panel chairs and panel members could follow the appended model letters.
- 10.7 Panel chairs should know the names of the other panel chairs, so that they may coordinate their selection processes when there are overlapping areas between two or more sections.
- 10.8 A panel can suggest a joint invitation for one lecture; two mathematicians can be invited together to report primarily on a joint project. In each such case, those invited can decide who will deliver the lecture.
- 10.9 The IMU Secretary should make sure that the OC sends invitations to the Congress to all persons serving on the PC and on sectional panels by making postal and/or e-mail addresses available to the OC.
- 10.10 These guidelines should be regularly updated.

Abbreviations:

EC	Executive Committee of the IMU
ICHM	International Commission on the History of Mathematics (a commission of the IMU)
ICM	International Congress of Mathematicians
ICMI	International Commission on Mathematical Instruction (a commission of the IMU)
ICMI EC	Executive Committee of the ICMI
IMU	International Mathematical Union
OC	Organizing Committee of the ICM
PC	Program Committee of the ICM

Section lists ICMs 2010, 2006, 2002, 1998

	2010	2006	2002	1998
1	Logic and foundations	Logic and Foundations	Logic	Logic
2	Algebra	Algebra	Algebra	Algebra
3	Number theory	Number Theory	Number Theory	Number Theory and Arithmetic Algebraic Geometry
4	Algebraic and complex geometry	Algebraic and Complex Geometry	Algebraic and Complex Geometry	Algebraic Geometry
5	Geometry	Geometry	Differential geometry	Differential Geometry and Global Analysis
6	Topology	Topology	Topology	Topology
7	Lie theory and generalizations	Lie Groups and Lie Algebras	Lie Groups and Representation Theory	Lie Groups and Lie Algebras
8	Analysis	Analysis	Real and Complex Analysis	Analysis
9	Functional analysis and applications	Operator Algebras and Functional Analysis	Operator Algebras and Functional Analysis	
10	Dynamical systems and ordinary differential equations	Ordinary Differential Equations and Dynamical Systems	Ordinary Differential Equations and Dynamical Systems	Ordinary Differential Equations and Dynamical Systems
11	Partial differential equations	Partial Differential Equations	Partial Differential Equations	Partial Differential Equations
12	Mathematical physics	Mathematical Physics	Mathematical Physics	Mathematical Physics
13	Probability and statistics	Probability and Statistics	Probability and Statistics	Probability and Statistics
14	Combinatorics	Combinatorics	Combinatorics	Combinatorics
15	Mathematical aspects of computer science	Mathematical Aspects of Computer Science	Mathematical Aspects of Computer Science	Mathematical Aspects of Computer Science
16	Numerical analysis and scientific computing	Numerical Analysis and Scientific Computing	Numerical Analysis and Scientific Computing	Numerical Analysis and Scientific Computing
17	Control theory and optimization	Control Theory and Optimization		Control Theory and Optimization
18	Mathematics in science and technology	Applications of Mathematics in the Sciences	Applications of Mathematics in the Sciences	Applications
19	Mathematics education and popularization of mathematics	Mathematics education and popularization of Mathematics	Mathematics Education and Popularization of Mathematics	Teaching and Popularization of Mathematics
20	History of mathematics	History of Mathematics	History of Mathematics	History of Mathematics

WORKING GROUP ON JOURNAL RANKINGS AND PRICING

DOUGLAS N. ARNOLD, CAROL HUTCHINS, JOHN D. S. JONES, NALINI JOSHI,
MALCOLM A. H. MACCALLUM, PETER MICHOR, STEFAN MÜLLER, AND TAO TANG

1. SUMMARY

1. Bibliometric data are used by organizations such as universities, funding agencies, libraries, to make decisions on the quality of a researcher (e.g., for promotion or grant assessment) or a journal (e.g., for purchase). [*The ERA results released in Australia on 31 Jan 11 rely almost entirely on such data.*]
2. Distortions in bibliometric data exist and can arise from deliberate manipulation (pointed out recently in the mathematical sciences by Arnold and Fowler, arXiv 1010.0278).
3. While many decisions about quality of a researcher or journal may be made by groups that include mathematicians, others rely on bibliometric data common in other fields and thereby make errors of judgment about mathematicians and mathematical journals. [*As Head, I had to argue against the decisions of promotion committees, which wanted to use such data to deny promotion to deserving mathematical candidates.*]
4. An informed ranking of journals in the mathematical sciences may provide a resource to enable mathematicians around the world to counter decisions relying on rankings based on absolute bibliometric data in other scientific fields or other factors. [*I am sorry to note that this includes corruption, based on information provided by a mathematician in another country concerned by what appears to be corrupt behaviour related to their national society's journal.*]
5. Rankings of journals that attempt to be very broad in their reach or those that are multi-disciplinary journals may rely on perceptions that are different to those that are narrower in their coverage. Moreover, rankings may vary from one sub-field to another. [*In Australia, physicists and mathematicians had very different views of journals in mathematical physicists. Also, analysts had very different opinions of journals in which combinatorialists published.*]
6. To be acceptable to the international mathematical community, such a ranking would have to be sanctioned and overseen by a respected international body such as the IMU and ICIAM.

It should be noted that a significant minority opinion was expressed against a ranking of journals, because it would appear to endorse the view that a paper could be judged by where it appears, rather than by its intrinsic quality as a paper.

Proposing a ranking should not mean that the IMU proposes to judge contributions to different fields of mathematics by just one measure. At least one member of the working group worried about the unintended consequences of such an adoption of a single measure, in particular for science policy makers and influential people from other sciences. It was suggested that adopting a ranking of journals as the only measure of quality could have the unintended implication that others outside mathematics could rely on only one measure too, such as impact factor. In areas such as molecular biology impact factor appears to work

Date: 19 February 2011.

Version 5, removing a duplicate sentence in item 11 noted by Carol Hutchins, incorporating typographical corrections provided by Malcolm MacCallum, addenda to item 11 provided by Carol Hutchins and Stefan Müller and addenda to item 6 provided by Malcolm MacCallum and Peter Michor.

pretty well, since there are so many laboratories and biologists around the world working on closely related subjects. But impact factor is not a good measure for mathematics. Adopting a ranking based on impact factor would reduce the percentage of science budgets going to mathematics (4% usually in most countries, while in France it is 7%). On the other hand, an IMU/ICIAM endorsed ranking might have a positive effect on the question of good allocation of budget inside mathematics. To counteract the unintended effect of adopting a single measure, it was suggested that IMU/ICIAM should also endorse other alternative rankings that have been produced or influenced by mathematical communities around the world, such as the AMS ranking of journals based on MCQ and the ERA ranking of journals in Australia.

7. A detailed ranking of journals in the mathematical sciences is likely to be time consuming to initiate and maintain. A coarse ranking, containing a few bands, may take some effort to initiate but may be easier to maintain.
8. A rankings committee modeled on the invited speakers committee of IMU/ICIAM/IMS could undertake this work. A possible model is to have a committee of 15-30 members, which appoints approximately 30 sub-panels, each with an average of 10 members. Each panel would be assigned an average of 40 journals to consider, with some journals assigned to multiple panels. One estimate puts the workload for a panel member as rating 8 journals and reviewing the ratings for approximately 40 journals. Another estimate puts the workload in terms of number of papers: approximately 400 reviewers who would rank 50-200 papers each.
9. Possible legal implications of a ranking system or changes in the behaviour of organizations will need more consultation to clarify.
10. It will be difficult to include preprint servers in the ranking.
11. No specific suggestion about pricing of journals was discussed. However, it was noted that many large publishers are creating and marketing their journals in broad subject groupings. It then becomes difficult to disentangle lowly ranked journals from the higher ranked ones in each grouping.

Access to the mathematical literature is crucial for research in mathematics. Often the role of excellent libraries for the mathematics is compared to the role of state of the art laboratory facilities in the experimental sciences. For an extended period, the prices of journals have risen significantly above inflation. This puts a serious threat to research and education in the mathematics. Recently journals are increasingly sold in larger bundles through consortia in particular by large publishers. While this trend has somewhat reduced the average cost per journal it also carries a number of disadvantages and risks, one of which is noted in the previous paragraph. Moreover, decisions on consortia are usually made on the level of a whole university or a consortium of universities. Specific aspects of mathematics, which highly depends on excellent access to the literature may not receive sufficient attention. Also increasing reliance on big consortia is likely to increase the dominance of very few very big publishers. As has been noted before the issue of journal pricing is complex and given the time frame this committee could not prepare any comprehensive proposal. It is recommended that IMU and ICIAM continue to give high priority to this issue and appoint a new committee to continue the investigation of this issue.

12. Other discussion touched upon future problems with longevity and durability of electronic records of papers.

**International Council for Industrial and Applied Mathematics (ICIAM)
International Mathematical Union (IMU)**

"Working Group on Journal Ranking and Pricing"

Terms of Reference

Introduction

One of the main current issues in mathematics (and other scientific disciplines) is the development of its scientific publication market and the role scholarly publications play. A particular problem is the use and misuse of citation data for the assessment of scientific research. The joint IMU/ICIAM/IMS Committee on Quantitative Assessment of Research discussed this issue at depth through its report "Citation Statistics". Despite the findings of this report, citation metrics such as the impact factor are increasingly used for the evaluation and ranking of journals, papers, individuals, projects and even whole departments. Hiring decisions, budget allocations, etc. are influenced by these numbers worldwide. In addition to the fact that the objectivity of these numbers is illusory, the magnitude of these numbers varies considerably between scientific disciplines, and this may hurt mathematics.

An additional aspect is that publication habits are beginning to change. Scientists rely increasingly on preprint servers which make current results much more quickly available than journals. Their value and the value of this service are frequently not considered by decision makers. One reason for the growth of "open access publication systems" is also that, despite gains in efficiency through new technology, journal prices are rising and, due to static or decreasing budgets, access to the published mathematical literature is becoming increasingly difficult for many.

Mathematics has to react to this situation. The current initiative was prompted by the paper "Nefarious Numbers" by D. N. Arnold and K. K. Fowler, the proposal "Thoughts about journals and the role of international mathematical organisations" by S. Mueller, and the questions by many "What actions should follow the findings of the "Citation Statistics" report?"

The Charge

1. The working group is charged with the task of proposing ideas to ICIAM and IMU of how to actively react to the situation described above.
2. Each proposed idea should be accompanied by an estimate of the efforts involved in establishing and maintaining an implementation of the idea in the long run.
3. The working group is asked to comment on the possible effects of each proposal, in particular, on changes in the behavior of researchers, universities, funding agencies, publishers etc. Are these acceptable? May there be legal implications?

4. One possible proposal could be a ranking system for journals created by the mathematical community. In addition, does it make sense to include preprint servers in such a ranking? If so, how? Is the work-load in establishing and maintaining a community based system acceptable? And will in practice sufficiently many mathematicians be prepared to be involved on a continuing basis? How can this process be organized?
5. The working group is also asked to consider what other possible options there may be for protecting against the inappropriate use of impact factors and similar manipulable indices for evaluating research.

The Executive Committees/Boards of IMU and ICIAM intend to discuss the ideas presented by the working group in depth in order to decide which of the possible routes to follow. IMU has its next EC meeting on February 26 and 27, 2011. It would, thus, be very helpful to have the report by 18 February, 2011.

Working Group Members:

Nalini Joshi <nalini.joshi@sydney.edu.au>, Chair of the Working Group
Phone: +61 2 9351 2172
Immediate Past President, Australian Mathematical Society, Australia

Douglas N. Arnold <arnold@umn.edu>
Phone: +1 612 626 9137
President, Society for Industrial and Applied Mathematics (SIAM), USA

Carol Hutchins <hutchins@nyu.edu>
Phone: +1 212 998 3314
Head Librarian, Courant Institute, New York, USA

John Jones <J.D.S.Jones@warwick.ac.uk>
Phone: +44 24 7652 3456
Publications Secretary, London Mathematical Society, UK

Malcolm MacCallum <M.A.H.MacCallum@bristol.ac.uk>
Phone: +44 117 980 6303
Director, Heilbronn Institute for Mathematical Research, University of Bristol, UK

Peter Michor <peter.michor@esi.ac.at>
Phone: +43 1 4277 50618
Fakultät für Mathematik, Universität Wien, Austria

Stefan Müller <stefan.mueller@hcm.uni-bonn.de>
Phone: 49 228 73 62253
Hausdorff Center for Mathematics, Bonn, Germany

Tao Tang <ttang@hkbu.edu.hk>
Phone: +852 3411 5148
Acting Vice President, Hong Kong Baptist University, Hong Kong

Terms of Reference approved by the ICIAM/IMU leadership on October 19, 2010

Services Agreement

This Agreement is by and between Friends of the International Mathematical Union (“FIMU”), a non-profit corporation organized under the laws of the State of Rhode Island, and the American Mathematical Society (“AMS”), a corporation organized under the laws of the District of Columbia, as of the first day of September, 2009 (the “Effective Date”). FIMU and the AMS may each be referred to herein as a “Party” and may collectively be referred to herein as “Parties.”

The Parties share a common mission of fostering research and scholarship in mathematics.

FIMU has no management or administrative staff other than the elected and appointed directors and officers who act in a part-time capacity and who may reside outside the State of Rhode Island. FIMU has no need for any staff on a permanent ongoing basis nor does it wish to incur the expense and administrative responsibility to employ individuals directly; and

The AMS has a full-time staff and maintains office and administrative facilities as a part of its corporate function. The AMS is interested in promoting and assisting FIMU in fulfilling its charitable activities.

THEREFORE, the Parties agree as follows:

1. Scope of Services. The AMS will provide office resources, administrative support, recordkeeping services and other services that FIMU shall require or deem necessary to fulfill its organizational needs and charitable purposes.
 - a. Administrative services for awarding of the quadrennial Chern Medal will be performed by AMS personnel. Such services may include assistance in the receipt and deposit of funds and the disbursement of funds in accordance with instructions of FIMU.
 - b. AMS personnel will receive, deposit and acknowledge contributions to FIMU. The AMS will acknowledge contributions on behalf of FIMU using processes and forms similar to those used by the AMS to acknowledge contributions to the International Mathematical Union Special Development Fund through 2008.
 - c. Services requiring professional expertise will be outsourced to an appropriate person or firm subject to the prior consent of FIMU communicated to the AMS by the Secretary of FIMU. In particular, the annual filing of Internal Revenue Service Form 990-PF and the performance of a routine Annual Financial Review will be delegated to an independent accountant. Legal functions such as filing of the Non-Profit Corporation Annual Report for the State of Rhode Island will be delegated to a lawyer experienced in the non-profit sector.
2. Recordkeeping and Reporting. The AMS will maintain accounting records of receipts and disbursements it handles on behalf of FIMU. The AMS will provide FIMU with a list of contributions received during each calendar year within three months after the end of

such year. The list will include donor contact information and dates and amounts of contributions. The AMS will provide an unaudited record of receipts and disbursements to the Treasurer of FIMU at least semiannually within three months after the end of each half year. The AMS will provide the Treasurer of FIMU and FIMU's auditors and accountants access to all financial records of FIMU, including in particular records necessary for compiling financial statements, preparing tax returns, and auditing FIMU's financial statements, at any time upon reasonable notice to the AMS. The AMS shall facilitate the fulfillment by FIMU of any of its financial reporting obligations, but is not obligated to prepare any financial reports apart from the records of receipts and disbursements.

3. Payment for Services and Other Direct Costs. FIMU will pay all direct costs of outsourced professional services such as accountant's and lawyer's fees. FIMU shall reimburse all out of pocket costs paid by the AMS on FIMU's behalf. FIMU shall pay the AMS \$600.00 per annum as compensation and reimbursement for services provided by AMS personnel under this Agreement. The fee paid to the AMS will be renegotiated at the time of renewal of this Agreement pursuant to paragraph 4. The AMS will invoice these expenses at least annually, and payment will be due within 30 days of such invoice.
4. Term of the Agreement. The initial Term shall be for one year from 1 September 2009 through 31 August 2010. The AMS will continue to support FIMU after the end of the initial Term until the earlier of the date by which all FIMU responsibilities in connection with the 2010 Chern Medal have been discharged or six months following the date of termination. This Agreement renews automatically at the end of each Term, for a renewal Term of four years coinciding with the award of the quadrennial Chern Medal. At the end of each renewal Term, the AMS will continue to support FIMU until the earlier of the date by which all FIMU responsibilities in connection with the Chern Medal of that renewal Term have been discharged or six months following the date of termination.
5. Termination. Either Party may terminate this Agreement upon six months written notice to the other Party. If this Agreement is terminated, the AMS shall cooperate with FIMU to provide the expeditious transfer of files and records to such persons or organizations as FIMU may designate in writing.
6. Jurisdiction. This Agreement shall be governed by the laws of the State of Rhode Island. In the event that there is any dispute among the Parties and there is any action or proceeding to resolve the dispute, whether by suit, arbitration or otherwise, the Parties agree that the State of Rhode Island shall be the jurisdiction in which the dispute is resolved.
7. Regulatory Compliance. Responsibility for timely compliance with regulatory requirements to which FIMU may be subject remains with FIMU.

Draft of 10 September 2009

IN WITNESS WHEREOF, FIMU and the AMS have executed this Agreement as of the Effective Date set forth in the introductory paragraph above.

AMERICAN MATHEMATICAL SOCIETY

By: _____

Name: _____

Title: _____

FRIENDS OF THE INTERNATIONAL
MATHEMATICAL UNION

By: _____

Name: _____

Title: _____

B Y - L A W S
of
FRIENDS OF THE INTERNATIONAL MATHEMATICAL UNION

(As Adopted July 17, 2008)

Article I

PURPOSES, POWERS AND NON-PROFIT STATUS

Section 1. Purposes. Friends of the International Mathematical Union (the "Corporation") is organized to carry out the purposes set forth in Article Third of the Articles of Incorporation of the Corporation, from time to time in effect (the "Articles of Incorporation").

Section 2. Powers. The Corporation shall have all the powers enumerated in the Rhode Island Non-Profit Corporation Act, as from time to time amended (the "Non-Profit Corporation Act") provided however, the Corporation shall exercise its powers only in furtherance of exempt purposes as such terms are defined in Section 501 (c) (3) of the Internal Revenue Code of 1986, as amended, and the regulations from time to time promulgated thereunder (the "Code").

Section 3. Non-Profit Status. The Corporation is not organized for profit and, unless otherwise permitted by 7-6-31 of the Non-Profit Corporation Act, no part of the net earnings of the Corporation shall inure to the benefit of or be distributable to any member, Director, or officer of the Corporation or any other person, except that the Corporation shall be authorized and empowered to pay reasonable compensation for services rendered and to make payments and distributions in furtherance of the purposes set forth in the Articles of Incorporation. In the event of any liquidation or dissolution of the Corporation, no Director or officer shall be entitled to any distribution or division of the Corporation's property or the proceeds thereof, and upon such liquidation, the Board of Directors of the Corporation, after the payment and discharge of or provision for all its debts and obligations, shall distribute all of the assets of the Corporation to such organization or organizations which, at the time of distribution, qualify

as exempt from federal income tax under Section 501(c) of the Code. Any of such assets not so disposed of shall be disposed of by the Superior Court of the county in which the principal office of the Corporation is then located, exclusively for such purposes or to such organization(s) as said court shall determine, which are organized and operated exclusively as organizations exempt from federal income tax under Section 501(c) of the Code.

Article II

OFFICES

The Corporation shall have its principal office at 201 Charles Street, Providence, Rhode Island 02904-2294 and may have other offices at such places within and outside the State of Rhode Island as may from time to time be determined by the Board of Directors.

Article III

MEMBERS

The Corporation shall have no members. The Board of Directors may, in its sole discretion, amend these By-Laws in the future to provide for the admission, qualifications and rights and privileges of members.

Article IV

DIRECTORS

Section 1. Powers. The affairs of the Corporation will be managed by the Board of Directors. The President shall appoint the person to preside over the meetings of the Board.

Section 2. Number and Selection. Except with respect to the initial Board of Directors, which shall consist of four (4) Directors, upon election of a fifth Director and thereafter, the number of Directors will be fixed at five (5). The Directors shall be selected as follows:

- (a) One (1) Director shall be the President of the International Mathematical Union;
- (b) One (1) Director shall be the Secretary of the International Mathematical Union; and
- (c) Three (3) Directors shall be appointed by the Board of Directors of the International Mathematical Union.

Section 3. Constitution and Term.

Section 3.1. Directors. The initial Board of Directors consists of those persons named in Article Sixth of the Articles of Incorporation.

Section 4. Meetings.

Section 4.1. Annual Meeting. The annual meeting of the Board of Directors shall be held on the first Thursday of April in each year if not a legal holiday in the place where it is to be held, and, if a legal holiday, then on the next day following which is not a legal holiday, beginning at 10:00 a.m. or such other date and time within the month of April in each year as the Directors shall designate; provided however, that the Directors may designate the date of the International Mathematical Union Executive Committee Meeting as the date of the Corporation's annual meeting. The annual meeting shall be held for the purposes of electing Directors whose terms expire, electing officers and transacting such other business as may properly come before the meeting. If for any reason the annual meeting of the Board of Directors shall not be held, the President shall cause a special meeting to be held in lieu of the annual meeting of the Board of Directors.

Section 4.2. Regular and Special Meetings. The Board of Directors may hold meetings, both regular and special, either within or outside the State of Rhode Island. Regular meetings of the Board of Directors may be held at such time and at such place as may from time to time be determined by the Board of Directors, provided that reasonable notice of the first regular meeting following any such determination shall be given to absent Directors. The Board of Directors shall cause a schedule of regular meetings to be given to each Director.

Special meetings of the Board of Directors may be called, and on the written request of the President or two Directors shall be called by the President on three days' notice to each Director as provided in Article V hereof; provided, however, that a special meeting may be called upon twenty-four hours notice if such notice is given personally or by telephone to each Director.

Section 5. Vacancies. Any vacancy occurring on the Board of Directors shall be filled by the Board of Directors in accordance with the provisions of Section 2 of Article IV, provided however, that any vacancy of a Director serving as either the President or the Secretary of the International Mathematical

Union, respectively, shall be filled by the successor to such President or Secretary, respectively, of the International Mathematical Union. A Director elected to fill a vacancy will serve for the unexpired term of his or her predecessor in office, except that a Director serving as either the President or the Secretary of the International Mathematical Union shall serve for a term coterminous with his or her term as President or Secretary, respectively, of the International Mathematical Union.

Section 6. Resignations. Any Director may resign at any time by giving written notice to the Board of Directors. The resignation shall take effect at the time specified in such notice, and unless otherwise specified in such notice, acceptance shall not be necessary to make it effective.

Section 7. Removal. Any Director, other than the President or Secretary of the International Mathematical Union (who may only be removed as a Director if simultaneously removed as an officer of the International Mathematical Union), may be removed from office with or without cause by majority vote of the full Board of Directors. A Director shall receive ten days prior written notice by registered or certified mail of a meeting concerning the removal of such Director and shall be entitled to appear and be heard, but not vote, thereat.

Section 8. Quorum. At all meetings of the Board of Directors, a majority of the Board of Directors will constitute a quorum for the transaction of business, and the act of a majority of the Directors present at a meeting at which a quorum is present will be the act of the Board of Directors, unless the act of a greater number of Directors is required by the Non-Profit Corporation Act, the Articles of Incorporation or these By-Laws.

Section 9. Committees of Directors. The Board of Directors, by resolution passed by majority of the Directors in office, may designate an executive committee and may designate one or more additional committees as the Board may determine to be necessary or appropriate for the conduct of the Corporation's affairs, each committee to consist of two or more Directors appointed by the Board. Except as provided by the Non-Profit Corporation Act, the Articles of Incorporation or by further resolution of a majority of the Board of Directors in office, an Executive Committee so designated shall have and may exercise all the authority of the Board of Directors. The Board may appoint one or more Directors as alternate members of any committee, who may replace any absent or disqualified member at

any meeting of the committee. Except as provided by the Non-Profit Corporation Act, any such committee will have and may exercise all the authority of the Board of Directors granted to it by resolution of such Board. Such committee or committees will have such name or names as may be determined from time to time by resolution adopted by the Board of Directors. Each committee will keep regular minutes of its proceedings and report the same to the Board of Directors when required. The Board of Directors may by resolution passed by a majority of the Directors in office, at any time change the members of, fill vacancies in, limit, expand or alter the authority of, and discharge any committee of said Board.

Section 10. Directors' Consent Vote. Any action required or permitted to be taken at a meeting of the Board of Directors or of any committee thereof may be taken without a meeting if a consent in writing, setting forth the action so taken, is signed by all the Directors or all the members of such committee entitled to vote thereon, as the case may be. Members of the Board of Directors or any committee designated thereby may participate in a meeting of such Board or committee by means of a conference telephone or similar communications equipment by means of which all persons participating in the meeting can hear each other at the same time, and participation by such means shall constitute presence in person at a meeting. Voting by proxy shall not be permitted.

Section 11. Prohibition of Compensation of Directors. Directors will not receive financial compensation for their services associated with work for the Corporation. This section shall not preclude any Director from serving the Corporation in any other capacity and receiving compensation therefor.

Section 12. Specification of Business. Neither the business to be transacted at, nor the purpose of, any meeting of the Board of Directors or of a committee of the Board of Directors of the Corporation need be specified in any notice or written waiver of notice except as otherwise required by the Non-Profit Corporation Act or herein expressly provided.

Article V

NOTICES

Section 1. How Delivered. Whenever under the provisions of the Non-Profit Corporation Act or of the Articles of Incorporation or of these By-Laws written notice is required to be given to any person,

such notice may be given by mail or by a generally recognized overnight delivery service, addressed to such person at his, her or its address as it appears in the records of the Corporation, with postage or delivery charges thereon prepaid, and such notice will be deemed to be delivered at the time when the same will be deposited in the United States mail or delivered to the delivery service. Notice may also be given to any director either personally or by telephone to his or her house or office either directly or by leaving a message thereat.

Section 2. Waivers of Notice. Whenever any notice is required to be given under the provisions of the Non-Profit Corporation Act or the Articles of Incorporation or these By-Laws, a waiver thereof in writing, signed by the person or persons entitled to such notice and who did not receive the same, whether before or after the time stated therein, will be deemed equivalent to the giving of such notice. Attendance of a person at a meeting will constitute a waiver of notice of such meeting, except when the person attends a meeting for the express purpose of objecting to the transaction of any business because the meeting is not lawfully called or convened.

Article VI

OFFICERS

Section 1. Number. The officers of the Corporation will be a President, a Secretary and a Treasurer. The Board of Directors may from time to time elect or appoint such other officers, including one or more vice or assistant officers, and with such titles as it may deem necessary or convenient. Any two or more offices may be held by the same person with the exception of the offices of President and Secretary.

Section 2. Election and Term. The officers of the Corporation shall be elected by the Board of Directors of the Corporation at its first meeting. Each officer will be elected to serve a term of one year immediately following each annual meeting or special meeting in lieu thereof, or until his or her successor will have been elected and will have qualified or until his or her earlier death, resignation or removal, as hereinafter provided. Any officer may be removed by the Board of Directors of the Corporation at any time, with or without cause. Such removal will be without prejudice to the contract rights, if any, of the person so removed. Election or appointment of an officer will not of itself create contract rights.

Section 3. Resignations. Any officer may resign at any time by giving written notice to the Board of Directors of the Corporation. A resignation shall take effect at the time specified in the notice thereof, and, unless otherwise specified in said notice, the acceptance of the resignation shall not be necessary to make it effective.

Section 4. Authority and Duties. The President shall exercise direct supervision of the affairs of the Corporation, shall preside at all meetings of the Board of Directors, and, in general, shall have such other duties and possess such other authority as may from time to time be assigned to him or her by the Board of Directors. The Secretary may attend all meetings of the Board of Directors, and shall act as clerk of the same and keep the minutes of the proceedings thereof. The Secretary shall, in general, perform all the duties and possess all of the authority incident to the office of Secretary and shall have such other duties and possess such other authority as may be assigned to him or her from time to time by the Board of Directors. The Treasurer shall collect and receive all monies that may be due the Corporation and shall, on behalf of the Corporation, endorse for collection, transfer or deposit to the credit of the Corporation, in such bank or depository as the Board of Directors may designate, all notes, bills of exchange, drafts, checks and other obligations for the payment of money which may be received by the Corporation. The Treasurer shall render to the Board of Directors whenever requested an accounting of his transactions as Treasurer and an accounting of the financial condition of the Corporation. He or she shall, in general, perform all duties and possess all of the authority incident to the office of Treasurer and shall have all such other duties and possess such other authority as may from time to time be assigned to him or her by the Board of Directors.

Section 5. Vacancies. A vacancy in any office by reason of death, resignation, removal or otherwise may be filled by the Board of Directors of the Corporation for the unexpired portion of the term.

Section 6. Signing of Instruments. All checks, drafts, orders, notes and other obligations of the Corporation for the payment of money, deeds, mortgages, leases, contracts, bonds and other corporate instruments may be signed by the President, by the Treasurer or by such other person or persons as may from time to time be designated by resolution of the Board of Directors of the Corporation.

Section 7. Voting of Securities. Except as the Board of Directors of the Corporation may generally or in particular cases otherwise specify, the President or the Treasurer may on behalf of the Corporation vote or take any other action with respect to shares of stock or beneficial interests of any other corporation, or any association, trust or firm, of which any securities are held by the Corporation, and may appoint any person or persons to act as proxy or attorney-in-fact for the Corporation, with or without power of substitution, at any meeting thereof.

Article VII

SEAL

The corporate seal shall consist of a flat-faced circular die, with the name of the Corporation, the year and state of its organization and such additional material as may be prescribed from time to time by the Board of Directors, cut or engraved thereon.

Article VIII

FISCAL YEAR

The fiscal year of the Corporation will be determined by the Board of Directors and in the absence of such determination will end on December 31.

Article IX

INDEMNIFICATION

Section 1. Agreement of Corporation. In order to induce the Directors and officers of the Corporation to serve as such, the Corporation adopts this Article and agrees to provide the Directors and officers of the Corporation with the benefits contemplated hereby.

Section 2. Acceptance of Director or Officer. This Article will apply, and the benefits hereof will be available, to each Director and officer of the Corporation who by accepting his or her respective position and serving on behalf of the Corporation will be deemed to have accepted the provisions of this Article and agreed to abide by the terms contained herein.

Section 3. Definitions. As used herein, the following terms will have the following respective meanings:

"Covered Act" means any act or omission by the Indemnified Person in the Indemnified Person's official capacity with the Corporation and while serving as such or while serving at the request of the Corporation as a member of the governing body, officer, employee or agent of another corporation, partnership, joint venture, trust or other enterprise.

"Excluded Claim" has the meaning set forth in Section 6, hereof.

"Expenses" means any reasonable expenses incurred by the Indemnified Person in connection with the defense of any claim made against the Indemnified Person for Covered Acts including, without being limited to, legal, accounting or investigative fees and expenses (including the expense of bonds necessary to pursue an appeal of an adverse judgment).

"Indemnified Person" means any director or officer of the Corporation who accepts election or appointment as a director or officer and agrees to serve as such in the manner provided in Section 2 hereof.

"Loss" means any amount which the Indemnified Person is legally obligated to pay as a result of any claim made against the Indemnified Person for Covered Acts including, without being limited to, judgments for, and awards of, damages, amounts paid in settlement of any claim, any fine or penalty or, with respect to an employee benefit plan, any excise tax or penalty.

"Proceeding" means any threatened, pending or completed action, suit or proceeding, whether civil, criminal, administrative or investigative.

Section 4. Indemnification. Subject to the exclusions hereinafter set forth, the Corporation will indemnify the Indemnified Person against and hold the Indemnified Person harmless from any Loss or Expenses.

Section 5. Advance Payment of Expenses. The Corporation will pay the Expense of the Indemnified Person in advance of the final disposition of any Proceeding except to the extent that the defense of a claim against the Indemnified Person is undertaken pursuant to any directors' and officers' liability insurance (or equivalent insurance known by another term) maintained by the Corporation. The advance payment of Expenses will be subject to the Indemnified Person's first agreeing in writing with the Corporation to repay the sums paid by it hereunder if it is thereafter determined that the Proceeding involved an Excluded Claim or that the Indemnified Person was otherwise not entitled to indemnity under these By-Laws.

Section 6. Exclusions. The Corporation will not be liable to pay any Loss or Expenses (an "Excluded Claim"):

(a) With respect to a Proceeding in which a final non-appealable judgment or other adjudication by a court of competent jurisdiction determines that the Indemnified Person is liable to the Corporation (as distinguished from being liable to a third party) for: (i) any breach of the Indemnified Person's duty of loyalty to the Corporation; (ii) acts or omissions not in good faith or which involve intentional misconduct or knowing violation of law; or (iii) any transaction from which the Indemnified Person derived an improper personal benefit; or

(b) If a final, non-appealable judgment or other adjudication by a court of competent jurisdiction determines that such payment is unlawful.

Section 7. Notice to Corporation: Insurance. Promptly after receipt by the Indemnified Person of notice of the commencement of or the threat of commencement of any Proceeding, the Indemnified Person will, if indemnification with respect thereto may be sought from the Corporation under these By-Laws, notify the Corporation of the commencement thereof. Failure to promptly notify the Corporation will not adversely affect the Indemnified Person's right to indemnification hereunder unless, and only to the extent that, the Corporation is materially prejudiced in its ability to defend against the Proceeding by reason of such failure. If, at the time of the receipt of such notice, the Corporation has any directors' and officers' liability insurance in effect, the Corporation will give prompt notice of the commencement of such Proceeding to the insurer in accordance with the procedures set forth in the policy or policies in favor of the Indemnified Person. The Corporation will thereafter take all the necessary or desirable action to cause such insurer to pay, on behalf of the Indemnified Person, all Loss and Expenses payable as a result of such Proceeding in accordance with the terms of such policies.

Section 8. Indemnification Procedures. (a) Payments on account of the Corporation's indemnity against Loss will be made by the Treasurer of the Corporation except if, in the specific case, a determination is made that the indemnification of the Indemnified Person is not proper in the circumstances because such Loss results from a claim which is an Excluded Claim. If the Corporation so determines that the Loss results from an Excluded Claim (although no such determination is required by the Corporation hereunder prior to payment of a Loss by the Treasurer), the determination shall be made:

(i) By the Board of Directors by a majority vote of a quorum consisting of Directors not at the time parties to the Proceeding; or

(ii) If a quorum cannot be obtained for purposes of clause (i) of this subsection (a), then by a majority vote of a committee of the Board of Directors duly designated to act in the matter by a majority vote of the full Board (in which designation Directors who are parties to the Proceeding may participate) consisting solely of three or more Directors not at the time parties to the Proceeding; or

(iii) By independent legal counsel designated: (A) by the Board of Directors in the manner described in clause (i) of this subsection (a), or by a committee of the Board of Directors established in the manner described in clause (ii) of this subsection (a), or (B) if the requisite quorum of the full Board cannot be obtained therefor and a committee cannot be so established, by a majority vote of the full Board (in which designation Directors who are parties to the Proceeding may participate). If made, any such determination permitted to be made by this subsection (a) will be made within 60 days of the Indemnified Person's written request for payment of a Loss.

(b) Payment of an Indemnified Person's Expenses in advance of the final disposition of any Proceeding will be made by the Treasurer of the Corporation except if, in the specific case, a determination is made pursuant to Section 8(a) above that indemnification of the Indemnified Person is not proper in the circumstances because the Proceeding involved an Excluded Claim.

(c) The Corporation will have the power to purchase and maintain insurance on behalf of any Indemnified Person against liability asserted against him or her with respect to any Covered Act, whether or not the Corporation would have the power to indemnify such Indemnified Person against such liability under the provisions of this Article. The Corporation will be subrogated to the rights of such Indemnified Person to the extent that the Corporation has made any payments to such Indemnified Person in respect to any Loss or Expense as provided herein.

Section 9. Settlement. The Corporation will have no obligation to indemnify the Indemnified Person under this Article for any amounts paid in settlement of any Proceeding effected without the Corporation's prior written consent. The Corporation will not unreasonably withhold or delay its consent to any proposed settlement. If the Corporation so consents to the settlement of any Proceeding, or

unreasonably withholds or delays such consent, it will be conclusively and irrebuttably presumed for all purposes that the Loss or Expense does not constitute an Excluded Claim. If the Corporation reasonably withholds its consent solely on the ground that the Proceeding constitutes an Excluded Claim, the Indemnified Person may accept the settlement without the consent of the Corporation, without prejudice to the Indemnified Person's rights to indemnification in the event the Corporation does not ultimately prevail on the issue of whether the Proceeding constitutes an Excluded Claim.

Section 10. Rights Not Exclusive. The rights provided hereunder will not be deemed exclusive of any other rights to which the Indemnified Person may be entitled under any agreement, vote of disinterested Directors or otherwise, both as to action in the Indemnified Person's official capacity and as to action in any other capacity while holding such office, and will continue after the Indemnified Person ceases to serve the Corporation as an Indemnified Person.

Section 11. Enforcement. (a) The Indemnified Person's right to indemnification hereunder will be enforceable by the Indemnified Person in any court of competent jurisdiction and will be enforceable notwithstanding that an adverse determination has been made as provided in Section 8 hereof.

(b) In the event that any action is instituted by the Indemnified Person under these By-Laws, the Indemnified Person will be entitled to be paid all court costs and expenses, including reasonable attorneys' fees, incurred by the Indemnified Person with respect to such action, unless the court determines that each of the material assertions made by the Indemnified Person as a basis for such action was not made in good faith or was frivolous.

Section 12. Severability. If any provision of this Article is determined by a court to require the Corporation to perform or to fail to perform an act which is in violation of applicable law, this Article shall be limited or modified in its application to the minimum extent necessary to avoid a violation of law, and, as so limited or modified, this Article shall be enforceable in accordance with its terms.

Section 13. Successor and Assigns. The provisions of this Article will be (a) binding upon all successors and assigns of the Corporation (including any transferee of all or substantially all of its assets) and (b) binding on and inure to the benefit of the heirs, executors, administrators, and other personal representatives of the Indemnified Person.

Section 14. Amendment. No amendment or termination of this Article will be effective as to an Indemnified Person without the prior written consent of that Indemnified Person and, in any event, will not be effective as to any Covered Act of the Indemnified Person occurring prior to the amendment or termination.

Article X

AMENDMENTS

The Board of Directors may, by vote of seventy-five percent (75%) of the full Board of Directors, alter, amend or repeal these By-Laws, or adopt new By-Laws.

The undersigned, being the Chairman of Friends of the International Mathematical Union (the "Corporation"), hereby certifies that the foregoing copy of the By-Laws is true and complete and that the By-Laws were duly adopted by the Board of Directors of the Corporation on July 17, 2008.



Professor David Mumford



Mathematics of Planet Earth 2013

The initiative consists in holding a year of activities in 2013 under the theme **Mathematics of Planet Earth (MPE)**

www.mpe2013.org

Indeed, the mathematical sciences have been involved in this theme only in a limited way, despite the large number of mathematical problems of great complexity, interest, and importance in a wide variety of related areas. This program will be a great opportunity to showcase the essential relevance of mathematics in planetary issues. We are optimistic that this highly visible activity can create opportunities for additional sponsorship and that, by pooling together resources, a significant level of impact can be achieved.

In this initiative, the project is to hold scientific activities and activities for the public, the media and the schools. The kind of activities that could take place around Mathematics of Planet Earth in 2013:

- Thematic programs
- Workshops
- Collaborative research groups
- Summer schools
- Activities for the public and the media
- Activities in schools and/or for the teachers
- Etc.

The partners in the initiative consist so far in institutes and learned societies. But a call has been sent to the planet to join. In particular, the learned societies could be involved in some of the following:

- Public activities: public lectures, radio or TV programs, exhibitions
- Activities for the schools: posters, special issue of mathematical magazines, activities on the web.
- Could the Math Awareness Month of 2013 be held on the theme?
- Making the initiative known to their members and to the public and schools
- Contact with teachers associations, so that they hold their annual congress on the theme

International collaboration is encouraged. For instance, posters produced in one country could be distributed in others. The same could be done with mathematical magazines (for instance, Pi in the Sky in Canada: a special issue could be printed and distributed in the US). The participation of societies on the scientific side is also encouraged by any means: holding their congress on the theme, having scientific articles on the theme in their Newsletter, etc.

The initiative was first launched by the North American Mathematical Sciences institutes (US and Canada). On their side, the plan is to develop a joint thematic program with the institutes



hosting scientific workshops and organizing public lectures. A joint (North American) Scientific Committee chaired by Christiane Rousseau has been formed to encourage joint multi-institutes activities. A poster (English and French) announcing the initiative has been prepared and distributed and a website created. Since then, a call has been sent to the planet, using the opportunity of the ICM 2010 and the meetings of the institutes' directors (IMSI) there. Institutes in mathematical sciences from around the planet have started to join. The partner institutes are ready to organize delocalized activities.

The invitation is starting to be sent to societies to join and several societies are just waiting for the approval of their board to become official partners.

Below are some possible themes related to **Mathematics of Planet Earth**. This list shows that the theme is very broad and can be interpreted in a creative way.

- Climate modeling and climate change
- Weather prediction
- Modeling of extreme events: tsunamis, hurricanes, earthquakes
- Environmetrics
- Mathematical ecology and evolution
- Geophysical and complex fluid dynamics
- Epidemiology: modeling, prediction and control of epidemics
- Connecting the planet together: the web graph
- Hydrological forecasting for water resources management
- Mathematical and statistical methods in geodesy, geomatics and teledetection
- Energy generation and allocation
- Statistical methods for complex survey data
- Economics and finance of climate risk and natural resources
- Mathematical and statistical challenges arising in genetics (Phylogenetics, phylogenomics, population genetics, coalescent theory, evolutionary game theory, genetic epidemiology, association studies, linkage analysis, gene expression, DNA sequencing)
- The mathematics of transportation: modeling of traffic flow in urban environments
- Celestial mechanics: the movements of Planets and the link with climate variations
- Collective dynamics and game theory

IMU, partner of MPE?

Some potential support of IMU to MPE:

- Sponsor lectures (colloquium type) by specialists of sustainable development to inform the mathematical community of the mathematical challenges, some of these lectures occurring in developing countries
- Sponsor scientific meetings on subjects related to MPE matters. Some of these meetings should take place in developing countries and focus on subjects that are important to developing countries: infectious diseases, invasive species, management of water resources, etc. Coordinate with CDC to have a call for proposals of such meetings.
- ICMI has been invited to become an official partner and could take care of outreach efforts
- A potential traveling exhibition (similar to “Experiencing mathematics”) that IMU and ICMI could be supporting
- MPE vignettes in the Klein project
- A leadership role at UNESCO: ask UNESCO to support the initiative

IMU should also focus some energy playing a role within ICSU on the matter

- Publish a short article on the matter
- Ask ICSU to add an item on the matter in the agenda of the next ICSU General Assembly in Rome and use the opportunity to look for the interest of other unions.
- Joint activities with other unions inside ICSU: joint meetings, articles in their Newsletter, inviting to other unions to produce special issues of their scientific journals on the theme. To get ICSU sponsoring the joint meetings, we need to have the support of a regional office. This seems easy for Latin America and Asia, but this has been quite difficult in the past for Africa.

A list of international unions from ICSU that could be potential partners. When there are (??) this means that I am not sure

International Astronomical Union (IAU) (??)

International Geographical Union (IGU) (includes biogeography and biodiversity, climatology)

International Society for Photogrammetry and Remote Sensing (ISPRS) (Photogrammetry and Remote Sensing is the science, technology and art of obtaining reliable information from

noncontact imaging and other sensor systems about the Earth and its environment, and other physical objects and processes through recording, measuring, analyzing and representation.)

International Union for Quaternary Research (INQUA)

International Union for Anthropological and Ethnological Sciences (IUAES)(??) (it hopes to contribute to a better understanding of human society, and to a sustainable future based on harmony between nature and culture. International congresses every 5 years. The next in 2013)

International Union of Biochemistry and Molecular Biology (IUBMB) (??)

International Union of Biological Sciences (IUBS)

International Union of Crystallography (IUCr)

International Union of Food Science and Technology (IUFoST) (??)

International Union of Forest Research Organizations (IUFRO)

International Union of Geodesy and Geophysics (IUGG)

International Union of Geological Sciences (IUGS)

International Union of History and Philosophy of Sciences (IUHPS) (??)

International Union of Pure and Applied Biophysics (IUPAB) ?? (Task force on bioinformatics IUBG)

International Union of Pure and Applied Physics (IUPAP)

International Union of Pure and Applied Chemistry (IUPAC) (??)

International Union of Soil Sciences (IUSS) (??)

Union Radio Scientifique Internationale (URSI) (??)

A list of international unions from ISSC (International Social Science Council) that could be potential partners.

International Association of Legal Science (IALS) (??)

International Economic Association (IEA)

International Institute of Administrative Sciences (IIAS) (??)

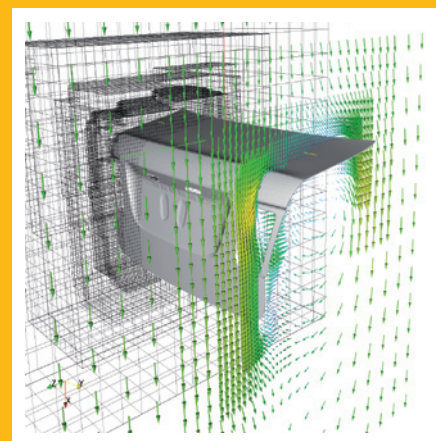
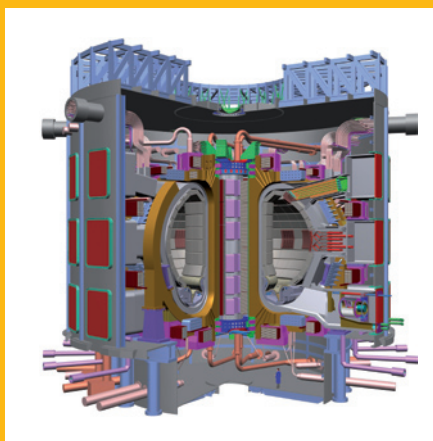
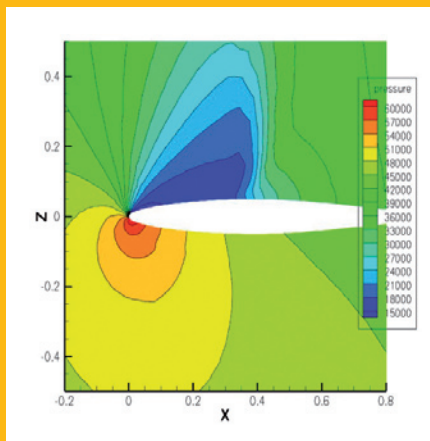
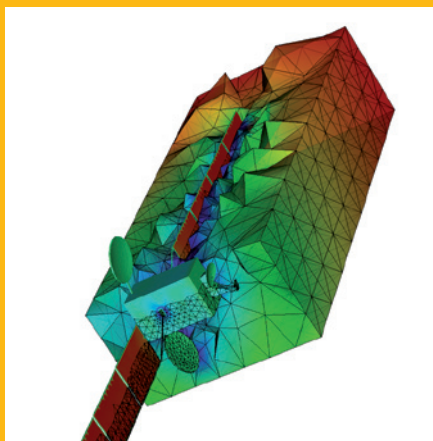
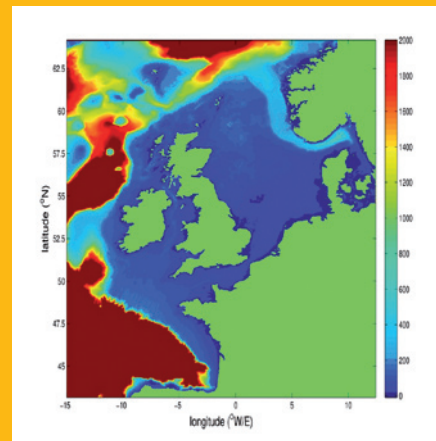
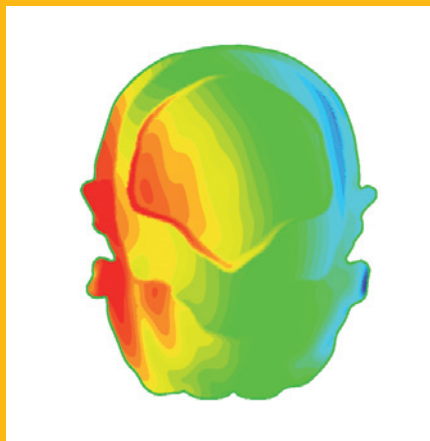
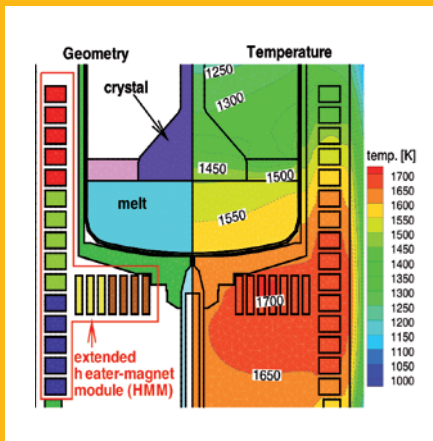
International Political Science Association (IPSA)

International Sociological Association (ISA) (??)

International Union for the Scientific Study of Population (IUSSP)

World Association for Public Opinion Research (WAPOR) (??)

Mathematics and Industry



European Science Foundation

The European Science Foundation (ESF) is an independent, non-governmental organisation, the members of which are 79 national funding agencies, research performing agencies, academies and learned societies from 30 countries.

The strength of ESF lies in the influential membership and in its ability to bring together the different domains of European science in order to meet the challenges of the future.

Since its establishment in 1974, ESF, which has its headquarters in Strasbourg with offices in Brussels and Ostend, has assembled a host of organisations that span all disciplines of science, to create a common platform for cross-border cooperation in Europe.

ESF is dedicated to promoting collaboration in scientific research, funding of research and science policy across Europe. Through its activities and instruments ESF has made major contributions to science in a global context. The ESF covers the following scientific domains:

- Humanities
- Life, Earth and Environmental Sciences
- Medical Sciences
- Physical and Engineering Sciences
- Social Sciences
- Marine Sciences
- Materials Science and Engineering
- Nuclear Physics
- Polar Sciences
- Radio Astronomy
- Space Sciences

www.esf.org

Forward Looks

The Forward Looks are the flagship activity of ESF's strategic arm. Forward Looks enable Europe's scientific community, in interaction with policy makers, to develop medium to long-term views and analyses of future research developments with the aim of defining research agendas at national and European level. Forward Looks are driven by ESF's Member Organisations and, by extension, the European research community.

www.esf.org/flooks

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Foreword

Many areas in academia and industry depend on mathematical sciences to open up new frontiers and advance discovery. Research in mathematics contributes to advances in areas such as medicine, cyber security, weather prediction, digital data compression and mining, aeronautics and computing, to name a few. Today's challenges faced by academia and industry are so complex that they can only be solved through the help and participation of mathematical scientists.

This ESF Forward Look initiative has involved representatives from all domains of European Mathematics. It has been carried out together with the *European Mathematical Society* (EMS) and in particular with its Applied Mathematics Committee. Moreover, all national mathematical societies in Europe within academia and industry have been directly involved at different stages. In addition, an online survey has been launched among mathematicians in academia and researchers working in the private sector. The results of the survey and the contributions from more than one thousand researchers, engineers and policy makers are reflected in this report.

The Forward Look springs from the strong belief that European Mathematics has the potential to be an important economic resource for European industry, helping its innovation and hence its capacity of competing on the global market. To fulfill its potential, special attention has to be paid to the reduction of geographical and scientific fragmentation in the European Research Area. Overcoming this fragmentation will require the involvement of the entire scientific community and of industry. Europe needs to combine all experiences and synergies at the interface between mathematics and industry and create strong areas of interaction to turn challenges into new opportunities.

The need to consider the issue of synergy is the main engine behind this Forward Look exercise. We identified the groups that carry out significant activities in the field of industrial mathematics and invited mathematicians, through mathematical societies and general communication means, to submit short summaries of their experience and success stories in their cooperation with industry. These "success stories" will be published separately, representing a snapshot of the impact and value created by European groups active in industrial mathematics.



Professor Marja Makarow
Chief Executive
European Science Foundation

A handwritten signature in black ink that reads "Marja Makarow".



Professor Mats Gyllenberg
Chair of the Standing Committee
for Physical and Engineering Sciences
University of Helsinki, Finland

A handwritten signature in black ink that reads "Mats Gyllenberg".

Executive Summary

Where do we want Europe to be in 2020 and beyond?

Three priorities should be the heart of Europe 2020**:

- Smart growth, by developing an economy based on knowledge and innovation.
- Sustainable growth, by promoting a more resource efficient, greener and more competitive economy.
- Inclusive growth, by fostering a high-employment economy delivering economic, social and territorial cohesion.

These three priorities are mutually reinforcing; they offer a vision of Europe's social market economy for the 21st century. Smart growth means strengthening knowledge and innovation as drivers of our future growth. This requires improving the quality of our education, strengthening our research performance, promoting innovation and knowledge transfer throughout the Union, making full use of information and communication technologies and ensuring that innovative ideas can be turned into new products and services that create growth, quality jobs and help address European and global societal challenges. At national level, Member States will need to ensure a sufficient supply of science, mathematics and engineering graduates and to focus school curricula on creativity, innovation, and entrepreneurship.

Purpose of the Forward Look

Knowledge has become the main wealth of nations, companies and people. Hence investing in research, innovation and education is now the key-leverage for competitiveness and prosperity in Europe. At the heart and foundation of this challenge, mathematics plays a crucial role as it provides a logically coherent framework to industry and a universal language for the analysis, simulation, optimisation, and control of industrial processes. Mathematics is an essential factor in the industrial creation of value and a driving force for innovations, but often, its contributions are invisible in the final industrial products. The use of mathematical techniques gives a competitive advantage to industry by suggesting innovative interdisciplinary approaches. In this context, the goal of the present Forward Look was to explore ways of stimulating and intensifying the collaboration between mathematics and industry. European scientific and industrial communities, in close interaction with policy makers, have developed medium to long-term views and analyses of common issues, questions, and "good practices" between mathematics and industry in order to envisage strategies for a stronger interaction of mathematicians with large and medium size companies aimed at technological advancement.

** EUROPE 2020, a strategy for smart, sustainable and inclusive growth, March 2010, European Commission

European context

Although there is a clear need in all areas of industry throughout Europe to use knowledge-based technologies in the development and improvement of products and services, it can be clearly seen that the level of cooperation between academia and industry needs to be increased and that is not equally well established throughout Europe. Strong efforts are necessary to correct this and deliver high-value collaborations across Europe.

Strategic objectives

Europe's competitiveness is to be achieved in a multilateral international environment through a common strategy for European Industrial mathematics by setting up the following key strategic objectives.

Strategic objectives to build the community:

- To foster a European Network in applied mathematics towards a Smart Economy.
- To allow Member States to build up a common strategy for European mathematics.
- To establish mathematics as a necessary component of European innovation.

Strategic objectives to develop the community:

- To overcome geographical and scientific fragmentation.
- To broaden and harmonise educational programs for students and teachers in mathematics at the European level.
- To facilitate the mobility between industry and Academia.

Strategic objectives to empower the community:

- To harmonise the curriculum and educational programmes in industrial mathematics.
- To encourage the exchange of knowledge and information between Academia and industry.
- To promote and improve the career path in industrial mathematics.

Recommendations

Recommendation 1: Policy makers and funding organisations should join their efforts to fund mathematics activities through a European Institute of Mathematics for Innovation.

Roadmap implementation:

- EU and National funding agencies should coordinate *clusters of excellence* in industrial mathematics and create a *European Institute of Mathematics for Innovation* (EIMI) for mathematicians and users of mathematics.
- EU and European governments should set up a Strategy Taskforce for Innovation and Mathematics (STIM) in order to develop a European strategy for mathematics.
- Policy makers should put in place a Small Business Act in Mathematics (SBAM) to encourage spin-off companies explicitly using mathematics.
- EU must identify industrial and applied mathematics as an independent crosscutting priority for the Framework Programme 8.

Recommendation 2: In order to overcome geographical and scientific fragmentation, academic institutions and industry must share and disseminate best practises across Europe and disciplines via networks and digital means.

Roadmap implementation:

- Researchers in academia and industry must adapt their mentalities to the different mathematical and scientific domains they interact with, and disseminate best practises.
- The mathematical community in collaboration with industry should create a journal devoted to industrial mathematics and contribute to a European Digital Mathematics Library.
- Academic institutions and industry must facilitate the employment mobility between academia and companies.
- The mathematics community and industry should work together on real opportunities in application-themed competitions.

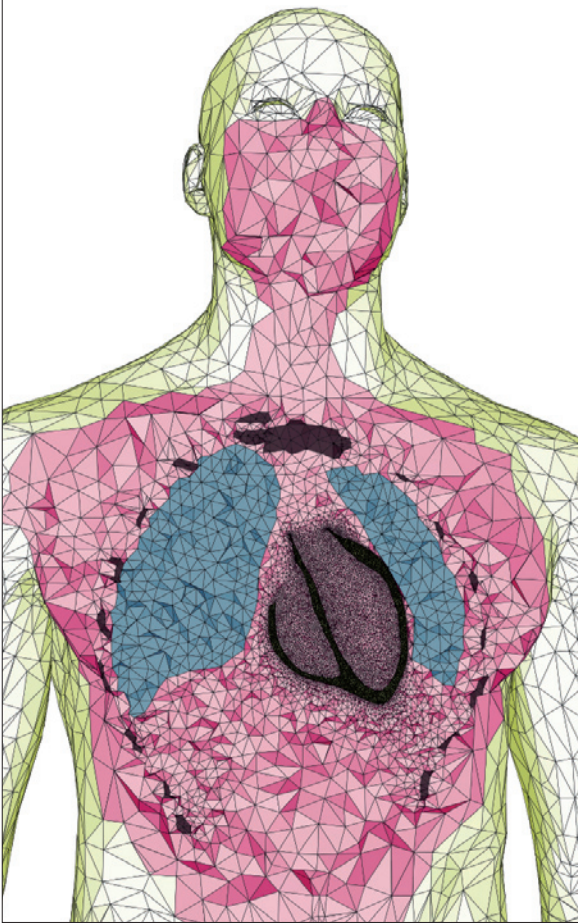
Recommendation 3: Mathematical Societies and academic institutions should create common curricula and educational programmes in mathematics at European level taking into account local expertise and specificity.

Roadmap implementation:

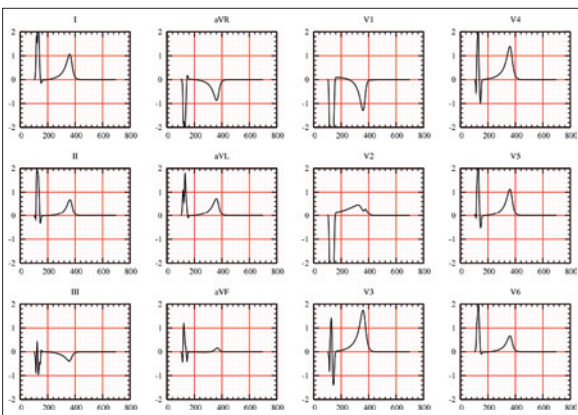
- Academia must create a European Curriculum for industrial mathematics and set up a pool of industrial mathematics engineers.
- Academia must develop new criteria to assess and recognise careers in industrial mathematics.

Conclusion

The basic message of this report is that if Europe is to achieve its goal of becoming the leading knowledge-based economy in the world, mathematics has a vital role to play. In many industrial sectors the value of mathematics is already proven, in others its potential contribution to competitiveness is becoming apparent. The benefits resulting from a dynamic mathematics community interacting actively with industry and commerce are considerable and certainly far outweigh the rather modest costs required to support such a community. Nevertheless, such benefits will not be realised unless action is taken to develop mathematics and a coordinated community of industrial and applied mathematicians needed for the future success and global competitiveness of the European economy and prosperity.



(Above) The computational domain for the Electrocardiogram
 (Below) "Healthy" ECG obtained by simulation
 (Courtesy INRIA Paris-Rocquencourt, J.-L. Lions Laboratory and Sorin Group)



trol and optimisation. Besides its role in science and engineering, the domains of application of mathematics include social, environmental, and economic phenomena. This is especially true in areas where innovation is contributing to the well being of society, such as health, security, communications, and environmental stewardship. The search for new life-saving drugs, the development of high-performance materials, the continued miniaturisation in electronics, and the protection of sensitive ecosystems – all of these application-oriented activities, and many others, are strongly dependent on fundamental research, and that research is inextricably linked to mathematics.

The relationship between mathematics, sciences and society has been the subject of study in numerous reports. We have been inspired by these documents that are listed in Annex 1. Here we focus on industrial aspects in the entire European context, aiming at sketching a roadmap for industrial mathematics in Europe. The fragmentation into countries present in the European landscape requires measures which would help combining all experiences and synergies, and creating a strong area of interaction between mathematics, industry and society at large. The need to address this issue is the main driver for this forward look exercise.

1.2. Mathematics as an innovation enabler for industry

The main challenge is to ensure that there is a good supply of people with mathematical skill sets as they are key to the development of our firm. This expertise is endemic within Google and while the firm can never be sure where the next innovation or product is going to come from, it needs a good supply of university graduates with new ideas and concepts.²

Larry Page, Google co-founder

Google is the apotheosis of how innovation in mathematics and technology can transform a few people into a world-leading services company. Google evolved from a research project by Larry Page, a PhD student in the Computer Science department at Stanford University. Page's dissertation explored the mathematical properties of the web, treating its link structure as a huge graph and the number and nature of links to a particular page as an indicator of its importance. From this, Page and Sergey Brin (another Stanford PhD student who joined the project later on) evolved a page ranking algorithm

2. <http://www.google.com/intl/en/corporate/execs.html>

1. Mathematics and its relationship with industry

and a search engine based on the rankings, forming a company based on the technology in 1998, in a garage in Silicon Valley. From these small beginnings, the company has since grown to over 10,000 employees worldwide. This example illustrates that mathematics should be recognised as a true innovation enabler for industry. There is a lack of understanding of this fact in both industry and academia, and it is extremely important for society that this gap is closed. Let us now try to better understand the situation.

1.2.1. Mathematics in the industrial context

The essential program of the applied mathematician when collaborating with industry follows essentially the following paradigm: first, identify the problem of concern; then, build a quantitative mathematical model, analyse and solve it, apply the results, and potentially create appropriate mathematical software that can be commercialised. The emphasis is in pointing out which are the important and relevant variables controlling the problem, which are the constraints and what is the goal. This is done through the understanding of the underlying mechanisms involved in combination with the analysis of the respective observations and data. The next steps concern the analysis of the created mathematical model, its numerical simulation in different scenarios, and the validation the model in comparison with experimental data. In addition it is important to investigate the robustness and sensitivity of the model. Note that this is typically an iterative procedure, since if the results do not explain or fit the observations, one has to modify and adapt the model, and repeat the cycle, until the model describes – as accurately as needed – the situation to be studied or simulated. Typically after the iteration of validating and adapting the model then, when the model is finally accepted, it would be used to improve, optimise or control the process that it describes. Model based control and optimisation is a crucial element of automation in all areas of industry, often reducing the cost and time of product, process and service innovation.

The aforementioned process is often not visible in published research, and requires an active collaboration with the source of the application. Therefore mathematical modellers must have particular skills in communicating with non-mathematical collaborators and the ability to translate in mathematical terms the real world problems, to study them by the use of mathematical techniques and finally to transfer the mathematical results for non-specialists who are typically not interested in the methods of solution. Modellers also have to be able to create models that take into account the main features of the situation or the object to be studied, as well as

the overall efficiency of the model when used in a virtual design environment. The complexity can be very high, and the complete system may be too complicated to be described. So, a mathematical modeller often has to make a trade-off: the best model is not the one that takes into account all factors but the one that incorporates the crucial ones. As Einstein said, “Things are to be made as simple as possible... but not simpler”.

It is evident that, in view of the ever-increasing complexity of real life applications, the ability to effectively use mathematical modelling, simulation, control and optimisation will be the foundation for the technological and economic development of Europe and the world.

1.2.2. Lack of recognition of industrial mathematics by the mathematical community

The attitude of the mathematical community with respect to collaboration with industry is far from homogeneous: sometimes one finds a simplistic supercilious attitude that denies industrial mathematics the citizenship in the ethereal world of science, under the unproved postulate that it consists only in the application of standard results and methods without any creativity. The other extreme position would assert that the only justification of mathematics lies in its “usefulness”. Both application-driven research and research motivated by the development of new concept and theories within mathematical sciences are indispensable within the essential framework of scientific research. To quote the OECD report on Mathematics and Industry³: “The distinction [*between pure and applied mathematics*] is vague, misleading, and useful at best for classification purposes. Excellent mathematics, however abstract, can lead to the solution of practical problems. In turn, hard problems in nature stimulate the invention of new mathematics”.

It is a common interest of the entire mathematical community to outreach activities to make society and industry aware that mathematics is the common denominator of much that goes on in everyday life, activating the many sectors of society that can benefit from mathematics. Indeed, promoting such awareness will bring resources to all mathematicians. As a result of our questionnaire one can see that the culture of mathematicians in academia to work with partners in industry or to do consulting is not widespread.

An additional delicate matter concerns the evaluation of industrial mathematics, as publication and citation

3. See Annex 1

records mostly guide quality criteria in the academic world. The structure of the academic world is not inclined to appreciate interdisciplinary cooperation and the contribution given by mathematicians to the solution of problems is not always fully evident and thus adequately appreciated.

1.2.3. Lack of recognition of mathematics by industry

An additional contribution to the gap between academia and industry is the lack of recognition of mathematics in industry. This has even culminated in cutting down on mathematics groups in industry, which mainly occurred in the 1990's. The main reason for this is the invisibility of mathematics; one can rightfully say that mathematics is characterised by “invisible contribution, visible success”. Designers use virtual design environments that rely heavily on mathematics, and produce new products that are well recognised by management. The major effort concerned with the construction of reliable, robust and efficient virtual design environments is, however, not recognised. As a result, **mathematics is not usually considered a key technology in industry**. The work-around for this problem usually consists of leaving the mathematics to specialised small companies that often build on mathematical and software solutions developed in academia. Unfortunately, the level of communication between these commercial vendors and their academic partners with industry is often at a very low level. This, in turn, leads to the observation that yesterday's problems in industry can be solved, but not the problems of today and tomorrow. The latter can only be addressed adequately if an effort is made to drastically improve the communication between industrial designers and mathematicians. Industry should realise that this is the only way their problems can be solved in a rigorous manner.

Example: A stunning illustration is given in Figure 1. In the electronics industry and far beyond, it is well known that the performance of chips improves by a factor of 2 every 18 months. Moore's law describes this trend. What is not known to the general public, and also not to designers and management in the electronics industry, is that numerical mathematics has achieved a similar speed-up in algorithms underlying the virtual design environments used to develop these new generations of chips! Europe must not miss this challenge that is also an opportunity.

The lack of recognition also occurs in more direct interactions between industry and Mathematics. When the Stochastic Operations Research Group at Twente University (Netherlands) proposed a new optimal strategy for reducing waiting times in hospitals from 4 weeks

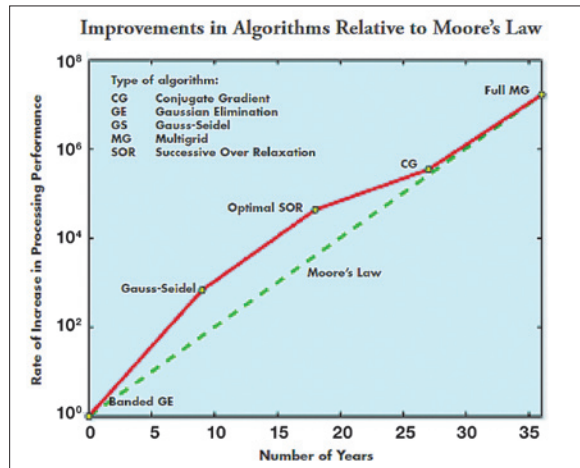


Figure 1. The relative gains in some algorithms for the solution of an electrostatic potential equation on a uniform cubic grid compared to improvements in the hardware (Moore's Law).

to 1 day, there was much scepticism and virtually no acceptance. Only after quite some investment in producing an animation, management was convinced and implemented the strategy with great success. This example shows that **recognition by industry must be earned**, and that it may take additional investment to achieve this. The mathematics community must be prepared to do this investment.

1.3. Means of interaction between mathematics and industry

Problems in industry which benefit significantly from mathematics, in addition to the standard workflows, typically are seen on different scales:

1. Specific problems where the current methods or commercial codes fail, where a new feature has to be included, where current models do not meet the requirement. In our survey, quite a number of Small and Medium Enterprises are addressing this kind of situation, but have difficulties to survive on this demand alone. Typically these are small-scale projects up to 12 person-months.
2. Medium scale problems where the transfer of a new technology, algorithmic approach or such has to be performed or where a new mathematical software product has to be brought into the market. This is very often done via companies that are spun out of a research lab or an academic institution. **These mathematical spin-offs show a high survival rate in the market or are bought out by global players thus**

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creating novel high-tech jobs with high salaries. This kind of projects typically requires 3-6 person years.

3. Large-scale multi-physics, multi-scale, multi-mathematics problems where different physical models are coupled, where different areas of mathematics are used and where there are essentially no methods available. An example of this is, for instance, the problem of modelling, simulating and optimising the gas transport in large gas networks, where stochastic, partial differential equations, numerics, discrete mathematics and optimisation all have to cooperate and where methods for the simulation are missing and where currently nobody can optimise the whole problem. Typically only a large centre or a consortium can handle such a problem where all the competence is available in-house. Such projects can have an order of 20-30 person years.

1.3.1. Areas of interaction

Probably the central question is the one about the fit or misfit between the competence available in academia and the actual demand in the business sector. The respondents of the ESF questionnaire, both from business and academia, were asked about the main areas of mathematical expertise as well as fields of applications of mathematics that are relevant for activities in their institutions. What follows is an analysis of a styl-

ised supply, understood as a structure of mathematical competence available in academic institutions, versus a stylised demand, understood as the relative importance of particular areas of applied mathematics that are especially of interest to the business sector. In Figure 2, the main areas of competence in academia are plotted versus major business challenges perceived in industry.

The first issue concerns the areas in which available mathematical competence in academia can support the industry, and those which the industry perceive as major business challenges in their companies. The comparison is presented in Figure 1. The location of each area, represented by a bubble, corresponds to relative its importance in academia (horizontal axis) and in industry (vertical axis). Areas above the dotted line are more often pointed out by the business respondents than by respondents from academia. Areas below the dotted line show the other way around: more often by academia than by business.

In general, **the perceptions in both groups are very similar.** This manifests itself in the fact that the areas align themselves quite closely to the diagonal line. The areas that seem to be most important (chosen most often) are those belonging to the areas of Systems Modelling, Computing/Algorithms, and Simulation. These are slightly more often chosen by academia than by industry. Areas chosen least often are Design and

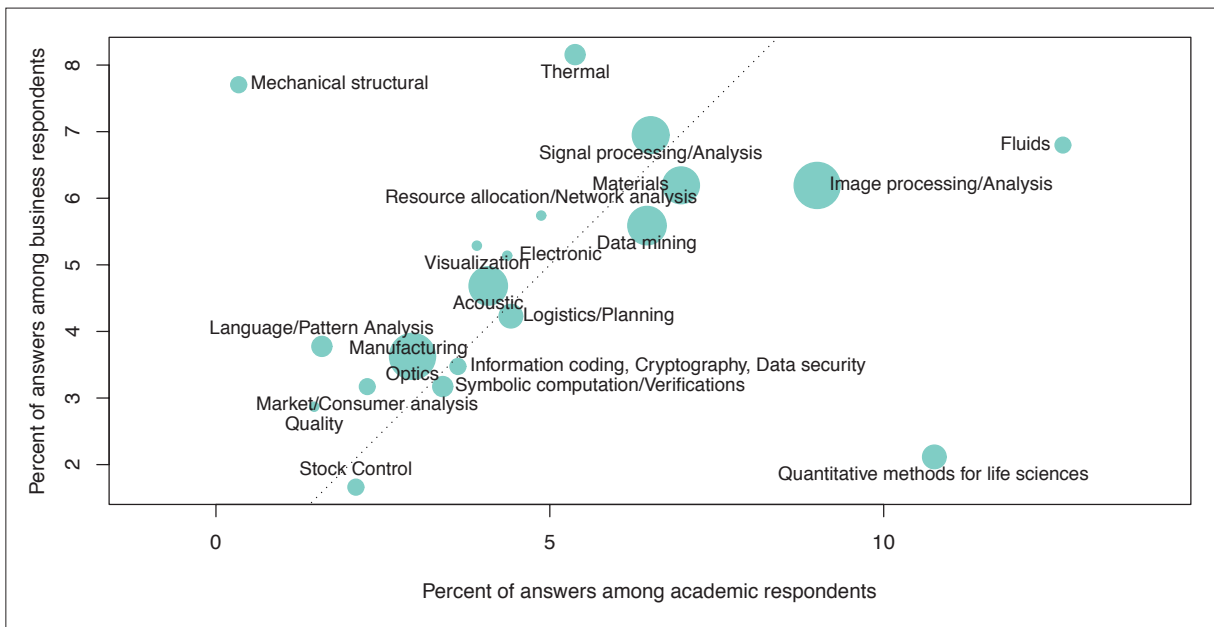


Figure 2. Main areas of competence available in academia versus major business challenges perceived by the industry. Size of the bubbles indicates total number of respondents.

Product optimisation. The largest misfit seems to be related to the areas of Risk management and Simulation. Risk management is perceived as the fourth most important business challenge in industry (12% of answers), however it is chosen by about 8% of respondents from academia (7th most important out of 9 areas).

Based on the declarations of the respondents we conclude that, in general, there exists a fairly good match between the structure of available mathematical competence in academia and the structure of the demand for mathematicians in business (Figure 2). However, there are several notable exceptions. These include mathematics for “structural mechanics” and “thermal engineering”, which are perceived as, on the one hand, most needed by the industry, but, on the other hand, not so frequently mentioned by academic respondents. Simultaneously, “quantitative methods for life sciences” and “Fluid mechanics” are popular in academic mathematics departments, but are not mentioned too often as crucial by the business respondents⁴.

The deviations in structural mechanics and fluids may be explained by mutual misconception between mathematics and, more engineering-oriented, simulation sciences. However, the result for life sciences has consequences on the entire health care area with a tremendous societal impact. Apparently there exists a significant discrepancy between academics and industry in the perception of the impact of today’s mathematics to life science problems. Of course, until today there are only a few examples, such as in pharmacokinetics or biostatistics, where mathematics provided a significant benefit for health care. Moreover, lots of activities in academic mathematics for biology are far away from the needs in health care. On the other side, it is well accepted that the tremendous amount of genomics, proteomics or epigenetic data which can be measured in parallel using the upcoming experimental technologies makes future mathematical involvement essential for the further progress of biomedical sciences. However, apparently both sides have to move significantly in order to realise the benefits from the tremendous investments in data today and in future. Only by novel, efficient information retrieval from these data the efficiency of the health care can be increased, as it is urgently needed in order to prevent the health care systems of the European ageing societies from a financial breakdown.

Example: *let us consider optimisation problems that are frequently encountered amongst the problems proposed by companies. Optimisation is a transverse domain of mathematics, which involves analysis, numerical analysis, combinatorics, and statistics. The problems of interest*

4. Note that the respondents from industry only represent part of the R&D departments of European companies.

for industry have some particular features that make them challenging for mathematicians. A particular and frequent feature of the industrial problems is that they often involve a lot of uncertainty, a large number of constraints, and several output quantities to optimise together. Typical problems are related to scheduling and task assignment, physical or chemical processing or optimal design. It turns out that the first challenge in this kind of problems is in their set-up, that is to say, the definition of the optimisation/cost function, which takes into account the budgetary, implementation and regulation constraints. The choice of the cost function is instrumental in the trade-off between the optimisation of several different outputs with several constraints of different natures. Moreover, industrial researchers often wish to keep flexibility, they do not look for “the” solution, but a class of answers or solutions that achieve different trade-offs between the different constraints. Confidence issues and uncertainty quantification are also critical. Industrial researchers of course prefer a reasonable and stable solution than an optimal and unstable one. Mathematicians can incorporate this idea in the optimisation routine, but the challenge for them is to form a group that incorporates experts from the different domains of mathematics needed to achieve this task.

Another frequent class of problems reported by the industry is related to data processing. Here, two types of problems may appear. The first type of problems arises when few data are available, and the challenge is to overcome data scarcity. Typically the problem is about interpolation estimations (with the minimal amount of data) and the identification of the key parameters of the process. The second type of problems occurs when industrial researchers or engineers have to process very large amount of data, and the challenge is more about data mining and the extraction of useful information. A typical example is the use of geophysical surveys for oil exploration. But it can be said that practically every field of mathematics has or will have its application in the industrial context. In parallel document, we have gathered some recent examples of successful cooperation between mathematics and industry in European research groups that give an idea of the variety of the applications and of the challenges.

1.3.2. Process of the interaction

First, it is relevant to note that mathematicians can contribute in all the different steps necessary to solve an industrial problem as follows.

- **Identification of the problem:** An industrial problem is *almost never* formulated as a mathematical problem; it can be very poorly characterised. One of the main contributions of the mathematicians can be

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the identification and characterisation of the problem itself and its origins by formulating the problem in an abstract framework, which can distinguish what is relevant and what is not.

- **Modelling of the problem:** The mathematical formulation helps to clarify the problem, identifying the main obstacles, and proposing the tools to tackle the problem. An additional concept that mathematics can bring is the notion of a hierarchy of problems going from easier to solve problems, where one can get analytical insight at a qualitative level, to highly complex ones where the situation to be modelled is better approached, but at a much higher level of detail and cost (for example, coupled electro-thermal or electro-mechanical models)
- **Simulation:** Efficient, robust and reliable mathematical techniques must be developed to solve the problem at hand, and provide realistic simulations. However, academic and industrial people may not agree on the same definition of “solution”. Industrial engineers and managers usually look for “a” solution in a given time (say, the best solution given the time allocated to the project, or at least a solution that fulfils the constraints). Academic mathematicians usually work on a different time scale and look for “the” optimal solution. Open discussions are necessary to clarify the different expectations and constraints.
- **Uncertainty:** Due to variability in the production process, uncertainties may occur. This needs to be taken into account by employing stochastic and statistical methods, in combination with the scientific computing techniques already employed to solve the problem.
- **Validation:** This is an extremely important aspect that is, however, often neglected. It is not sufficient to be able to solve the mathematical problem; one always needs to validate the results obtained with measurements. In this sense, there must be strong interactions between modelling and simulation. It is crucial to identify and characterise the range of validity of the model.
- **Optimisation:** due to the increased computational power and the achievements obtained in speed-up of algorithms (see Figure 1), optimisation of products has become into reach. This is of vital importance to industry. Again, however, this calls for open discussions and good communication channels between mathematics and industry.

The question is whether, and to what extent, the above is already taking place in interactions between Mathematics and Industry. In this context, it is interesting to look at the responses given in our questionnaires. Respondents from academia differ in terms of the scientific profile

of their host institutions. The majority of respondents come from Mathematics (36%) and Computational Mathematics (23%) departments. A relatively smaller share of respondents come from departments specialising in Control Theory, Financial Mathematics, Computer Science and Bioinformatics, jointly they constitute about 10% of all respondents from academic institutions. Most of the academic institutions of the respondents do consulting for business, on average 71% of respondents answers report that fact. However, consulting for industry varies substantially depending on the scientific profile of the institution. This type of academia-industry collaboration happens most often in departments specialising in Computational Mathematics, it is reported by 85% of respondents from these institutions. Other specialisations reporting a high rate of industry consulting include Engineering Mathematics, Control Theory, Computer Science, and Financial Mathematics. Consulting for industry happens least often in Pure Mathematics departments (61%). A vast majority of people from industry, over 90%, report that their company does run a Research and Development department.

Despite of the outlined limits of our survey, an overall message that can be concluded from the answers of the questionnaire is the high demand for mathematical research and mathematical tools in industry. This is demonstrated, in particular, by the following two features evident from our survey:

- Industry is more and more challenged to accommodate two contradictory requests: the need to optimise all the steps of the industrial process; and the dramatic increase of budgetary and regulatory constraints. **Only mathematics can help industry to optimise more and more complex systems with more and more constraints.** The contributions of mathematicians are also helpful as an internal tool for industry to assess the validity of a new project and also as a proof of rigor and robustness that can be used by supervising and regulatory authorities.
- When new mathematical or computational techniques are introduced and prove themselves to be efficient, the natural trend is to disseminate these techniques and to apply them to other problems. This often makes sense, but may represent a risk. Indeed, mathematical results are always conditioned to a set of hypotheses (a mathematical statement has always the form “if... then”) and by extending the domain of application one may exit the domain of validity. It is important that mathematicians be more associated to the development process and that more people receive a basic training in mathematics in order to avoid this risky behaviour. Black boxes can be dangerous, because they can sometimes give answers that are not appro-

priate. Mathematicians or mathematically trained engineers are aware of this and will analyse results before taking them for granted.

1.3.3. Requirements for a fruitful interaction

An important remark is that the use of mathematics in the whole design or production process is most of the time invisible in final industrial products or services. In other words, mathematics is typically an “enabling technology... [whose] economic impact is real, and many companies –old, as well as new– have achieved a competitive advantage though the judicious use of mathematics” [OECD report of Annex 1]. This fact that can be phrased as “invisible contribution, visible success” needs to be acknowledged. **Hence the absolutely most important challenge for mathematicians is to further convince industry that they need more and modern mathematics and mathematicians to develop new competitive products and technologies.**

A means of convincing more people about the presence of mathematics everywhere could be to put stickers “Math Inside” on products where mathematical techniques have proved the reliability and robustness. A real challenge is also to convince also policy makers that it is not just engineering, chemistry or physics that are key technologies, but mathematics as well. A difficulty is the missing profile of the “industrial mathematician”. Mathematicians in industry often work in a team and are used as all-rounders or trouble-shooters. It is, therefore, not sufficient to point out that mathematics is everywhere if mathematicians are visible nowhere in their role as mathematicians! Good and relevant mathematics can only be developed and applied by mathematicians, people who know how to model, how to analyse the models and how to make relevant computations, estimate errors and to characterise the range of reliable applicability. These tasks are crucial for high quality products and processes and they are not possible for people who just apply commercial or classical methods that have been available for decades and which might not well adapt to new situations.

As a matter of fact the complexity of most of the problems that are currently encountered and the rate at which mathematics is developing are such that a fruitful collaboration is only possible if the industrial mathematician is familiar with the latest advances of contemporary mathematics; especially when new ideas are needed that can induce real innovation. Indeed, some of the most powerful new ideas in mathematics that are finding fruitful application are complex and sometimes difficult to use, which is why professional mathematicians are required.

Let us note that concerning specific needs from industry, it is very hard to anticipate them, but that clearly model based simulation, optimisation and control will be key issues in the next 10-20 years. Most of the times, the design of a new product requires taking into account opposite constraints (robustness and cost, reliability and speed of conception...). Therefore, in order to achieve a proper balance between opposite needs, mathematical tools are an alternative to the classical means relying on the expertise and lifelong experience of some engineers or on trial and error evaluation of preliminary prototypes that are extremely expensive. Mathematically based tools are already of current use in some industrial fields (aeronautics and aerospace, automotive, energy, etc) but they are not so frequent in other fields (such as pharmacology) and absent in most sectors. Doing this requires some effort for the modelling of the process, the definition of the proper simulation algorithms, the wrapping of these high-level scientific concepts into an expert system that can be used in the conception workshop. The goal of these simulation tools is to provide the same output as a true experience. Thanks to the availability of these in-silico experimental benches, the second achievement is to lead to an in-silico expert tool that is “intelligent” and that out of many numerical simulations is able to provide the optimal product capable to achieve different optimal regimes under industrial constraints.

Another example is related to the time consuming assimilation of over representative data in industrial decision time; mathematical models are able to synthesise the trends in these data and understand which is currently out of reach while automatic acquisition systems are more and more available. On the opposite, there are situations where the data are very scarce and hard or expensive to acquire. Here again mathematical models may lead to get valuable information from the combination of a priori different representations of the same situation.

It should not be hidden that, if most of the problems encountered in the industrial context will certainly benefit from mathematical input, currently most of them are out of reach for at least two reasons: the first one is that industries are not aware that their problem can be cast into a solvable mathematical frame; the second one is that sometimes the necessary mathematical theory is not available, at least under a form that is directly applicable. A one-stop shop where illustration of realisations (success stories) and post list of problems are available would facilitate the meeting of academic research groups and industrial engineers.

Mathematicians can also meet the needs of industry if they are able to exploit all the potential of high performance computing. The proper algorithms for

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many problems of interest are available and are the subject of active research, but for the actual problems of industrial needs, with sizes that are not equivalent to academic problems, further investigation needs to be performed.

Example: *In the chemical and pharmaceutical industry, the development of novel products and processes has to tackle an increasing complexity. The systems which have to be optimised, e.g. in functional materials or in bioengineering, are highly complex and are not fully understood in detail. Therefore the established mechanistic modelling, which is based on a detailed translation of the underlying mechanisms to mathematics, cannot be applied. Hence hybrid, grey box models have been developed which combine mechanistic modelling with machine learning approaches. Successful applications ranging from process optimisation, materials design up to gene diagnostics show the typical character of high-end mathematics as an enabling technology for a broad range of applications. However, the drawback of the high efficiency is that validation becomes extremely challenging, such that highly skilled mathematicians are the key technology “champions” in industry.*

1.3.4. Forms of interaction

The collaborations of industrial and academic researchers are often the results of personal contacts: typically former students or colleagues working in industries and keeping contact with their former advisors or other members of the academic mathematics departments. A connection can also be established during a workshop or a conference. The early steps of the connections are critical and should benefit from rather simple measures:

- It is not easy for industrial engineers or researchers to know whom to contact in academia when they do not have a priori contacts. There are many mathematics departments throughout Europe but the information about who does what is not easily available. The WebPages of the mathematics departments rarely contain special links to guide the potentially interested people towards a presentation of the recent achievements of the department or specific contacts who could answer the first questions. **This could be improved without too much effort, but there would have to be an initiative from the side of European institutions like EMS in this direction.**
- Academic researchers usually have slides ready to present their most recent work, but usually do not spend time preparing a presentation that could be more accessible to people potentially interested by submitting industrial problems but without the math-

ematical background expected from a mathematician. It is often much more effective to present practical challenges than ‘perfect’ solutions.

There is a full spectrum of opportunities for groups who are interested in genuine industrial collaboration. These opportunities can range from setting up a fully-fledged mathematics-in-industry group, with a full-time project facilitator and regular symposia and collaborative meetings with industrial partners to having a group, which occasionally works on industrially relevant problems. In [OECD report April 2009] the forms in which collaboration can start are described on the basis of concrete experiences of many groups and laboratories across the world and the different mechanisms are illustrated. It can be noted that, in cases of complex problems and tasks, typically not all the competence and skills can be found in the same laboratory and research group. For large companies a one-stop-office partner typically is the highest priority, this would require the **formation of large clusters where all the industrially relevant mathematical competence is available.** But sometimes to get the excellence in different areas even trans-regional or transnational groups may be the best answer. As a consequence a set up of databases and a strong coordination activity would be necessary.

Once a connection is established between industrial and academic partners specific programs should be available to develop the collaboration. Several types of such cooperation programs can be identified:

- **Short-term cooperations** (a week up to a few months) that can be implemented at any time and can be realised very quickly. This would allow to make a proof of concept, or to test ideas with a rather tiny budget. As an example, we mention specific internship programs that bring a student and his/her advisor together with the industrial partner, or the cooperations that arise from industry workshops (modelling weeks), where industries present specific problems that are addressed by a group of students and researchers.
- **Medium term cooperations** (approximately one year) where an identified project is carried out jointly by a group of researchers both from industry and academia. Here a clear and very specific project goal needs to be identified and a clear time frame.
- **Long-term projects** (a few years) that include the temporary transfer of academic researchers to the industrial partner of the project as well as engineers and researchers from the industrial partner to the academic one.

In any case a clear estimate of the timescale, the uphold of the deadlines, the focus given to the problem proposed, a careful and well-prepared presentation of

the results (leaving to appendices all technical details that might seem crucial to the mathematician but absolutely obscure and not relevant to the company) are essential ingredients for a successful cooperation. **It is evident from the results of the questionnaire that there is often little experience in academia in setting up such cooperations, in estimating time-frames and in identifying clear and realistic goals.**

Let us end this section by pointing out that, in our opinion, a new type of position is needed in the academic research centres. Indeed, industrial partners usually expect a solution to their problem in a form (a report, an algorithm, a code) that is more finalised than the one that an academic mathematician is prepared to deliver. There are different reasons. First, an academic mathematician may not be an expert in programming. Second, an academic mathematician is evaluated on the number of publications and there is no incentive to spend time and energy on the development of a practical user-guide or a code. The new type of position, which we may call **mathematical engineer**, would be devoted to the management and development of industrial projects. The establishment of such positions should be encouraged.

1.3.5. The particular case of Small and Medium Enterprises (SMEs)

The case of SMEs is very different from that of large companies. Academic mathematicians often have very few contacts with SMEs although, at the same time, a lot of innovation is created in this kind of companies. In fact, SMEs could bridge the gap between Mathematics and Industry. Therefore, it is extremely important that this kind of collaboration is triggered much more than currently is the case.

For instance, it seems very important to keep contact with former students who have not chosen an academic carrier and have started a carrier in industry. These former students should be privileged interlocutors for establishing contacts between industry and academia. An obvious way for that would be to maintain an alumni directory, but this is not so common, and this should be recommended. Another way should be to invite them during special events like the “Modelling Weeks”. These invitations are interesting in two different ways. They offer mathematical students the opportunity to discuss with non-academic people and to realise that it is possible to think about a career that is wider than the academic world. They also allow former mathematicians working in industry to feel part of the mathematical community. They can share their experiments, provide advice, and they can present their current problems to the students and researchers, which could initiate collaborations.

The problem of the response time of academic mathematical project partners is at least as critical and probably even more critical for SMEs than for large companies. Here it is important to be able to give at least partial answers very quickly, and it is clear that such answers can only be delivered by a well-organised group with researchers competent in different domains of mathematics and with mathematical engineers capable to deliver answers and products that can be put in a more or less final form. As already noticed, permanent training sessions, internships and modelling weeks proposed by mathematical research departments would certainly be a nice way to start collaborations between SMEs and academic departments.

1.3.6. Improving the mathematics-industry interaction through training

The structure and the contents of curricula in mathematics in most European universities are in most cases excellent with respect to the basic education and to updated information. But they do not contain all the tools necessary to collaboration with other disciplines and even with different branches of mathematics. The current trend to premature overemphasised specialisation is a problem that should deserve a deeper attention within the community. It is important that bachelor programs focus on a broad and fundamental education and that specialisation is restricted to a minimum.

At a later stage, however, a specific training towards the collaboration with other disciplines should be addressed. One possibility that could be offered is a specific curriculum at master degree and/or at graduate level; this is discussed in Section 3.2 below. But also the invigoration of the key area of mathematical modelling in all mathematics degrees is needed. Within this framework (but also having in mind students that will not become industrial mathematicians) some opportunities of encountering non-mathematical problems that can be dealt with mathematical means should be offered. For example:

- Graduate students are usually proposed to follow a variety of courses in mathematics during their training. One could suggest that some of these courses could be taught by industrial researchers or engineers, by taking the form of “**modelling problems**”.
- **Study Groups.** The typical format of Study Groups extends over one week as follows. During the first day industrial researchers present different problems to an audience of academic researchers (which may or may not include students). During the next three days the academic researchers split into subgroups to address the different industrial problems. The final day is devoted to the report of the progress made

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and exchange between participants. The follow-up may take different forms depending on the progress made during the week.

- In some universities special weeks are proposed during which the students (not only in mathematics) are taken out of the university (in order to focus their attention) and receive different lectures about oral and written presentations, **career opportunities** and the job market. The purpose of this week is to allow them to gain confidence, to learn how to promote themselves and to realise that they have a huge potential.
- It is also common that the students, mostly at graduate levels, organise special seminars, where they present their work. It would be a good opportunity to **encourage invitation of external people** during this seminar so that the students can discover problems presented by industrial researchers. In this non-formal seminar the students would be more willing to ask questions and react to the presentation.
- **Modelling Weeks.** These weeks would have the same form as the Study Groups but would be targeting the students: we note also that this form, as well as the organisation of study groups, can be instruments for promoting more intensive and focused interactions with companies.
- **Internships** where students work on specific problems brought by a company under the supervision of senior mathematicians can also be very interesting for the students and a valuable part of their training. An internship is a research project of short duration (typically 4-6 months) that is undertaken in collaboration with an industry partner and places a graduate student or postdoctoral researcher part-time in the company.
- Finally it may be interesting to build **courses for start-up companies**, with the experience of founders to encourage young students to think to entrepreneurially if they have an idea.

1.3.7. Confidentiality and intellectual property rights

It is clear that academia and industry have completely different attitudes towards research. For scientists, circulation of information is essential and the publication of every interesting results is viewed as the mean of contributing to the advance of knowledge (as well as the means of progressing in the career). On the contrary, an industrial company may be reluctant to publish not only the solutions to its problems, but even the problems themselves, as they may disclose the directions of research and development of the company. It would be very profitable for both partners to smooth this process

by avoiding the cumbersome task to write a new agreement for any new collaboration. The idea would be to create an open library that proposes standard agreements⁵ that could be the bases of a contract so that everybody can concentrate his time and energy to the problem at hand and not on confidentiality and copyright issues. These agreements would typically describe:

- How the work is carried out (typically the company pays the university for the time spent by the academic researchers or the mathematical engineers on the project).
- Who keeps the intellectual property of the discovery (typically the company keeps the property while the university keeps the free use of the discovery for non-profitable purposes) and how it will be protected under the restrictions of European patent regulations with respect to mathematics and software.
- When the results can be disclosed and published.

1.3.8. Towards a mindset shift for mathematicians

In the previous sections we have shown how companies can benefit from collaborating with mathematicians. But academia also benefits from its interaction with industry. This interaction stimulates research in new directions and also fosters the development of new analytical and computational methods. New tools have to be designed for new needs. Advances in mathematics can and should arise from this interaction. A recent example is the new algebraic theory for structured matrix polynomials, which arose from an industrial project in analysing vibrations for high-speed rail tracks⁶.

Mathematicians have played an essential role in the task of making the computer revolution work to the benefit of industry and commerce. Their role and importance in the future is likely to increase not decrease. It follows that there is an urgent need for a new generation of mathematicians to take up the challenges and opportunities presented by industry as Europe seeks to become the leading knowledge-based economy. Despite the wonderful mathematical tradition in Europe in all disciplines, the numbers of students studying mathematics is not increasing in many countries, in stark contrast to the needs of society.

Research that has traditionally been considered as a part of Pure Mathematics and motivated by theoretical development has recently found many practical applications in such areas as tomography, internet searching

5. See for example, the UK's Lambert Agreements at <http://www.innovation.gov.uk/lambertagreements>

6. D.S. Mackey, N.Mackey, C.Mehl, V.Mehrmann. SIAM Journal Matrix Analysis and Applications, Vol. 28, p 971, 2006

algorithms, cryptology, biology, climate change, insurance, the economy, etc. Application-driven Mathematics has usually been associated with problems appearing in industry, science and engineering. These areas are now understood in a broader sense and also include statistical treatment of large data sets, numerical algorithms and computer packages.

Within modern technological development it does not make sense any longer easy to distinguish between Pure and Applied mathematical problems.

The majority of applications require a deep knowledge of fundamental mathematics as well as the development of new tools and algorithms. For many years companies have successfully worked with the classical techniques that were developed years ago. The high complexity of current industrial problems requires the combination of all areas of theoretical and applied mathematics. Furthermore, recent developments in mathematical sciences have reinforced two general tendencies that can be traced back far in the history of mathematics, namely the quest for unity of the discipline and its stimulation through challenges coming from other sciences and engineering. These may appear contradictory but they are not at all. Indeed, when mathematicians speak about unity of their field, they do not have in mind a static architecture of their discipline but rather a very dynamic process that accounts for a permanent rearrangement within the mathematical sciences of its different components and reflects new impacts of one branch on another. A good example for such an application is the development of new optimisation techniques, which immediately move the frontier of solvable problems far beyond current methods. It is essential for mathematicians in academia to be aware of the demand in industry so that they react by developing new techniques and transferring them to industry.

***Example:** A typical example of the latter is the growing influence of stochastics in many areas of mathematics, from geometry to the analysis of partial differential equations and combinatorics. On the other hand, challenges coming from outside can be typically taken up through combinations of techniques borrowed from different parts of mathematics and/or the emergence of new concepts. Here also typical examples are new security procedures, critical to data transmission, relying on special codes mixing in new ways combinatorics and algebraic geometry, or medical imaging techniques that rely on sophisticated geometric concepts and discretisation techniques. This shows that it is more important than ever for mathematicians to be on alert for new frontiers of their discipline in both pure and applied areas, and to exchange and share their expertise, tools and knowledge.*

1.4. International context

As mentioned previously, despite some of the deficiencies, the mathematical community in Europe has one of the top positions in international research and development; and in applied and industrial mathematics is clearly in the worldwide leading position. On the other hand keeping this lead position is not for granted, since the number of scientists in some other parts of the world is steadily increasing while stagnating in Europe. The situation can be easily compared to the field of computer science, which started out with many great developments (including the first computer) in Europe and today Europe is lagging behind. In this context, the National Science Foundation (NSF) of the United States (2008) announced Mathematics as an NSF-wide priority area⁷ recognising that:

“Today’s discoveries in science, engineering and technology are intertwined with advances across the mathematical sciences. New mathematical tools are needed to understand scores of subjects, from the complex processes that drive the climate system to interactions of magnetic fields and fluid flows in the hot plasmas within stars. Mathematical modelling plays a key role in research on micro-scale, nano-scale and optical devices. Furthermore, for the United States to remain competitive among other nations with strong traditions in mathematics education, we must attract more young Americans to careers in the mathematical sciences.”

The focus on training and education in mathematics and science in the US was further enhanced after president Obama’s launch in November 2009 of the “Educate to Innovate” Campaign for Excellence in Science, Technology, Engineering and Math (STEM) Education. This is a US-wide effort including new investments of over US\$ 260M to “move American students to the top of the pack in science and math achievements over the next decade”. President Obama⁸ furthermore stated that: “Reaffirming and strengthening America’s role as the world’s engine of scientific discovery and technological innovation is essential to meeting the challenges of this century. That’s why I am committed to making the improvement of STEM education over the next decade a national priority.”

1.4.1. The European context

Counted together, European mathematics is one of the strongest World leading schools. In many European

7. http://www.nsf.gov/news/priority_areas/mathematics/index.jsp

8. <http://www.whitehouse.gov/the-press-office/president-obama-launches-educate-innovate-campaign-excellence-science-technology-en>

1. Mathematics and its relationship with industry

universities and research centres, mathematicians are frequently organised in communities at national level. In collaboration with industry, they have developed a large expertise at the forefront of research involving most fields of mathematics. There exist scattered networks of centres, exchanging students in common training programs in industrial mathematics, that have a long tradition and experience, forming a scientific community in the making. The diversity of approaches and cultural differences is a key factor for cross-fertilisation.

Despite the work and efforts of the European mathematical organisations, the communities are still not sufficiently connected and remain fragmented. Among European countries large differences remain in the tradition of establishing links between research and industry. Companies have in many cases insufficient awareness of and belief in academic research and particularly in mathematics. This is particularly true for small and medium enterprises, for which innovation should be the main concern, in order to face worldwide competition. Regardless of the vital societal and scientific role of industrial mathematics, its recognition is not high in the European and national political agendas. In addition, the scientific community has often underestimated the value of applied and application driven research. This has led to a difficulty in its evaluation and recognition.

Despite the crisis, the hiring of mathematicians in all business sectors continues, the higher the qualification the better. Even in the present period of financial crisis, more mathematicians are hired. Mathematicians solve many important industrial math problems and mathematical software is provided through academic institutions and small spin off companies, but the demand for good mathematicians is much higher than is currently available.

As is true in many fields but even more in mathematics, if the mathematical schools of the various countries in Europe are considered together, Europe represents the broadest, most vivid and most productive school in the world. There is a strong history on which can be built in all areas of mathematics. The trench between pure and applied mathematics that is still very present in some countries has been bridged in many others. The community of colleagues that are active in developing collaborations with industries is growing and it will certainly benefit from strong promotion of success stories and the success of other people in Europe.

The way pupils, students, engineers, and mathematicians are trained still differs widely throughout Europe and also the job market for mathematicians is very different in Europe. There are also various economic and sociologic models and what is possible in one country may not be feasible in another. Some critical questions

as “what falls within the competence of a mathematician” “what falls within the competence of a researcher or an engineer” “how to use the material developed by pure mathematicians in applications” all have elements in various countries that should be compared and published. On this firm ground, the exchange of experience is certainly worthy, as some of the approaches for improvement will be possible in some countries.

1.4.2. Strengths and weaknesses of European Industrial Mathematics

Strengths in Europe:

- Mathematics is the language of innovation, which is vital for society and industry.
- Counted together, European mathematics is by far the World leading school.
- In some European universities and research centres, mathematicians are frequently organised in communities at national level. In collaboration with Industry, they have developed a large expertise at the forefront of research involving most fields of mathematics.
- There exist scattered networks of centres, exchanging students in common training programs in industrial mathematics, which have a long tradition and experience, forming a scientific community in the making. The diversity of approaches and cultural differences is a key factor for cross-fertilisation.
- Communication channels between Industry and Academia are already established in many countries. In some cases, mathematicians occupy important positions in industrial R&D, especially within large companies that have in-house research departments.

Weaknesses in Europe:

- Despite the work and efforts of the European mathematical organisations, the communities are still not sufficiently inter-connected and remain fragmented.
- Among the European countries large differences remain in the tradition of establishing links between research and industry. In many cases companies have insufficient awareness of and belief in academic research and particularly in mathematics. This is particularly true for SMEs, for which innovation should be the main concern, in order to face worldwide competition.
- Regardless of the vital societal and scientific role of industrial mathematics, its recognition is not high in the European and national political agendas. In addition, the scientific community has often underestimated the value of applied and application driven research. This has led to a difficulty in its evaluation and recognition.

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- For various reasons and for many years, industrial mathematics research was neglected in many academic institutions, and this task has been taken over by engineering groups. While this has changed in several European countries, this attitude still persists in many others.
 - Academic careers in the field of industrial mathematics have somehow suffered from a lack of recognition and of a clear identity. Similarly, large companies often have an in-house research department but no specific career development paths for mathematicians.
 - In the mathematical community at large, there has been no clear sign of integration of mathematicians working in companies.
 - Mathematics as a research topic is highly underrepresented in European research funding despite the fact that it is often well represented in national funding programs.
 - Research programs for the direct collaboration between math and industry exist only in very few European countries and such programs are completely missing on the European level.
 - The situation to deal with the demands from industry is very unevenly distributed in Europe. In several countries a variety of structures is available that can (in principle) meet this demand, but in several countries such structures are missing completely. Furthermore, in almost all countries, the education systems are not providing the means to generate academically trained staff that can fully meet the challenges. Even if people partially have the appropriate training, typically the know-how has aged after 5-10 years and continuing education is essential. Only very few institutions in Europe provide such (re-education) programs. The fact that the development of methods is so rapid implies that industrial mathematics has to maintain a strict and permanent contact with the University: otherwise, in the long term it will lose its innovation potential and will risk to “sell” obsolete methods.
 - The development of new mathematical methods progresses rather rapidly and the software development as well as the relevant analysis is often behind. Very few institutions that have recognised this demand operate on a European level, but they often fail to meet all the demand and only collaborate those partners that are active already.
 - There is no infrastructure in Europe to provide the demands and in particular there is no structural support to change the situation in math-industry underdeveloped parts of Europe. The situation is drastically different in the US where mathematics oriented start-ups have quickly become global players (MATLAB) or where the concentration of global

mathematical software development is highest (e.g. NASTRAN, ANSYS). European initiatives (even very successful ones like the SLICOT library in control which was developed through the NICONET initiative via EU support) often do not get supported further than over very short periods.

As we have already outlined, mathematics is a universal language in science and in many cases the same strategy can be applied in different contexts. This leads to the conclusion that mathematicians are valuable members of the multidisciplinary teams that are required to carry out modern development projects with industry and companies (and also multidisciplinary projects within Academia). But even more can be said: they are the natural candidates to steer the groups, since they master the language that is the vehicle of trans-disciplinary interaction.

2. Challenges and opportunities

If the boost for doubling the funding of US mathematicians wins the backing of Congress and the next US administration, the whole of science – and society at large – stands to benefit. The initiative will help tackle problems that affect us all.⁹

Rita Colwell, director of the National Science Foundation (NSF) in 2000

NSF budget for the Division of Mathematical Sciences:

US\$ 110M in 2000, US\$ 241M in 2010¹⁰

The major players in science and technology, e.g. USA, China, Canada, have made a substantial increase in the funding of research in many areas of Mathematics over the last decade. For example, the total budget dedicated to mathematics in USA from all funding organisations has increased from US\$ 380M in 2005 to US\$ 540M in 2010. Within this budget, the funding of the National Science Foundation (NSF) Division of Mathematical Sciences has more than doubled from US\$ 110M in 2000 to US\$ 241M in 2010. It is interesting to note that, in strong contrast to the situation in Europe, the NSF funding for Physics is equivalent to that of Mathematics with US\$ 290M for 2010.

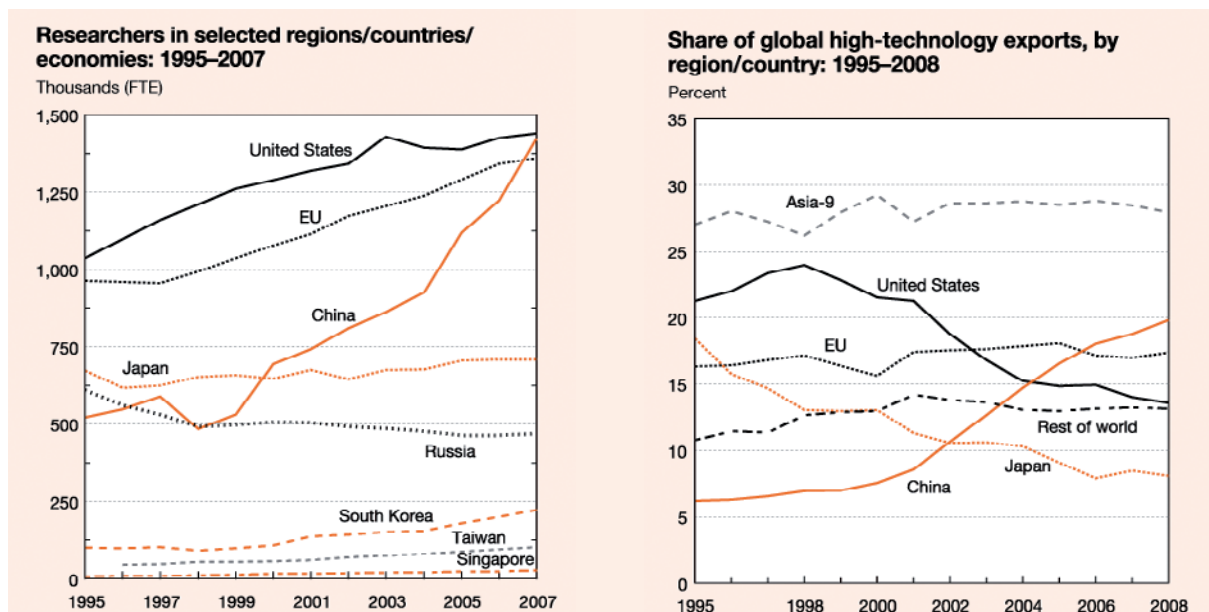
9. Nature 407, 929 (26 October 2000)

10. <http://www.ams.org/notices/200807/tx080700809p.pdf>

Over the past several decades, numerous countries (including some with smaller budgets dedicated to science) have gained international standing in mathematics. More recently, other developing countries have emerged as vibrant centres of mathematical research and training, with faculty and students competing successfully on the world stage.

In each case, it had been understood that a strong national capacity in mathematics is a key to promoting both science and science-based development. Equally importantly, these countries have concluded that domestic competency in mathematics has an important bearing on the overall quality of a nation's educational base, from economics to engineering and from medicine to sociology. India's growing progress in information technology owes much to the mathematical know-how of its knowledge workers. China's contributions to space science and biotechnology are likewise due, in part, to the mathematical skills of its researchers. China now has more than 8,000 graduates with doctorates in mathematics.

The above important developments show that mathematics is a necessary tool for creating innovation (for processes and products) in an interdisciplinary and strategic approach. Hence, innovation and the necessary investment in mathematics are key challenges for European industry and funding organisations in order to face competition in the global market.



From the OECD report entitled *OECD Science, Technology and Industry Scoreboard 2009*.

2.1. Key challenges for industrial mathematics

The start of the twenty-first century is a particularly exciting time, because there is an ever increasing need for new mathematical concepts and tools to solve problems coming from classical fields as well as from new ones, like Biology, Medicine, data mining, security, communications, and other information technologies. Industrial mathematicians can make the difference, allowing these fields to make significant strides, many of them of immediate importance to companies and to the society in general. In order to make that progress, the corresponding actors must have the necessary mathematical background and knowledge, which goes far beyond the common training of engineers or other scientists. Indeed, the latter are essentially taught to implement existing techniques and ideas, but in general they cannot develop new mathematical concepts and tools that are fundamental to provide efficient, robust and reliable methods. Abstraction allows simplifying and going to the essential features of a problem.

The Mathematics Subject Area Group¹¹ was unanimous in identifying three skills, which it believes every mathematics graduate should acquire:

- The ability to conceive a proof,
- To solve problems using mathematical tools,
- And to model a situation.

It is fair to say that this general principle has been used to design the curricula in many European universities, but has been neglected in a number of countries. For instance, many groups pay lip service to the notion and re-label a differential equations course as being a course in mathematical modelling, which is only a preliminary part of it. In this context, one should differentiate between applications for which the innovation and/or industrial problem comes from including *existing* mathematics within other engineering or scientific disciplines to produce *new* applications, and the ones for which the innovation and/or industrial problem eventually points out the need for *new* mathematics. It is important to note, however, that in this list of skills, the development of mathematical algorithms, the analysis of robustness and reliability of these algorithms and their implementation on modern high performance computers should be added to complete the picture.

The concept of mathematical modelling is central to the practical applications of industrial and applied mathematics. Mathematical modelling and simulation can be

11. EU commissioned project: "Tuning educational structures in Europe" in "Towards a Common Framework for Mathematics Degrees in Europe"; Newsletter of the European Mathematical Society September 2002, pp. 26-28

identified¹² as the core outlet for applied mathematics in the UK. Furthermore the same document states that: "*mathematics now has the opportunity more than ever before to underpin quantitative understanding of industrial strategy and processes across all sectors of business. Companies that take best advantage of this opportunity will gain a significant competitive advantage: mathematics truly gives industry the edge.*" This sentiment can be extended to Europe (See MACSI-Net roadmap in Annex 1 for example), and the coordination of our mathematical resources in this way is desirable, essential even, for the regeneration of economic success.

Mathematical modelling alone, however, is not enough; it has to go hand in hand with mathematical methods for the numerical simulation, control and optimisation. Mathematical methods have to design and analyse, and they also have to be implemented and maintained as production software that incorporates error and sensitivity analysis as well as failure control. In this respect another item has to be added to the list of important skills that a mathematician has to master, i.e. understanding, analysing and implementation of algorithms for numerical simulation, control and optimisation methods in finite precision arithmetic.

The computer revolution initiated during the 20th century is an essential part of the scientific revolution and has transformed science and engineering as a whole and its importance cannot be overestimated. The computer has created needs of mathematical expertise in almost all fields of human scientific endeavour. Close interaction between mathematicians, computer scientists and application field experts is necessary to correctly and fully exploit the enormous potential that the computer has brought. This interaction is not optimal today.

The data revolution is connected with the computer revolution. In many applications, coming from e.g. finance, astronomy, meteorology or life sciences, both the number of measured variables and samples can be very large (10^4 - 10^{10}) resulting in enormous datasets. Large amounts of money are invested worldwide in obtaining these data and much could be gained if we used just a small additional fraction of this money to analyse the data more thoroughly. In this endeavour mathematicians are necessary. A point connected with all the above and worth singling out is "software development".

It must be emphasised that the philosophy of industrial mathematics is to operate in a problem driven environment based on the core research areas of expertise available to the group. While this approach is multi-dis-

12. Mathematics: giving industry the edge – http://www.industrialmath.net/web/?url=News/Roadmap/index_html/view

2. Challenges and opportunities

ciplinary by its very nature, it is a model that is known to work and to produce both scientific advancement and significant mathematical innovation as illustrated by the unquestionable success of many research groups. One of the consequences of all this is that in industrial mathematics the aim is not to write the most possible elegant and general proof in the infinite world of mathematics, but to solve a real problem in an efficient manner and with the constraints imposed by a finite world (finite time and finite resources). Many mathematicians have accepted this, but it is far from being accepted by the community at large, which generates difficulties of recognition and valorisation.

Historically, the investigation of real problems has been the mechanism for some of the most significant mathematical developments. The exposure to industrial problems naturally leads to associate theoretical problems that, de facto, involve the areas that are necessary to give industry and science an edge. Industrial mathematics groups thus include in their mission the wider aim of building up expertise in the core mathematical areas of most relevance in industry and science e.g. modelling, optimisation, statistics, differential equations, multi-scale phenomena, numerical simulations. There is a need for mathematics to be considered as an enabling technology in its own right and for mathematicians to be regarded as scientists with a particular “technological” expertise that goes to the heart of all scientific disciplines. This has not necessarily been the case for all mathematicians in the past and will involve industrial mathematicians of this type obtaining a broader fundamental education with at least introductory courses in physics, chemistry, biology, finance, economics etc. being part of the undergraduate program. Industry needs flexible access to a more connected and well-informed academic community.

New priority areas in industrial mathematics for the next 5 years are:

- **Optimisation** discrete, continuous with all types of constraints, differential equations, stochastic in particular with all these combined.
- **Control and dynamics** of real world processes, Simulation and control of whole process chains e.g. in production, including development of software tools.
- **Mathematical modelling**, in particular directly for industrial projects with high complexity, creation and extension of modelling software, model reduction and validation.
- **Visualisation** and geometry processing.
- **Data mining** handling for large data sets in sciences and engineering as well as the respective model identification tools.
- **Software and algorithm development** in collaboration with computer scientists in order to be able to fully exploit the potentiality of new computer hardware.

General challenges for Europe:

- Industrial mathematics is at the basis of the economical pyramid and is instrumental in the innovation process and in governing complexity. In the context of globalisation, **a lack of innovation will make Europe less competitive and will have a dramatic influence on the job market.** This will reduce our reaction time to adapt to new challenges.
- A lack of political, societal and financial support will also prevent young researchers from choosing a mathematical career. As a consequence, **Europe may not keep its leading role in mathematics.**
- International competition is very tough, not only from the traditional competitors for Europe, but also, and more importantly, from emerging countries, like China or India.
- **Fragmentation needs to be overcome!** Confinement to diverse and independent national priorities would indeed be counter-productive without a strategy at the European level. The launching of a Joint Programming Initiative in the domain of European mathematics and industry could overcome fragmentation.
- **Engineering systems and manufacturing processes are becoming increasingly complex;** design optimisation, time-to-market, and cost effectiveness have become major concerns.
- The ubiquity of powerful microprocessors and the advent of inexpensive data storage devices have led to an ever-expanding capability to collect data, but the useful integration of such data in an industrial context requires that they be processed, preferably in real time, and transformed into information and knowledge.
- **Societal concerns have led to regulatory actions that reflect more stringent requirements for the safety and reliability of products;** they demand new methods for validation, verification, and the quantification of uncertainties.
- **Globalisation, awareness of resource limitations, increasing sensitivity to anthropogenic effects on the environment, and general concerns about sustainability impose constraints on industry, as well as on society as a whole. They force industry to continually analyse and evaluate its activities in a broader social context, beyond the bottom line.**
- The traditional methods of the physical sciences and engineering are no longer adequate to answer many of the questions raised in an industrial environment.

Today's problems are complex and nonlinear, they involve phenomena on multiple length and time scales, and their analysis can extend well beyond the realm of textbook mathematics. **Industry requires more than ever access to qualified mathematicians** who appreciate and understand its needs, who have been trained to capture the essence of an industrial problem in mathematical terms, who can apply methods of contemporary mathematics, and who are familiar with recent advances in scientific computing and numerical algorithms. Only such people can produce the transformative new ideas that drive future innovations.

- **The educational challenge appears at the curriculum level and in the way applied mathematics is taught.** Also, examples of success stories based on mathematical concepts and tools may be fascinating for students and attract good people to the field.

Therefore, mathematicians are the natural candidates for the coordination in industrial problems solving groups, where in addition to the modelling, simulation, control and optimisation, the implementation of robust and reliable production software is also necessary. Therefore, there must also be a basic education in modern computer science methods and modern computer architectures.

2.2. Opportunities for Europe

Recognition for mathematics is overdue

Nature 407, 929 (26 October 2000)

We recall again that the scientific revolution is happening now. There have never been so many scientists as now¹³. At the same time, all over Europe, there is a general phenomenon of lack of attraction towards scientific studies. But luckily mathematics is not the most affected field in this respect.

Most mathematicians in positions in Europe have been trained in Europe. Moreover, the European scientific policy has helped in starting the creation of a European mathematical community through networking and mobility. Due to this, among scientists the feeling of belonging to a European community is stronger than the average, and this can be used to build initiatives at the European level allowing overcoming fragmentation.

The European mathematical school is being structured through the recent initiatives of the European Mathematical Society but it does not exist as such

13. http://www.its.caltech.edu/~dg/crunch_art.html

yet. If all the national indicators in mathematics were summed up at the European level, the European mathematical school would be the most diverse, innovative and powerful one in the world. It is an opportunity to direct at least a part of this potential towards applications to industrial and societal problems.

On the other hand, we are not aware of any model of collaboration between mathematics and industry that has not been implemented in some European country. The existing expertise can be used to spread the best-suited models all over Europe, taking into account the diversity and the richness of the different European countries.

General opportunities:

- **There is a general increasing awareness about the necessity of using mathematics to improve the competitiveness of the world economy** (see for instance the various reports that are listed in Annex 1).
- **The arising awareness of the needs of mathematical modelling, illustrated recently for instance in the financial crisis or the global environmental changes, together with the willingness of the mathematicians, makes the timing right to create the necessary synergy.**
- Even if complexity is a problem addressed by mathematicians only recently, results already exist and allow to deal with some real life problems in a pertinent way. The latter is amplified by the exponential increase in computing power.
- **The expertise in mathematics is extremely high in Europe, both in variety and quality.** More and more mathematicians are ready to participate in industrial projects. The potential is there.
- **Existing experiences and knowledge can be shared in order to increase the level of industrial collaboration in all countries.** Indeed, the existing and reproducible examples of collaboration with industry can and must be spread all over Europe.
- **It is timely to start developing common networks and databases of industrial problems, mathematical experts and examples of collaboration.** An effort has to be made, but many of the necessary ingredients are already available and will be put in place if our recommendations are followed. Indeed, Europe has already greatly contributed to the building networks across the European boundaries at the academic level. At the same time, companies are more and more international.
- **The European industrial landscape is characterised by the strong presence of SMEs. The**

2. Challenges and opportunities

development of stronger interactions and networking in the mathematical community would be an opportunity for both industry and Academia.

- **The present increase of the amount of data in many fields will require the development of new mathematical and statistical approaches.** Moreover, the necessary level of mathematics is nowadays often too sophisticated for a single researcher or research group, so building a strong community is more crucial than ever in order to be able to tackle those problems. Reciprocally, available tools of data mining will be able to treat the huge amounts of data that were impossible to deal with until recently. This gives the opportunity to structure data in such a way that models can be built upon it.
- **Knowledge is the key source of competitive advantage in today's advanced economies. European Member States need to boost productivity and performance through better use of knowledge, especially for innovation. Productivity is about making the most of available resources, combining them in new ways and creating new sources of value. It is the key driver of smart economic performance and sustainability enabled by industrial and applied mathematics.** That is why Europe needs to adapt to a smarter economy that is also a more sustainable and innovative economy – characterised not least by the capacity to adapt quickly to changing circumstances.
- Finally, concerning the very delicate question of confidentiality in industrial research, the mathematicians already involved in industrial have learned to deal with it and can share this knowledge with colleagues in other European countries.

3. Mathematics and industry: the missing strategic link

Europe invests billions of euros in knowledge-based industries, but there is concern that links between industry and research are weak, and that market fragmentation is causing investment to leak out of the research infrastructure.¹⁴

Kostas Glinos, European Commission,
DG Information Society and Media
Head of GEANT and e-Infrastructure Unit

One way to look at or model the interaction between society as a whole and the university is the *Triple Helix approach* developed by Henry Etzkowitz and Loet Leydesdorff. It is based on the viewpoint of the University as a leader of the interaction with Industry and Government to generate new knowledge and innovation. In the words of Etzkowitz:

“The increased importance of knowledge and the role of the university in incubation of technology-based firms has given it a more prominent place in the institutional firmament. The entrepreneurial university takes a proactive stance in putting knowledge to use and in broadening the input into the creation of academic knowledge. Thus it operates according to an interactive rather than a linear model of innovation. As firms raise their technological level, they move closer to an academic model, engaging in higher levels of training and in sharing of knowledge. Government acts as a public entrepreneur and venture capitalist in addition to its traditional regulatory role in setting the rules of the game.”¹⁵

As just one small manifestation of this new global innovation landscape the *Journal of Knowledge-based innovation in China* was created in China in 2009. The objective of the journal is to publish research that addresses emerging or developed innovative practices in modern China, and illustrate how innovation is feeding into the country’s rapidly growing knowledge economy. Furthermore, the journal will explore the nature of the Triple Helix Model in China and the creation of the journal is propelled by the fact that China **“is undergoing a fast transformation from the world’s manufacturer to a leading player in the field of knowledge-based innovation.”**¹⁶ As is acknowledged by the already quoted “Educate to Innovate” campaign in the US in STEM-education, mathematics plays a key role in this emerging innovation landscape, being the unifying theme and common language of all science, technology and engineering. That education in mathematics already at the basic school levels is crucial for a competitive knowledge-based society is stated in the report “Building a Science, Technology, Engineering and Math Agenda”¹⁷: **“Studies of results from TIMSS 2003 suggest that the top-achieving countries have coherent, focused, and demanding mathematics curricula”**

Naturally, coherent, focused and demanding mathematics curricula at the university level are also mandatory to create and maintain a successful knowledge driven economy. It is clear that **Mathematics plays a key role as the backbone of the Triple Helix.** In this context,

15. Social Science Information, Vol. 42, No. 3, 293-337 (2003)

16. Editorial Objective of the Journal of Knowledge-based innovation in China

17. <http://www.nga.org/Files/pdf/0702INNOVATIONstem.pdf>

14. ERCIM News, Simulation and modelling for Research and Industry, Number 81, April 2010

3. Mathematics and industry: the missing strategic link

we remind that, counted together, Europe already has the potential of being the world leader in Mathematics when it comes to either fundamental or applied and industrial research. However, the European Mathematical community is fragmented. **We have the opportunity to focus the strength of European mathematics and use it as a catalyst for European innovation.** Major pillars for success in such a venture are education, training and career possibilities in industrial mathematics. Key to making such a venture a truly European effort are student and staff mobility and the spread of best practices. Mobility, joint ventures and the spread of best practices have the potential to positively influence and strengthen every aspect of education, training and research. This includes the unfortunate gender imbalance in the mathematical community and the differences in gender imbalance across Europe as reported in the work “Statistics on Women in Mathematics” by Catherine Hobbs and Esmyr Koomen¹⁸. This work shows considerable differences between regions in Europe where southern countries such as Italy, Portugal and Spain have a much higher proportion of women in mathematics than northern countries such as Germany or Sweden. The work shows that there exists an unused potential pool of female talent and expertise particularly in the northern countries. In the same work one can see that the trend is positive, but that development goes slowly. This progress would certainly go much faster with increased mobility and truly joint ventures in European Mathematics.

3.1. Building a community

Strategic objectives to build the community:

- **To foster a European Network in applied mathematics towards a Smart Economy.**
- **To allow Member States to build up a common strategy for European mathematics.**
- **To establish mathematics as a necessary component of European innovation.**

There is a need to coordinate groups interested in mathematics in industry at the European level. An obvious way of doing this is a bottom-up approach where each country is given responsibility for coordinating its own network and there is a European coordinating organism that takes care of common activities (from a web portal for the organisation of events, sharing of expertise databases, etc), pro-

18. <http://womenandmath.files.wordpress.com/2007/09/statisticswomen.pdf>

notes transnational research projects whenever the complexity of the problems requires this approach and develops and coordinates opportunities of training. This can be done in the framework of the European Mathematical Society and could benefit from the experience of ECMI, of its Educational Committee and Special Interest groups.

The coordination should not be too difficult to organise at the academic level. But that will be much more difficult at the level of companies. One of the main problems is that people working in industry and dealing with mathematics, such as engineers, physicists, technicians, MDs or CEOs, do not consider themselves as mathematicians any longer. One of the reasons for this is the lack of recognition, and the lack of evaluation of what they are doing. Moreover, many of them become often in charge of tasks, which are more administrative than scientific. This should not be avoided necessarily, but there should be a way of a better evolution of those mathematicians and also it should be possible for them to remain close to problem resolution activities. Structuring this part of the community is thus not so obvious.

On the other side also, the activity of mathematicians that get confronted with collaborative efforts with industries is barely recognised when it comes to promotion on faculty positions. The output of these activities may give rise to a journal publication but this reflects only a little part of the work done, and from the promotion point of view it often pays off much more to concentrate on academic problems than solving real world ones.

So, it is high time to actively promote ways of highlighting the scientific and intellectual value of industrial mathematics. The creation of a journal of industrial mathematics has been evoked, together with the associated with pros and cons. On the “pros” side: such a journal could become a platform for learning how to evaluate these activities, and also to promote by the example. On the “cons” side: most of the work done in the interaction with industry is of a bespoke nature, and it is not research oriented and the evaluation should not be done with standard tools... others should be invented.

It is fair to say that many mathematicians do not really wish to solve real industrial problems. This fact should be acknowledged from the outset. But it is enough that those who want to do it, can do it and are properly evaluated and recognised for that work. Another situation that should be avoided is where a group of mathematicians, with no real modelling experience, claims to solve industrial problems, when actually they only solve mathematical problems of interest to themselves rather than to industry. This sort of activity undoubtedly damages the case for mathematics in industry. After experiences like these, industrial and company partners will invariably

disengage from the collaboration and express the opinion that mathematicians do not solve real problems. In the controversial words of Bernard Beuzamy, one time professor of pure mathematics at the University of Lyon, who later set up his own mathematical consultancy¹⁹: “It (mathematics) brings solutions nobody understands to questions nobody asked.” It is not sufficient to *claim* an interest in industrial applications to be an industrial mathematician. In this context, a good example is the so-called “industry-motivated papers” where the industrial problem just appears in the title or in the introduction to justify a bunch of theorems (that in any case could have an interest in themselves); this is a real danger that also journals devoted to industrial mathematics should avoid. For instance, Springer is planning a new journal on Industrial mathematics together with ECMI and it should be worth following its evolution and applying appropriate evaluation measures to deem its success and impact.

3.2. Developing the community

Strategic objectives to develop the community:

- **To overcome geographical and scientific fragmentation.**
- **To broaden and harmonise educational programs for students and teachers in mathematics at the European level.**
- **To facilitate the mobility between industry and Academia.**

Education for Innovation

Since higher education plays a key role in the transformation of the society from industry to knowledge based, many actors are entering the scene: not only professors and students, but also public authorities and social partners. All actors have to adjust to this new reality: a reality with a greater number of legitimate actors representing the interests of society, wanting to give their views on and indications to the direction of the development of higher education in the future. Research and development must be developed as a whole covering universities, polytechnics, research institutions and industry. Public investments are crucial when the role and quality of higher education institutions in innovation need to be improved. The role of public funding will remain crucial, and indicative of the determination of the public authorities. Furthermore, one way of developing research resources of universities is promoting the use of private

19. Irish Math Soc. Bull., 48 (2002), 43-46

investments from industry together with public funding. In order to establish “one European Mathematical Community” that is ready to act as a catalyst for innovation in Europe is the establishment of common points of reference at the Bachelor and Master Degree levels. The formation of European Model Master Curricula in Mathematics and Industrial Mathematics are necessary (See Annex 2 for an example).

3.3. Empowering the community

Strategic objectives to empower the community:

- **To harmonise the curriculum and educational programmes in industrial mathematics.**
- **To encourage the exchange of knowledge and information between Academia and industry.**
- **To promote and improve the career path in industrial mathematics.**

A European Model Master in Industrial Mathematics

It is certainly true that Mathematical sciences always have developed in symbiosis with real world applications. This was clear already from the time of Archimedes but has been even clearer since the days of Newton. It is also clear that Mathematics, together with Science as a whole, has taken a giant leap during the 19th and 20th century and today present many new potentially revolutionising opportunities for Society. It is clear that these opportunities for innovation can only be realised with a focused investment on education and training in mathematics and science across Europe. That a new curriculum development for Industrial Mathematics, taking all the above points into account, can be achieved on a European scale has been proved by the European Curriculum Development program called ECMIMIM²⁰ that took part during 2007-2009. The outcome was a “European Model Master in Industrial Mathematics” developed by the nine participating European Universities. The project work has already been acknowledged by the fact that at the Dissemination Conference of the project in Dresden in September 2009 the nine participating universities from eight different European countries signed a statement that the Model Master program will be implemented at the participating nodes²¹. In conclusion, Europe should ensure the production of mathematical students suffi-

20. http://www.uc3m.es/portal/page/portal/postgrado_mast_doct/masters/Masters_in_industrial_mathematics/Project

21. tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_mathematik_und_naturwissenschaften/fachrichtung_mathematik/emp-im-2009

3. Mathematics and industry: the missing strategic link

cient in number, quality and breadth to meet the needs in teaching, in research in the industrial mathematics and in other disciplines. **Europe should consequently increase its funding for the mathematical sciences to a level comparable to those in the physical and biological and engineering. It should also encourage activities that connect mathematics to other areas of science, technology, business, finance and government, together with strengthening the connections between pure and applied mathematics.**

Opening up higher education in a lifelong learning perspective

Higher competence and skills are not only a question of higher education but also vocational training. Different levels of formal education must not be seen as opposite, but as complementary elements in lifelong learning. Europe needs to take two leaps simultaneously to raise the qualifications and skills of its researchers and workers in industry, academia and companies. On average the number of graduates from higher education is lower than in competing economies, but this is not the case in all member states. At the same time the number of non- or low-skilled workers is too high in Europe. Statistics shown in the Commission's communication indicate a clear link between the educational level of the population and employment. There is also a correlation between the educational level of the population and the GDP in western countries. Lifelong learning is a key to achieving the EU objectives of full employment, enhanced competences, high qualifications and worker mobility, as well as a fairer distribution of income and the balance between professional and family life. Access to training in mathematics should be opened up to motivated and talented adults who did not have the chance to study in their youth and for those who come from socially and financially disadvantaged backgrounds. Moreover, higher education institutions need to increase their role in continuous training of their graduates as part of improving their attractiveness among industry and working life. The task of higher education could be divided into initial and continuous training where continuous training or adult education does not only mean postgraduate education. **Lifelong learning and the modernisation of the national educational and vocational training systems, especially in industrial mathematics will be the cornerstones in preventing long-term unemployment and increasing the labour force mobility in Europe.**

4. Recommendations: giving European mathematics and industry the edge

Business-as-usual in science will leave an ever-growing gap between 'have' and 'have-not' nations – in financial as well as human-development terms.

US Inter Academy Council Report
January 2004

The essential role of the mathematical sciences in almost all aspects of the scientific, engineering, and educational enterprise has become increasingly apparent. Together with this greatly expanded capacity for discovery and its subsequent applications to meet societal needs has come a dramatic demand for new mathematical techniques and capabilities that will ensure the continued growth of European scientific and technological capacity. To respond to this demand, substantial progress in the development of new fields of fundamental mathematics is required. Further, in light of our increasing reliance on science, engineering and technology to sustain economic growth and to improve the national quality of life, there is a growing need for improved education and training in mathematics and statistics, both for the scientific and technical workforce and for the population at large. **Europe's competitiveness is to be achieved in a multilateral international environment through a common strategy for European Industrial mathematics.**

To answer the strategic objectives presented in section 3 for **a strong European future in industrial mathematics**, and to enable maximal socio-economic benefits, the Forward Look Steering Committee proposes a number of concrete, near-term actions. These recommendations are listed below in order of impact and urgency, starting with the highest priority:

4.1. Recommendations to policy makers and funders

Recommendation 1: Policy makers and funding organisations should join their efforts to fund mathematics activities through a European Institute of Mathematics for Innovation.

Roadmap implementation 1.1:

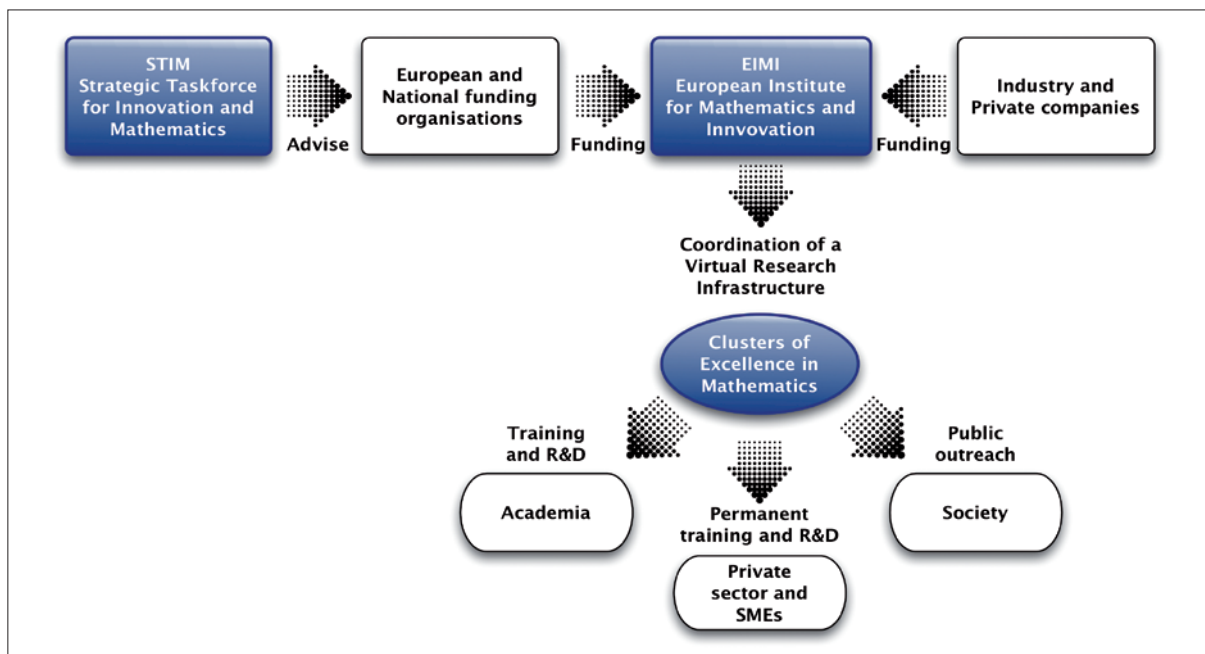
EU and National funding agencies should coordinate *clusters of excellence* in industrial mathematics and create a *European Institute of Mathematics for Innovation (EIMI)* for mathematicians and users of mathematics

Global companies often need to collaborate with more than one specialised area in mathematics and so, capitalising on existing leading-edge mathematical expertise, large clusters or competence centres should be formed as for example the *Excellence Clusters*²² in Germany. They should be highly visible, collaborative and provide competences in all areas of applied mathematics including computational mathematics. These should be closely linked to universities and research institutes so that young students get involved directly. The clusters should have clear points of contact to access experts and industrial mathematicians, and create appropriate engagement mechanisms where they are not already available. Clusters must be based on knowledge hubs of international excellence and market foresight. Indeed, the development of groups of experts should not only be based on a greater allocation of funds but also through a clearer recognition that an intensification of economic globalisation and the rise of new global players require strong international partnerships.

The European funding organisations should provide financial support for the creation of a dedicated and sustainable **Institute of Mathematics for Innovation** through a world-class **European virtual infrastructure** to act as the basis of sciences and innovation. It would involve Academia, Researchers and Industry across Europe and beyond. Additional funding could be provided by national governments and agencies. **Such an Institute would be built from the knowledge and expertise of industrial mathematicians to access the best experts, databases, libraries and facilities for mathematicians and users of mathematics. It would provide mechanisms for exchange and dissemination of knowledge and be a unified channel for international funding in the area of industrial**

22. <http://www.excellence-initiative.com/>

4. Recommendations: giving European mathematics and industry the edge



and applied mathematics. The EIMI should include fundamental, industrial, and computational mathematics in order to support a sufficient number of researchers and activities, and should offer companies a one-stop-shop for collaborations.

Indeed, the strength of European higher education and research does not lay only in excellence of a few institutions but also in the high quality of the majority of institutions. There should be a closer coordination between the EU and Member States, for mutual benefit, with a more coordinated use of all available instruments, through better strategic planning and the developing of new working methods and procedures. The creation of a coordinated and coherent virtual structure in mathematics and its applications is therefore crucial for Europe's competitiveness and impact as it is done for example in Canada through MITACS²³, Australia with MASCOS²⁴, or in the UK with the Industrial Mathematics Knowledge Transfer Network²⁵. In addition to universities and research centres, private partners should constitute the core of the partnership within the European virtual infrastructure. The European Institute of Mathematics for Innovation would be particularly instrumental for SMEs that are seen as a major source of future job creation in Europe and will be central to how member states emerge from the ongoing financial crisis. Moreover, small

23. www.mitacs.math.ca

24. www.complex.org.au

25. www.innovateuk.org.mathsktn

companies face major challenges when attempting to tap into European funding programmes, given the time and financial resources required to apply. A European Institute of Mathematics for Innovation would provide a fertile environment in which SMEs can access research infrastructure available within universities. In addition, it would also allow research institutes to tap into the dynamism offered by small firms and start-ups.

Roadmap implementation 1.2:

EU and European governments should set up a Strategy Taskforce for Innovation and Mathematics (STIM) in order to develop a European strategy for mathematics

In order to support the creation of a political, technological and administrative framework for a coordinated and efficient use of distributed resources in industrial mathematics, we recommend the creation of a strategy task force to define and recommend best practices and major initiatives across Europe. It would include official government delegates and key representatives from the private sector from all the EU countries. The Strategy Taskforce for Innovation and Mathematics (STIM) would produce white papers, roadmaps and recommendations, and analyses the future foundations of the European Knowledge Society and the added value of industrial mathematics to address Global Grand Challenges. The STIM would also coordinate activities with similar international initiatives. Europe's competitiveness is to

be achieved in a multilateral international environment through a common strategy for European Industrial mathematics.

Roadmap implementation 1.3:

Policy makers should put in place a Small Business Act in Mathematics (SBAM) to encourage spin-off companies explicitly using mathematics

Europe should establish an industrial policy creating the best environment to maintain and develop a strong, competitive and diversified industrial base in Europe. National and International supports for the creation of spin-off companies using mathematics, which have shown to have very high success rates in Germany and Sweden for example, should be provided, taking into account the timescale of the market dynamics for Small and Medium Enterprises (SMEs). Standardisation, confidentiality and Intellectual Property regulations should be disseminated in the Community through the Small Business Act in Mathematics.

The main objectives of the Small Business Act in Mathematics should include:

- Simplifying the conditions and providing incentives to involve mathematics and mathematicians in innovative businesses, improving the entrepreneurial environment and reducing the administrative burden,
- Simplifying the access of SMEs to the EU's pool of industrial mathematicians,
- Simplifying the access of SMEs using mathematics to investment funding,
- Openly fostering industrial mathematics engineers at the interface between SMEs and academia.
- Giving specific guidelines for possible forms of user-friendly interaction.
- Suggesting some indicators for the evaluation of the success of the collaboration

Roadmap implementation 1.4:

EU must identify industrial and applied mathematics as an independent crosscutting priority for the Framework Programme 8

Research is an area where Member States have the main responsibility, hence the important differences of research policies across Europe. The European Union's role in this area is essentially that of establishing a framework encouraging more public and private investment in research activities, as well as the direct funding of research activities through the Framework Programme. Mathematics should be an essential priority of the future Framework Programme 8 from the European

Commission. If the Lisbon strategy is to create a knowledge-based economy and to raise the educational level of society, then Europe has to invest more in the key and fundamental area of mathematics. A dedicated call from the European Commission should also be created for research and development activities in the domain of industrial and applied mathematics.

4.2. Recommendations to both academia and industry

Recommendation 2: In order to overcome geographical and scientific fragmentation, academic institutions and industry must share and disseminate best practises across Europe and disciplines via networks and digital means.

Roadmap implementation 2.1:

Researchers in academia and industry must adapt their mentalities to the different mathematical and scientific domains they interact with, and disseminate best practises

It is crucial for mathematicians in industry and even more in academia to change and adapt their view regarding other fields of mathematics and other scientific domains. Indeed, the mathematical community needs a stronger cohesion and unity. In this context, a wider and more frequent dialogue between fields is essential and can be achieved through a federated structure such as the European Institute of Mathematics for Innovation (EIMI) suggested previously. Mathematicians could also make more regular use of existing research infrastructure such as High Performance Computing centres in which they could play a role. Moreover, sharing best practices, and also unsuccessful investigations, across Europe will help to level out geographical and economical differences between Member States. Web access to information about problems, methods, solutions, centres of excellence, and available expertise especially for multi-disciplinary approaches, will be particularly useful for companies. Moreover, mathematics has an important role in education and permanent training for companies and society. The community should develop educational documents and electronic tools to disseminate knowledge about success and failure, and assess the quality of information in the field of industrial and applied mathematics. The use of open databases of experts, expertise, and problems and of the corresponding search tools should be created to allow users to identify the

4. Recommendations: giving European mathematics and industry the edge

best available partners and methods for their specific problems. It would allow publicly funded research to be made available to society at large.

Roadmap implementation 2.2:

The mathematical community in collaboration with industry should create a journal devoted to industrial mathematics and contribute to the European Digital Mathematics Library

A Journal on mathematics in industry would raise the visibility of the community. It would bring together high level research works on the developments of applications of mathematics to industrial problems, including both methods and computational challenges they encompass. It would show the actual use of mathematics in industry, through the improvement of industrial processes and major challenges deriving from cost and ecological issues. By publishing peer reviewed papers of high quality and originality, it would serve as an essential resource for academic researchers and practitioners alike, and would provide a common platform for scholars interested in the mathematics required and specifically motivated by concrete industrial applications, thus favouring the interaction of academia and industry. The journal would be set-up with a worldwide editorial board consisting of scientists in industry, academia and contract research organisations.

In the light of mathematicians' reliance on their discipline's rich published heritage and the key role of mathematics in enabling other scientific disciplines, the European Digital Mathematics Library has strived to make the significant corpus of mathematics scholarship published in Europe available online, in the form of an authoritative and enduring digital collection, developed and curated by a network of institutions. Mathematicians from academia and industry should contribute actively to this collective effort in constructing the Europe-wide interconnections between their collections to create a document network as integrated and trans-national as the discipline of mathematics itself, through secure and open access to their texts.

Roadmap implementation 2.3:

Academic institutions and industry must facilitate the employment mobility between academia and companies

Industry can make its environment more attractive for qualified researchers if an acceptable compromise can be reached between the long timescale typical for mathematics research and the much shorter timescale typically faced by industry. Industry can enhance its

presence in academia by actively supporting activities that potentially increase the impact of mathematics in industry. The creation of joint positions, or special chairs or faculty positions for researchers from industry should be given careful consideration and would provide real role models for students. Academia should also promote successful implementations of such flexibility and provide mechanisms to answer industrial short-term needs. Incentives should be put in place to facilitate a stronger mobility.

Connections, formal and informal, between non-academic organisations and academic mathematicians can build pathways for a two-way flow of both concepts and results. A better transfer of mathematical methods and technology into industry is needed. Societies and academic institutions should offer opportunities for mutual exchange of knowledge and workshops, where industry can come with their specific problems and where these can be addressed. Academia should adapt training to long term and future research fields in addition to the short timeframe adaptation of training for short-term needs of companies. Moreover, the challenges for mathematics arising from future industrial needs must be defined and addressed. Societies and academic institutions should organise specific "grand challenge workshops", focussed on industrial application areas with high relevance for future economic needs in Europe. Their multidisciplinary teams of experts from academia and industry should jointly identify the mathematical gaps which have to be solved in order to enable quantum leap innovations.

Short courses in continuing education as proposed by academic mathematics departments should be a privileged way to promote interaction between mathematics and industry. It would allow the academic and industrial researchers to meet and allow engineers to acquire or to upgrade a mathematical culture. It would allow the academic researchers to have immediate feedback from the industrial researchers about their needs through the questions asked during the training sessions, and would be the opportunity to establish direct contacts between academic and industrial researchers, creating opportunities for research participation at all levels. Early exposure whets the appetite, and nothing beats hands-on experience. The opportunities may include industrial internships, modelling camps, and summer schools.

Roadmap implementation 2.4:

The mathematics community and industry should work together on real opportunities in application-themed competitions

The mathematics community and industry have shown some reluctance to bid for projects within application-

based funding competitions, largely because of previous experiences where mathematics has not been considered core to the application. If funders can include mathematics explicitly then the mathematics community should respond by moving into this new territory. The mathematicians from academia and industry should use all opportunities and expertise in from other scientific fields outside mathematics to participate in dedicated proposals in application-themed competitions. The participation in dedicated calls could be done through the EIMI (See recommendation 1).

4.3. Recommendations to academia

Recommendation 3: Mathematical Societies and academic institutions should create common curricula and educational programmes in mathematics at European level taking into account local expertise and specificity.

Roadmap implementation 3.1:

Academia must create a European Curriculum for industrial mathematics and set up a pool of industrial mathematics engineers

For this crucial recommendation to overcome fragmentation, the European Master and PhD programs for mathematics and industry should be created, where students learn the necessary mathematics and software skills but where they also learn the language of practitioners e.g. engineers, medical doctors etc. Education in Master programs should provide the option of specific problem solving on industrial internships²⁶ with support from interdisciplinary scientists if necessary. They would give students the flexibility to explore career options outside academia. To develop curriculum options that prepare the students for a career at the interface of mathematics and industry, curricula should reflect the reality that such a career requires both a solid background in mathematics and the intellectual curiosity to go beyond mathematics. The curriculum should be flexible but subject to rigorous quality control. It should stress innovative applications of mathematics, highlight problems that are industry-driven, and encourage students to broaden their scientific interests. The curriculum should also take into account the training of schoolteachers in order to create a continuum in the dissemination of knowledge in mathematics. Above all, it should be designed to demonstrate that the interaction of mathematics and industry leads to exciting research opportunities and benefits.

26. See for example www.ktn-internships.net

Considering the need for Academia to adapt to the short timescales of companies, a pool of specialists who can quickly and adequately answer requests from industry in terms of mathematical modelling and solutions would be a valuable resource for companies to draw upon. As a consequence, new long-term professional careers of mathematical engineers should be offered by scientific organisations at national and European levels mainly funded by industry. Permanent positions should be the norm. The communication between industry and the world of mathematics should be facilitated through the creation of techno-mathematician translators such as the Technology Translators²⁷ at the UK's Knowledge Transfer Network, since the problems in industry are not expressed in the language of mathematics in an obvious way, and since this language itself has developed its own idioms and syntax.

Roadmap implementation 3.2:

Academia must develop new criteria to assess and recognise careers in industrial mathematics

The community should set standards for the evaluation of the dual career of industrial mathematicians between academia and industry. There should be teaching and research positions devoted to industrial and applied mathematics following educational programs built with industry. Such programs offer a first-hand experience of working in an industrial environment and thus a realistic perspective on a career in industry, while preserving the option of an academic career. The younger generation of mathematicians should also be encouraged to start spin-off companies and to move between countries and disciplines.

27. www.industrialmath.net/web/?url=About/mathsKTN/KTNManagement

Annexes

Annex 1

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Annex 2

Example of Model Master in industrial mathematics

The aim of the master programme in Industrial Mathematics is to develop the student's mathematical and computational skills to solve industrial problems and development tasks in innovative ways in collaboration with other science departments, e.g. engineering. Fundamental capabilities to be trained are:

- Modelling and analytical skills, knowledge of numerical methods, skills in programming, simulation, experience with mathematical models in industry,
- Ability to handle huge amounts of data by integrating mathematical, numerical and statistical methods,
- Team working, cooperation, communication with and presentations for mathematicians and engineers.

The master programme is international. The education is given in English when possible. The duration of the master programme is two years (120 European Credit Transfer and Accumulation System or ECTS). There are three course blocks (A, B and C) which are related to both the requirements for admission to the master study and compulsory courses of the master programme.

Requirements for admission to the master programme

(A) 180 ECTS of undergraduate study at university level (bachelor degree), (B) Prerequisite courses covering the topics in course block A, (C) Prerequisite courses covering topics of an amount of at least $\frac{1}{2}$ of the total ECTS in block B, (D) Since the education is given in English, good communication skills in English are required both orally and in writing.

Requirements for the master degree

The following is required in the master study to receive the master degree. (A) At least 120 ECTS in total, corresponding to two years study, (B) Courses covering the remaining topics in block B (see requirements for admission), (C) At least 60 ECTS of elective courses in course block C. Among these courses there are required mathematical courses summing up to at least 42 ECTS as well as courses in a minor field of study related to mathematics of at least 12 ECTS, (D) Modelling activities of at least 9 ECTS, and a master thesis of 30 ECTS, (E) Further Courses up to 120 ECTS in total.

Additional requirements

In addition to the above requirements for the master degree in industrial mathematics the following is required (1) at least one semester of the study or the final master thesis project at one of the other universities of the network, (2) practical training in mathematical modelling,

organised in a regular modelling seminar, Workload: 6 – 15 ECTS, (3) Participation in the International Modelling Week (3 ECTS), (4) Mathematical courses in Scientific Computing, Optimisation and Mathematical Statistics. Each student's qualification is finally assessed on the basis of two review reports of the thesis.

Study blocks

- **Block A:** Prerequisites (for admission to the Master programme)

Required topics:

Basic knowledge in calculus	18 ECTS
Linear Algebra	6 ECTS
Some basics in numerical analysis	6 ECTS
Programming skills	6 ECTS
Basic knowledge in physics or mechanics	6 ECTS
Basics in statistics	6 ECTS
Total amount of courses	48 ECTS

- **Block B:** At least $\frac{1}{2}$ of the listed topics are required for admission. The remaining topics are required during the Master study.

Required Topics:

Transforms, linear systems, basics in ODE	6 ECTS
Basics in PDE	6 ECTS
Numerics for differential equations	6 ECTS
Minor field of study related to mathematics	6 ECTS
Total amount of courses	at least 24 ECTS

- **Block C:** Elective courses in the field of industrial mathematics. Every student can choose among offered specialisation courses at her/his home university or at an ECMI partner university.

Requirements:

Total amount of courses in block C, among these courses:	at least 60 ECTS
Mathematical courses	at least 42 ECTS
Courses in a minor field of study related to mathematics	at least 12 ECTS

- **Modelling activities**

Modelling activities (e.g. modelling seminar, summer school, study groups, industrial project, internships etc.)	at least 9 ECTS
--	-----------------

Annex 2

Example of Model Master in industrial mathematics.

- **Master thesis:** The thesis should be related to a real industrial problem. It could preferably be carried out in an interdisciplinary environment involving participants from industry.

30 ECTS

Total ECTS for Master degree:

$12 - x$ (Block B) + 60 (Block C) + 9 (Modelling) +
 30 (Thesis) + $9 + x$ (free) = 120 ($0 \leq x \leq 12$)

Details on the topics in block B

**Transforms, linear systems, and basics in ODE:
(examples of topics)**

- Fourier series, Fourier and Laplace transforms
- Systems of linear differential equations (state space theory, diagonalisation, stability)
- Quadratic forms and Input-output relations (transfer function, impulse response)

Basics in PDE: (examples of topics)

- First order PDE, Linear second order PDE
- Series expansions, Fourier's method, Green function
- Wave propagation, Functions spaces and norms, Distributions

**Numerics for differential equations:
(examples of topics)**

- Methods for time integration, Finite difference methods
- Explicit and implicit Runge-Kutta, Multistep methods
- Error analysis, stability and convergence
- Object-oriented programming

Annex 3

Forward Look Steering Committee and activities

Mario Primicerio (Chair)

Istituto Matematico “Ulisse Dini”, Università degli Studi, Firenze, Italy

Maria J. Estebà

CNRS – CEREMADE, Université Paris-Dauphine, Paris, France

Magnus Fontes (Coordinator of Working 1)

Centre for Mathematical Sciences, Lund University, Sweden

Yvon Maday (Coordinator of Working 3)

CNRS UMR 7598, Laboratoire Jacques-Louis Lions, Université Pierre et Marie Curie, Paris, France

Volker Mehrmann (Coordinator of Working 2)

Institut für Mathematik, TU Berlin, Germany

Goncalo Quadros

Critical Software SA, Coimbra, Portugal

Wil Schilders

NXP Semiconductors, Eindhoven, The Netherlands and TU Eindhoven, Faculty of Mathematics and Computer Science, Eindhoven, The Netherlands

Andreas Schuppert

Process Technology – E41, Bayer Technology Service GmbH, Leverkusen, Germany

Heather Tewkesbury

KTN for Industrial Mathematics, Surrey Technology Centre, United Kingdom

ESF Liaison

Dr Thibaut Lery

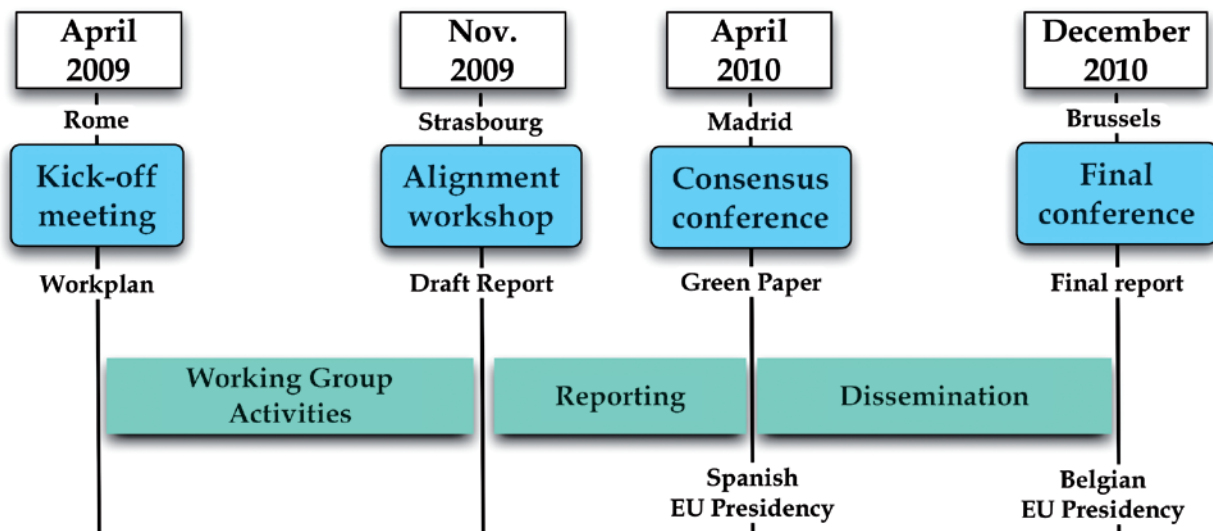
Science

Ms Chantal Durant

Administration

Activities of the Forward Look

Forward Look Timeline



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Sylwia Markwardt

Von: ec14-bounces@mail.mathunion.org im Auftrag von IMU Secretary [secretary@mathunion.org]
Gesendet: Samstag, 19. Februar 2011 16:24
An: cdc14-grants@mathunion.org
Cc: IMU CDC; ec14@mathunion.org; CDC14@mathunion.org
Betreff: [EC14] Grants Selection Committee: cdc14-grants@mathunion.org, a new e-mail distribution list

Dear colleagues in IMU's
CDC Grants Selection Committee,

I was informed by Herb Clemens and Kesavan that the Grants Selection Committee is complete. Thanks to everyone for agreeing to serve!

1. Members

=====

The CDC colleagues on the Grants Selection Committee (called "internal members") are (in alphabetic order):
Carlos Cabrelli (Argentina)
Kesavan (India) (Chair of Grants Selection Committee)
Hoang Xuan Phu (Vietnam)

The additional members (called "external members") are:
Jean-Pierre Gossez (Belgium)
Fanja Rakotondranjao (Madagascar)
Patrick Scott (US)
Jiping Zhang (China)

The selection of the members of the Grants Selection Committee was decided at the CDC meeting on January 30, 2011 in Berlin following the rules specified in item 5 of CDC's Terms of Reference, see http://www.mathunion.org/fileadmin/CDC/CDC-Terms-of-Reference-final_100816.pdf

2. New e-mail distribution list

=====

At the IMU Secretariat in Berlin, we have set up an e-mail distribution list

cdc14-grants@mathunion.org

that is operational from now on. Whenever you send an e-mail to this address, the IMU mail server will distribute this e-mail to the following addresses:

cabrelli@dm.uba.ar
clemens@math.ohio-state.edu
frakoton@yahoo.fr
gossez@ulb.ac.be
hxphu@math.ac.vn
phu@iwr.uni-heidelberg.de (Phu's second e-mail account)
jantdelap@gmail.com
jzhang@pku.edu.cn
kesh@imsc.res.in
icmi.cdc.administrator@mathunion.org (Lena Koch)
pscott@nmsu.edu

in other words, to all grants selection committee members,

and in addition to
Herb Clemens (CDC Secretary for Policy),
Jose de la Pena (CDC President) and
Lena Koch (IMU's CDC and ICMI administrator).

3. Archiving

=====

All e-mails to cdc14-grants@mathunion.org will be archived electronically at the IMU Secretariat.

4. Submission and moderation

=====

Everyone on this e-mail distribution list and every IMU EC member is allowed to send e-mails to the list. The list is moderated (to avoid spam). Every e-mail to cdc14-grants@mathunion.org coming from another person goes to Wolfgnag Dalitz (technician@mathunion.org). He will check it. If it is junk he will delete it. If it sounds "reasonable" he will forward the e-mail to the Grants Selection Committee members.

Welcome to the e-mail distribution list and best regards

Martin

```
+-----+
|           Martin Groetschel           |
|           Secretary of the            |
| International Mathematical Union (IMU) |
|           URL: http://www.mathunion.org |
|           e-mail: secretary@mathunion.org |
+-----+
| Postal Address:                       |
| International Mathematical Union      |
| Secretariat                          |
| Markgrafenstr. 32, 10117 Berlin, Germany |
| Tel: +49 30 20372 431 or +49 30 84185 210 |
| FAX: +49 30 20372 439 or +49 30 84185 269 |
+-----+
| personal URL: http://www.zib.de/groetschel |
+-----+
```

Term of CEIC membership

Peter Olver 01.07.2008 - 31.12.2014, yes MG mail 6.1. 14:19

James Davenport 01.07.2008 - 31.12.2012 yes, 6.1.11

Carol Hutchins, 01.07.2008 - 31.12.2012, yes 5.1.11

Olga Caprotti, 01.07.2008 - 31.12.2012, yes 5.1.11

Laszlo Lovasz 01.01.2011 - 31.12.2014 ECmeeting Bangalore

T. Bouche 01.01.2011 - 31.12.2014 ECmeeting Bangalore

R. Vakil 01.01.2011 - 31.12.2014 ECmeeting Bangalore

COMMITTEE ON ELECTRONIC INFORMATION AND COMMUNICATION (CEIC)

Terms of reference

(As approved by the IMU Executive Committee, Bangalore, 2010
and announced at the IMU General Assembly, Bangalore, on August 16, 2010.)

The CEIC is a standing committee of the Executive Committee (EC) of the International Mathematical Union, reviewed every four years by the EC at its meeting preceding that of the IMU General Assembly. Members are appointed in even-numbered years for staggered four year terms, normally commencing on January 1 of the following year, using criteria similar to those for IMU Commissions.

The mandate of the CEIC is to advise the EC on matters concerning information and communication.

The CEIC's duties include:

- (a) Reporting regularly to the EC, advising it on aspects of IMU operations related to information and communication, including financial implications, and keeping it informed of new developments.
- (b) Reviewing the development of electronic information, communication, publication, and archiving so as to keep the EC abreast of current and emerging issues. Publicising relevant developments to the wider community via IMU on the Web and other methods.
- (c) Advising the EC about potential opportunities to endorse standards ('best practice recommendations') on issues related to publication and communication, including such matters as the use of software and data repositories.
- (d) Advising the EC about potential opportunities to foster the growth of electronic infrastructure, and selectively creating tools for this purpose.

Von: IMU Secretary [mailto:secretary@mathunion.org]
Gesendet: Mittwoch, 16. Februar 2011 16:57
An: Bill Barton (barton@math.auckland.ac.nz); president@mathunion.org
Betreff: WG: ICMI Nominating Committee

Dear Bill and Ingrid,

My suggestion on this matter would be to wait for Cheryl's report about the ICMI EC meeting in Beijing at the IMU EC meeting in Perth and discuss the issue under the agenda topic ICMI. We will be discussing lots and lots of people, and this brainstorming may bring to the fore persons that do not automatically come to mind.

I have no objection against Bernard at all, but Bernard has influenced ICMI for a long period of time and it is not bad to give other people a chance to bring in new ideas.

Best regards, Martin

Von: Bill Barton [mailto:b.barton@auckland.ac.nz]
Gesendet: Mittwoch, 16. Februar 2011 09:49
An: Martin Groetschel
Betreff: Fwd: ICMI Nominating Committee

Dear Martin,
I sent this to Ingrid a few days ago and forgot to send it to you for your information.
I remedy my mistake.
Regards
Bill

Begin forwarded message:

From: Bill Barton <b.barton@auckland.ac.nz>
Date: 13 February 2011 10:03:19 PM
To: ingrid@math.princeton.edu
Subject: ICMI Nominating Committee

Dear Ingrid,
I knew there was something more I had to talk to you about--the details of the ICMI elections. I need to start the process now, even though the General Assembly is not until 2012 in Korea.

We need to establish a Nominating Committee. This Committee prepares the "slate" which is then voted on at the GA--like IMU.

The process of establishing the Nominating Committee is twofold. The first phase is to appoint three "Core Members". This must be done by 25th March. Then four more members need to be appointed in a process that involves the "Core Members". This is to be completed by April 15th.

I seek your help for Phase 1. The three "Core Members" are:

Chair of the Nominating Committee

The Chair of the ICMI Nominating Committee shall be chosen by the President of the ICMI in consultation with the President of the IMU and must not be a current member of the IMU EC or the ICMI EC, or be working in the country of either president.

President of ICMI, or his/her nominee

The current President of the ICMI, or a nominee of the President, in the year that the ICMI

Nominating Committee is formed, shall be a member of the ICMI Nominating Committee.

President of IMU, or his/her nominee

The current President of the IMU, or a nominee of the President, in the year that the ICMI

Nominating Committee is formed, shall be a member of the ICMI Nominating Committee.

I intend that I shall myself be a core member. I confess that I shall probably closely consult with

Michèle Artigue, the immediate Past President--indeed we have already had some discussions.

Do you intend to take your place, or will you appoint a nominee?

The last Chair was Mogens Niss from Denmark. My first thoughts for the new Chair include:

Bernard Hodgson, Canada, (as immediate past Secretary-General he knows what is involved, is extremely fair-minded, and will be efficient).

Jill Adler, South Africa, (also on the last Executive and extremely responsible with a very broad view of the organisation).

I'm sure I could find another couple from the Mathematics Education world, particularly Europe, which, if you and I are on it would be ok as far as representation goes. You might like to suggest some IMU names who have a knowledge of the mathematics education scene? I'm sure Cheryl will have some views on it.

Let us discuss it for a little while--we have some time.

Best Regards

Bill

IMU activities in ICSU 2011

This brief report includes most of the activities of IMU in relation with ICSU.

The most relevant event of ICSU in 2011 is its **30th ICSU General Assembly**. IMU should nominate the members of its delegation.

Place and dates: Rome (Italy), 26-30 September 2011

Online registration will open on the General Assembly website on 1 March and will close on 16 September 2011

1) IMU should decide about **potential nominations for the EC of ICSU**:

- Nominations for Officers.
 - o Deadline 6 March.
 - o Nominating Committee's slate of Officers, sent to all Members of ICSU, with reminder regarding resubmissions. Deadline 26 May
 - o Final date for receipt of resubmissions of names of candidates for Officers or additional nominations for Officers. Deadline 26 July
- Nominations for Ordinary Members of the Executive Board
 - Deadline 26 July
- In case to present a nomination for Ordinary Members, IMU:
 - o should contact the unions of its cluster in order to pass the first round. Remember that the cluster of Mathematics, Physics and Chemistry is formed by the following unions: (IMU, IUCR, IUMRS, IUTAM, IUPAP, IUPAC).
 - o should contact with some countries for the second round (votations in the GA).

2) **Items for the ICSU GA**

IMU could propose items for the ICSU GA.

- Items proposed for inclusion in the GA Agenda to be received by the Secretary General should be sent before 26 May
- So, IMU should identify those items to propose to ICSU for discussion (EC February meeting in Perth?).
- Suggestions:
 - o Mathematical Education? IMU-ICMI has sent an elaborated document for the ICSU Science education review, and there are complains about the role that mathematical education should play.
 - o Mathematics of Planet Earth 2013.

3) **IMU Poster**

- IMU should update the poster and the booklet (copies of the booklet could be distributed to all the participants in the GA).
- These are the ICSU recommendations about posters: "All National Scientific Members, Interdisciplinary Bodies and Scientific Associates are strongly encouraged to display a poster at the General Assembly. It is a unique opportunity to communicate with the ICSU community and our Italian hosts. The posters should provide general information about your organization and its scientific activities. Posters reporting on activities funded by an ICSU grant are also welcome."

4) **Collaboration with other unions**

International Union of Crystallography (IUCr)

- **International Year of Crystallography in 2013.**
 - With respect to the Mathematic of Planet Earth (MPE 2013), the IUCr commission on Mathematical and Theoretical Crystallography cover the scientific activities in mathematical aspects of crystallography and we shall ask the chair of this commission Professor Massimo Nespolo to contact Professor Christiane Rosseau.
 - Manuel de León has contacts with the Spanish organizers of the **XXII Congress and General Assembly of the International Union of Crystallography (IUCr)** that will be held in Madrid,

Spain, in August 2011; next summer, Professor Sine Larsen (President of the IUCr) will meet Manuel de León in Madrid.

5) Nominations for ICSU committees

IMU has nominated two persons for Steering Committee for Earth System Research for Sustainable Development

- Jörn Behrens from Hamburg, Germany
- Pedro Silva Dias from Petropolis, Brazil.

Chistiane Rousseau has coordinated this issue.

6) Other matters

- CFRS Review of Statute 5: the rewording of ICSU Statute 5 'Principle of the Universality of Science' proposed by the Committee on Freedom and Responsibility in the conduct of Science. **IMU sent a report by January 2011.**
- **Science education review:** the draft report, including the recommendations on a future role for ICSU in science education. IMU and ICMI have prepared a profound report asking for a special treatment of mathematics in this issue.
 - o Bill Barton and ICMI
- **Foresight Analysis** (Dec-Feb): the draft report, including the four proposed scenarios for the development of international science over the next 20 years, in coincidence with centenary of ICSU in 2031.
 - o Manuel de León will take care of this issue
- Elaboration of the 2nd ICSU Strategic Plan, 2012-2017 (Jan-Feb): the draft plan.

This is brief information about the initiative. Christiane Rousseau has all the details.

- The North American Mathematical Sciences Institutes will organize a special year of emphasis on the Mathematics of Planet Earth in 2013. **Chair: Christiane Rousseau**
- The members of the North American mathematical community are invited to submit proposals for activities related to the theme.
- Expressions of interest for individual workshops or other activities should be directed directly to one of the institutes (AIM, AARMS, BIRS, CRM, DIMACS, Fields, IMA, IPAM, MBI, MITACS, MSRI, NIMBioS, PIMS, SAMSI).
- The joint North American scientific committee will consider the proposals of joint thematic activities.

TYPE OF ACTIVITIES TO TAKE PLACE AT MATHEMATICS OF PLANET EARTH

- Thematic Programs
- Workshops
- Collaborative Research Groups
- Summer Schools
- Activities for the Public and the Media
- Activities in K-12 Education
- Special Issues of Scientific Journal

VENUE

Activities will take place throughout North America, focused at different institutes across the US and Canada. Several activities will be organized jointly by more than one institute.



Background and draft Terms of Reference for an ICSU Planning Group on Health and Wellbeing in the Changing Urban Environment

Brief background

Human Health is an identified priority in the ICSU Strategic Plan 2006-2011 with the overall goal (p32-33):

to ensure that health considerations are duly taken into account in the planning and execution of future activities by building on the relevant strengths of Scientific Unions and Interdisciplinary Bodies.

And the following specific actions:

- *ICSU will establish an ad hoc Scoping Group to more clearly define how it might contribute to science for human health taking into account the ongoing development of two new research initiatives:*
 - *Science for Health and Wellbeing (SHWB) is an ambitious initiative, bringing together the perspectives of many ICSU Unions in an integrated approach to human health;*
 - *Global environmental change and Human Health is a new project that is being planned as part of the Earth Systems Science Partnership; and*
- *New Partnerships will be developed as necessary..... to ensure that any ICSU initiatives are needs-based and policy-relevant.*

The prescribed *ad hoc* Scoping Group was established by the Committee on Scientific Planning and Review (CSPR) in 2006 and liaised with the aforementioned ICSU initiatives to produce its report “Towards a Systems Analysis Approach to Health and Wellbeing in the changing Urban Environment”. This report was sent out to Members and Interdisciplinary Bodies (IBs) for consideration and presented at meetings of the Scientific Unions and ICSU Executive Board in April 2007. It was positively received and the decision of the Board was:

To request CSPR to establish a Planning Group in consultation with the InterUnion initiative and ICSU membership, to take forward the recommendations of the ad hoc Scoping Group.

In making this decision, the Board emphasised that the aim should be to develop a single integrated interdisciplinary ICSU programme in this area and that the planning process should be designed so as to ensure ongoing consultation with the membership and with the Unions in particular. In the light of the Scoping Group report, the Unions participating in the SHWB initiative had already begun to plan for a workshop at the end of 2007/early 2008 on Urban Health. This will be co-organised with CSPR/ICSU and thus incorporated into the planning process for the new programme. To this end, a member of CSPR has been appointed as co-chair of the workshop organising committee.

Planning Group Draft Terms of Reference

Taking into account the report of the CSPR *ad hoc* Scoping Group on Human Health – Towards a Systems Analysis Approach to Health and Wellbeing in the changing Urban Environment; and

the planned workshop of the International Scientific Unions (likely to occur Dec 07-Jan 08) on this topic that will assist and inform the Planning Group on the elements identified in 1, 2, 3, 4, and 5 below;

The Planning Group will:

1. develop an inventory of existing (sub-system or sectoral) data applicable to health and wellbeing in the urban environment, and related models, where such exist;
2. consult with relevant stakeholders (WHO; city, regional, and national policy-makers; business; and, NGOs) and define the key health policy questions to be addressed in relation to the changing urban environment;
3. define the short, medium and long-term goals and deliverables for a new interdisciplinary programme in this area;
4. develop an overall systems analysis framework that incorporates 1, 2, and 3 and also takes into account the interactions between key external drivers and sectoral factors (see report of the *ad hoc* Scoping Group);
5. define the data and information sources necessary to carry out an informative systems analysis using this framework;
6. identify a small number of cities in which this model could be tested and refined;
7. define the structures and identify possible funding sources that would be necessary to ensure the initial implementation of the programme in the identified cities;
8. develop a mechanism that, during both the planning itself and subsequent programme implementation, ensures the full involvement of all interested ICSU constituents (Unions, National Members, IBs and Regional Offices);
9. provide an interim progress report to the ICSU General Assembly in October 2008

Planning Group composition/profile

All ICSU Members and IBs should be consulted for nominations for the Planning Group, which should be made up of scientific experts. Areas of relevant expertise include:

- Systems analysis/modelling
- Specific urban sectoral areas, including:
 - water,
 - food,

- sanitation,
- health systems,
- energy,
- transport
- Public health, including:
 - Epidemiology/health monitoring
 - Health care delivery
 - Medical sociology
 - Health policy/policy studies
 - Statistics/indicators
- Social sciences, including:
 - Political science
 - Social innovation, vulnerability and change
- Behavioural Science
- Human geography, including demography
- Urban planning
- Environmental change
- Economics

For reasons of cost and efficiency, the maximum size of the Group should be ~15 members and so members who have cross-disciplinary expertise would be particularly valuable. It will also be important to ensure that different regional perspectives, including developing and developed countries, are included. There should also be some continuity with the Scoping Group, SHWB and GEC-Health initiatives.

Timetable

July 2007	Consultation with members and nominations for Planning Group
July-Oct. 07	SHWB coordinating committee proceeds with plans for workshop
September 07	CSPR agrees final ToR, establishes programme Planning Group and approves plans for workshop co-organised with the Scientific Unions
Dec 07/Jan 08	2-day Workshop followed immediately by 1 st Planning Group meeting
Jun/July 08	2 nd Planning Group meeting (and possible ‘open consultative forum’)
Oct 08	Interim report to the ICSU General Assembly
2009-2010	Publish programme plan and launch programme

Resources

€35k has been set aside from ICSU resources for 2007 and a similar amount is provisionally planned for 2008. This will cover the costs of the proposed Planning Group meetings. The costs of the Dec 07-Jan 08 workshop will be largely covered by the SHWB grant that was awarded to the Unions in 2006.



Draft for consultation

ICSU Strategic Plan II, 2012-2017

(Including a summary of progress made in implementing the Strategic Plan I, 2006-2011)

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Executive Summary

Max 2 pages highlighting transition from strategic plan 1 to strategic plan 2 and major achievements, challenges, new directions and programmes.

To be written when the rest of the document is completed.

Summary of proposed strategic activities, 2012-2017

The activity headings in the table below are taken from Strategic Plan I, 2006 -2011. Although the overall themes are largely conserved for 2011-2017, there are very significant changes in direction and/or new actions proposed in the majority of these areas. For more details on progress between 2006 and 2011 see [annex 1](#).

Planning and coordinating research

Activity	Status, July, 2011	Actions, 2012 - 2017
Sustainability research and Global Environmental Change	Visioning exercise complete	Implement new strategic framework for sustainability research and re-structure as necessary Launch new initiative
Global Earth Observation Systems	GEOSS process well advanced with ICSU as partner	Establish WDS role in relation to GEOSS. Review role of ICSU in earth observation systems
International Polar Year, 2007-2008	Programme completed	Monitor legacy aspects, eg data and information Review future coordination of polar research and ICSU's role (including IASC, SCAR, Union activities etc)
Natural and human-induced hazards	New programme launched in 2009 (IPO established in 2010)	Implement IRDR programme and link with regional initiatives
Millennium Assessment follow-up	PECS programme launched in 2009 (IPO in 2011)	Implement PECS programme and link with regional initiatives
Energy	ISPRES shut down in 2009	Implement and ensure coordination of regional science plans
Human Health	Science programme plan presented to GA	Implement new programme (<i>if GA approves</i>)
New scientific horizons and future directions	Foresight scenarios to be presented to GA	Incorporate foresight outcomes into implementation of strategic plan. Establish working group on emerging issues

Science for policy activities

Activity	Status July 2011	Actions, 2012-2017
Sustainable Development	RIO+20 planned for 20102	Represent science in Rio+20.
Commission on Sustainable Development (CSD)	ICSU has formal role in providing input to CSD	Continue to provide scientific input on specific topics
UNEP and IPBES	IPBES likely to be established	Provide scientific input to IPBES Develop stronger links with UNEP in other areas
Regional and national policy fora	Some regional links established	Identify and target key regional fora Organise workshop on "climate change: science and national policies"

Strengthening the Universality of Science

Activity	Status July 2011	Actions, 2012-17
Universality Principle	Revised statute 5 presented to GA in 2011	CFRS to continue to defend freedoms and promote responsibilities of science
Data and Information	WDS being established; SCCID interim report to GA	Consolidate and expand WDS Review CODATA Implement SCCID recommendations
Science and Society/Science Education	Science education review completed in 2011	Implement recommendations from Sci Ed review CFRS to organise workshops on science-society issues
Regional Offices	3 Offices reviewed 2009-2010	establish Office for the Arab region. Integrate regional and global plans and activities
CIS countries	Several meetings of Academies convened	Target various activities to the region, where appropriate
Capacity Building	Priority area assessment completed in 2005	Integrate into new initiatives and build up Regional Office-Union/Interdisciplinary Body links, using the grants programme

Other major activities

Activity	Status July 2011	Actions, 2012-2017
Grants programme	Reviewed in 2007	Continue with focus on regional

		activities
Unions meetings	Meet at General Assembly in 2011	Further meetings in 2013, 2015(G.A.) and 2017
National Members	Members meet together at General Assemblies and in regional groupings	Strengthen Nat. and Union Member involvement in new initiatives such as Rio+20 and Global Sustainability
Membership	A membership review completed in 2005 and report on social sciences to GA in 2008	Strengthen representation of social engineering and medical science sciences within ICSU; Review the role of Associates
Interdisciplinary Bodies	5 IBs disbanded and 4 new ones established since 2006	Implement new single-host model for new IBs; Review all IBs periodically Strengthen IB-Regional Office links
Communication and outreach	Communication officer appointed in 2008 New website launched in 2011	Increase ICSU visibility and media presence Develop interactive aspects of new website
Partners	Well-established relations with several key partners	Strengthen strategic partnerships and develop new partnerships on a 'case by case' basis
Funding	Dues review completed in 2008 IGFA restructured in 2009	Implement new dues structure. Work with IGFA and Belmont forum as strategic partners. Diversify funding sources, including the private sector.
Evaluation	Previous external assessment of ICSU in 1996. First strategy in 2006	Conduct new independent assessment in 2013

1. ICSU in a changing world

1.1 *ICSU: past and present, form and function*

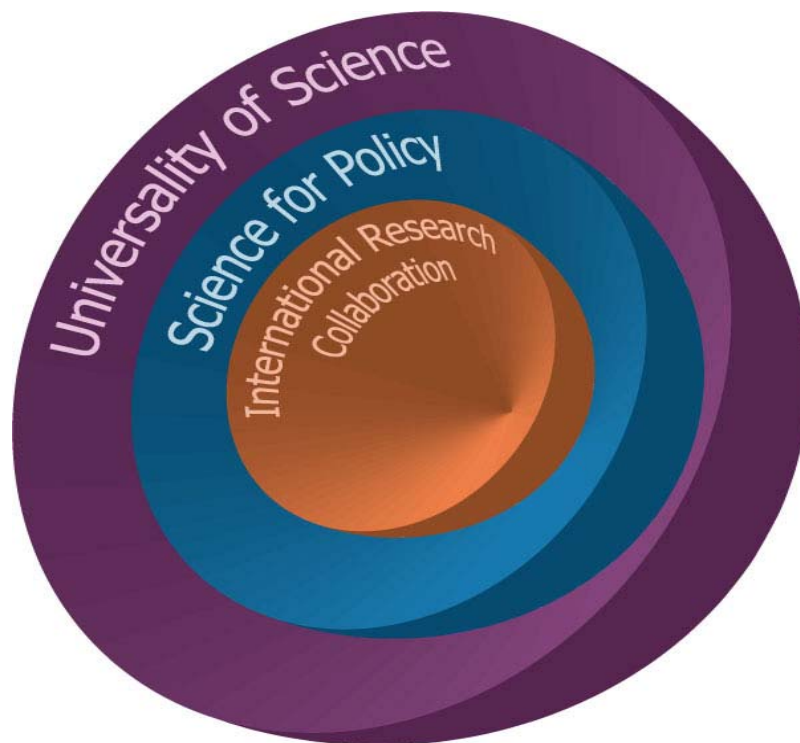
ICSU - the International Council of Scientific Unions, as it was then called was created in 1931, although its roots can be traced back to 1899. Its establishment was recognition, even in those early days, that science was both international and interdisciplinary and that there was added value in combining these two aspects. This was reflected in the dual membership of international disciplinary unions and national interdisciplinary bodies (mainly academies). In 1998, the name was changed to better reflect its 'mixed' composition and it became the International Council for Science.

Over time, ICSU's role has changed significantly, although its primary focus on international, interdisciplinary science remains the same. Starting with the International Geophysical Year in 1957, ICSU has established itself as the leading non-governmental organization for planning and coordinating global research in the area of the environment. This has led to it being the institution of choice for representing science in many international policy fora, in particular within the United Nations system. And, promoting the freedom – and more recently the associated responsibilities of scientists – is an integral aspect of the Principle of Universality of Science which has underpinned ICSU activities from the very outset. In order to contribute effectively in these three key domains (fig 1) ICSU has, over time, established interdisciplinary bodies, some of which are co-sponsored with other organisations. There are currently 20 of these bodies, which are listed in table 1.

The ICSU vision (see below) and mission – *strengthening international science for the benefit of society* – were first articulated in conjunction with the development of the 1st strategic plan, 2006-2011. Most importantly, they make explicit what had been already been understood for some time, i.e. that ICSU's role was not just to promote excellence in international interdisciplinary science but to link this to societal benefit.

The ICSU Vision

The long-term ICSU vision is for a world where excellence in science is effectively linked to policy making and socio-economic development. In such a world, universal and equitable access to scientific data and information is a reality and all countries have the scientific capacity to use these and to contribute to generating the new knowledge that is necessary to establish their own development pathways in a sustainable manner.

Fig. 1 Key domains of activity**Box 1. ICSU Interdisciplinary Bodies**

The Interdisciplinary Bodies bring together different scientific disciplines to address scientific issues of international relevance that are of interest to ICSU Members. Some of these bodies are co-sponsored with other organisations.

THEMATIC BODIES

Committee on Space Research (COSPAR)

Integrated Research on Disaster Reduction (IRDR, with ISSC and UN ISDR)

Programme on Ecosystem Change and Society (PECS, with UNESCO)

Scientific Committee on Antarctic Research (SCAR)

Scientific Committee on Oceanic Research (SCOR)

Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)

GLOBAL ENVIRONMENTAL CHANGE PROGRAMMES

DIVERSITAS: an International Programme of Biodiversity Science (with UNESCO, IUBS, IUMS, and SCOPE)

International Geosphere-Biosphere Programme (IGBP)

International Human Dimensions Programme on Global Environmental Change (IHDP, with ISSC)

World Climate Research Programme (WCRP, with IOC of UNESCO and WMO)

MONITORING/OBSERVATION BODIES

Global Climate Observing System (GCOS, with WMO, IOC, FAO, and UNEP)

Global Ocean Observing System (GOOS, with WMO, UNEP and IOC)
 Global Terrestrial Observing System (GTOS, with FAO, UNEP, UNESCO and WMO)

DATA AND INFORMATION BODIES

Committee on Data for Science and Technology (CODATA)
 International Network for the Availability of Scientific Publications (INASP)
 Scientific Committee on Frequency Allocations for Radio Astronomy and Space
 Science (IUCAF)
 World Data System (WDC)

Within the framework of its mission and vision, ICSU has 3 three overarching goals

1. *Research coordination and planning* – to enable excellent international interdisciplinary research in selected priority areas of importance to society
2. *Science and policy* - to ensure that science is integrated into policy development at the international and national level and that relevant policies take into account both scientific knowledge and the needs of science.
3. *Universality of science* – to promote the freedom and responsibilities of scientists and access to data and information as a critical contribution to strengthening the global science community.

ICSU is committed to working with its Members, associates and strategic partners in order to deliver these goals. To this end, the criteria for selection of specific ICSU activities are shown in Box 2.

Box 2 Criteria for selection of ICSU Activities

ICSU activities are proposed by the Committee on Scientific Planning and Review and/or Executive Board in consultation with Members. The 6yr strategic plan and any major new initiatives are subject to formal approval by the General Assembly. The general selection criteria for all activities are as follows:

1. Does the activity fit with ICSU's mission – *to strengthen international science for the benefit of society* – and longer term vision?
2. Does it build on the strengths of ICSU Membership, i.e. is it interdisciplinary and international?
3. Is there a unique niche that ICSU can fulfill, distinct from that of other international organizations and potential partners?
4. Does ICSU have a track-record in the area or obvious potential to contribute?
5. Is the activity of interest to a significant proportion of the ICSU Membership?

1.2 *The evolving context for science*

Text to be developed drawing on initial outcomes of the Foresight scenarios exercise

1.3 *Recent progress and lessons for the future*

Progress in implementing the specific actions that were included in the first ICSU strategic plan, 2006-2011, is summarized in the relevant chapters of the current document and at annex 1. The majority of the agreed actions have been successfully carried out and in some cases, such as the implementation of the International Polar Year, the impact has unquestionably been significant. In other areas, such as sustainable energies or exploring new horizons, progress has been less consistent. It is important that ICSU learns both from its successes and relative failures in planning its future activities. These lessons need to be considered along-side the rapidly evolving context for science in deciding on future priorities for ICSU and on the most appropriate mechanisms to address these priorities.

Three major cross-cutting challenges have emerged or become more evident since 2006 and during the implementation of the first ICSU Strategic Plan.

- **Integrating regional and global activities:** since, 2005 ICSU has established three regional offices for Africa, Asia and the Pacific, and Latin America and the Caribbean. Their role is to reach out to the lesser developed countries in these regions. These Offices have developed their own science plans, building on expertise in the regions, and are at the early implementation stage of these plans. In most, but not all, cases, they are complementary to ICSU's global initiatives but the challenges in ensuring their synergy, eg in relation to funding, should not be underestimated.
- **Integrating disciplinary perspectives** (including the Unions) into interdisciplinary initiatives: ICSU concentrates its activities on the interface between scientific disciplines, leaving the main responsibility for organizing and promoting the disciplines themselves to its Union Members. The Unions and ICSU have different and complementary roles and the mechanisms for more fully exploiting the disciplinary expertise of the Unions in ICSU activities need to be improved.

A relatively new, but increasingly important, challenge for ICSU is incorporating disciplinary perspectives that are not represented by the current Union membership into its activities. Extensive efforts have been made to include social sciences in the new ICSU initiatives that have been developed over the past 6 years and this needs to continue and be expanded to incorporate the medical and engineering sciences

- **Structure-Function issues:** in several areas, there is some discordance between ICSU's mission and goals and the structures that are expected to deliver these. At one level this relates to the composition and roles of ICSU Members and

Associates. It also relates to the models for implementing ICSU initiatives and the links with funding agencies and policy-makers. (see section 5)

2. International Research Collaboration

Goals

¹**Science for Global Sustainability* - to promote a more fully integrated approach to Earth systems research that involves the full range of sciences and humanities and addresses key aspects of sustainable development.

Human Health – to ensure that health considerations are duly taken into account in the planning and execution of future activities by building on the relevant strengths of Scientific Unions and Interdisciplinary Bodies.

New Scientific Horizons – to monitor emerging international research issues of importance to science and society and to develop mechanisms to ensure that these can be addressed in a timely manner by the relevant members of the ICSU family

Progress and achievements, 2006-2011

Beginning with the International Geophysical Year in 1957-1958, ICSU has a long tradition in planning and coordinating international research endeavors, particularly in the area of the environmental research. In order to understand the complexities of the earth system, these initiatives have become progressively more interdisciplinary and in the Strategic Plan 2006-2011 this trend was continued with commitments to review existing structures and develop and launch several new programmes and assessments. Progress in meeting these commitments is summarized in annex 2 and more details on specific areas are given in section 2.1 However, looking to the future, it is useful here to illustrate the scale and potential impact of ICSU's research activities with just a few key highlights from the past 6 years:

- A series of expert reviews of the ICSU-sponsored, Global Environmental change programmes highlighted the essential role that these have played in providing the science that underlies the assessment of the Intergovernmental Panel on Climate Change (IPCC) ;

¹All strategic goals highlighted with an asterisk are new for 2012-2017. Those that are not highlighted are continuing goals that were originally identified for the 2006-2011 strategic plan.

- The International Polar Year, 2007-2008, which was planned and co-sponsored by ICSU, mobilised thousands of scientists and educators from over 60 countries to study and highlight urgent issues in the polar regions;
- Two major international programmes on Disaster Reduction (IRDR) and Ecosystem Change (PECS) were launched in 2008 and programme offices have been established with substantial support from host countries.
- A world-wide consultation was launched in 2009 to identify the key research questions for earth system research in relation to sustainable development over the next decade. The identified Grand Challenges provide an integrated strategic framework that has been rapidly adopted by a number of major national and international science funding agencies.

Challenges over the next decade

There are a number of challenges that ICSU is faced with over the coming years with regards to its changing portfolio of research programmes and initiatives.

An appropriate balance needs to be struck between nurturing new programmes and initiatives and terminating matured activities. There needs to be a division of efforts between reviewing and, where necessary, re-aligning existing activities and developing new initiatives.

Balancing disciplinary and interdisciplinary perspectives, is an ongoing challenge. As the emphasis within ICSU's programmes is increasingly on meeting societal needs, then inevitably the need to include perspectives from social sciences is heightened. Likewise stronger links with engineering and health sciences need to be fostered.

Attracting young researchers into ICSU's programmes is critical for ensuring their future viability and influence. There are many obstacles for younger researchers wanting to get involved in international, interdisciplinary research programmes and ICSU's own membership networks do not necessarily reach out to those that are interested. At the same time, programmes such as IPY can provide a focus for the development of dynamic new interdisciplinary networks.

Financial support for both existing and new global research coordination activities is severely limited. There is an urgent need to develop more efficient and effective mechanisms for working with traditional research funding agencies and with development agencies and other funders.

2.1 Earth system science for global sustainability

Following reviews of the Global Environmental change programmes (see ahead 2.1.1.), a visioning exercise was launched in 2009 identify the key scientific questions

for earth system research over the next decade. The resultant document, *Earth Systems Science for Global Sustainability: the Grand Challenges* (ICSU-ISSC, 2010) represents a very significant milestone in the development of ICSU's research portfolio. It provides a Framework for the evolution of global environmental change research and the necessary integration of natural and social sciences. It is notable that this has been developed in partnership with the International Social Sciences Council (ISSC) and this partnership is likely to be increasingly important over the next decade.

The five Grand Challenges, which are laid out in the ICSU-ISSC document and have been identified after extensive worldwide consultation with the scientific community, are:

1. Forecasting: Improve the usefulness of forecasts of future environmental conditions and their consequences for people.
2. Observing: Develop, enhance and integrate the observation systems needed to manage global and regional environmental change.
3. Confining: Determine how to anticipate, recognize, avoid and adapt to abrupt global environmental change.
4. Responding: Determine what institutional, economic and behavioural changes can enable effective steps towards global sustainability.
5. Innovating: Encourage innovation (coupled with sound mechanisms for evaluation) in developing technological, policy and social responses to achieve global sustainability

These Grand Challenges have been broadly accepted as priorities by research funding agencies and discussions are ongoing with representatives from the existing Global Environmental Change (GEC) programmes and their co-sponsors to look at what contribution they can make to this ambitious agenda. New ICSU initiatives on hazard risk (IRDR) and ecosystem change (PECS) have an important part to play as do the co-sponsored Global Observing Systems. Polar research and regional activities on sustainable energy can also be taken forward within the framework of the Grand Challenges framework. Details of how these various activities will be further developed are given in the following sections 2.1.1 – 2.1.6 followed by a summary of specific actions.

2.1.1 Global environmental change programmes

ICSU is a co-sponsor of four GEC programmes (see table 1 for full titles, acronyms and co-sponsors) that are focused on climate, geosphere-biosphere, biodiversity and human dimensions. For the past 2-3 decades, these four programmes have served global science (and society) by developing strategies and promoting and coordinating research in their respective areas of interest. They have also increasingly been involved in communicating the outcomes of this research. As mentioned above, they have made a major contribution to the assessment work of the Intergovernmental Panel on Climate Change (IPCC). In 2001, the four programmes joined together to

form the Earth Systems Science Partnership (ESSP), which has been responsible for cross-cutting projects in areas such as carbon, water, food systems and health.

Reviews of the majority of programmes and the Partnership between 2005 and 2008 (DIVERSITAS was not reviewed) raised issues about prioritisation, integration, coordination and overlap. It was recognised that ESSP was not currently equipped to adequately respond to these concerns and the possibility of restructuring was raised. The need for an over-arching strategic framework and for all GEC activities was strongly emphasized. It was as a direct result of these reviews that the an earth system science visioning process was launched, resulting in the Grand Challenges document.

Several meetings have been organized in 2009-2011 with lead-scientists, sponsors and funders of the GEC programmes to discuss the Grand Challenges and the implications for existing and new institutional structures. It is recognized that some of the existing interests and activities of the programmes will need to continue into the future but these will need to be supplemented by a new focus on integrated science.

Key Partners: International Social Sciences Council; intergovernmental sponsors of the GEC programmes (WMO, UNESCO, IOC, UNEP, UNU); Funding agencies – Belmont Group and International Group of Funding Agencies (IGFA); individual national funders and development agencies; Private Foundations and donors.

2.1.2 Global Earth Observations

ICSU is a co-sponsor, together with various UN agencies, of the three main Global Observing systems, which cover the oceans, the climate and terrestrial aspects of the earth system as a whole. In 2003, an inter-governmental Group on Earth Observations (GEO) came together and agreed to develop Global Earth Observation System of Systems (GEOSS). The intention was to build and expand on the existing structures to implement a more comprehensive and integrated global network.

ICSU has been a partner in GEO from the outset and is variously represented on several of its key committees², including a period as co-chair of the S&T committee. The ICSU- World Data System (see ahead section 4.2) has a potentially key role to play in long-term stewardship of GEOSS data and it is actively involved in the data architecture committee of GEO.

² Over the past 6 years, several Interdisciplinary Bodies have played critical roles in taking forward the various GEO work packages: the ICSU Committee on Data for Science and Technology (CODATA) has taken the lead in developing the GEOSS data access policy; DIVERSITAS has taken the lead in developing the framework for a biodiversity and ecosystems services observation network (GEO-bon); the ICSU Committee on Space Research (COSPAR) has taken over ICSU's role as co-chair of the GEOSS S&T committee.

The eventual success of GEOSS depends on continued governmental commitment and close interaction between the operational and research aspects of earth observations. One of the five grand challenges for global sustainability research is to develop, enhance and integrate socio-environmental observation systems. ICSU has a continuing role to play over the next 6 years, in advancing this agenda and representing the interests of the global science community, in GEOSS.

At the same time, it is timely to re-assess the ongoing sponsorship role of ICSU in relation to the three existing global observing systems. A strategic assessment of ICSU's environment programmes (ICSU, 2003) suggested that the links between these programmes and the observing systems were relatively weak. The various UN co-sponsors of the systems have also variously questioned how these links might be strengthened. Given the importance of observations for responding to the Grand challenges and the potential for GEOSS to bring the existing observation systems (climate, ocean and terrestrial) more closely together, a strategic review of ICSU's future role in relation to observation systems is proposed.

Key Partners: GEO, WMO, IOC, FAO

2.1.3 Polar research

The poles provide unique historical insights, serve as barometer of the current state of the planet and can act as an indicator of future. Hence, polar science is critical aspect of global sustainability research.

The International Polar Year, 2007-2008 was planned by ICSU and co-sponsored with the World Meteorological Organisation. It brought together tens of thousands of scientists and educators from more than 60 countries in a two-year internationally coordinated campaign of multidisciplinary research and outreach. It culminated in the largest ever polar science meeting, convened in Oslo in June 2009. Many of the studies initiated during IPY are still ongoing and much of the collected observations and data have yet to be fully analysed. Another major conference, is being planned for Montreal in 2012, when the policy implications of IPY science will be considered.

IPY revealed the strengths and weaknesses of the long-standing mechanisms for coordinating polar research. There is now renewed enthusiasm and a pressing need to address the legacy issues arising from IPY: to strengthen long-term polar observation systems; to ensure easy access to quality controlled data; to continue public education and outreach. Building on the solidarity between scientists from different nations that characterized IPY requires continuous and active global leadership. ICSU has a critical role to play as many of the structures involved in global coordination are either interdisciplinary bodies or associates of ICSU itself and/or affiliated with ICSU Unions.

It is proposed that a strategic review of polar research needs and structures be carried out within the framework of the Grand Challenges for sustainability research.

This would include consideration of the roles of: the Scientific Committee for Antarctic Research, the International Arctic Science Council, the International Permafrost Association, the IUGG Cryosphere Commission and the links between these and the GEC programmes

Key partners: WMO

2.1.4 Disaster Risk

A new 10 year initiative on Integrated Research on Disaster Risk (IRDR) was approved at the ICSU General Assembly in 2008 and an International Programme Office (IPO) was established in Beijing in 2009. This is a 10 year initiative that integrates research across hazards, disciplines and geographical regions. Acute disasters are a major obstacle to sustainable development and the IRDR initiative has a potentially important role to play in addressing various aspects of the five Grand Challenges.

Natural Hazards is also a priority for all three ICSU Regional Offices, which have developed their own scientific plans that focus on specific hazards that are predominant in the regions. This additional regional focus should help to promote the involvement of scientists from lesser developed countries that are often most vulnerable to natural hazards. Ensuring the smooth integration of the regional and global strategies and plans will require considerable efforts in terms of communication and exchange.

Key partners: ISSC, ISDR and potentially UNESCO

2.1.5 Ecosystem change

The Programme on Ecosystem Change and Society is a 10 year initiative that was approved at the General Assembly in 2008. An International Programme Office that is jointly hosted in Stockholm and Penang was established in 2011. This new initiative originated out of the follow-up to the Millenium Ecosystem Assessment and focuses on the relationship between governance, ecosystem services and human wellbeing, at global and local scales. The integration of social and natural sciences is at the core of this work.

This initiative cuts across the longer-established GEC programmes and directly addresses several aspects of the grand challenges in an integrated way. Biodiversity and Ecosystem Services is a priority for the Regional Offices in Latin America and the Caribbean and for Asia and the Pacific. The former has developed its own science plan and the latter is working with the global scientific committee to define how it can best promote and implement the initiative at the regional level.

Key partners: UNESCO

2.1.6 Sustainable energy

Addressing sustainable energy needs is a crucial aspect of any agenda for global sustainability research. The International Science Panel on Renewable Energies (ISPRES) was created in 2007 as a joint initiative between ICSU, the International Council of Academies of Engineering and Technological Sciences (CAETS) and the Renewable Energy Network for the 21st century (REN21). The Panel produced 2 reports, assessing the current global status and future priorities for research in the areas of biomass, and photovoltaic and wind energy (ICSU, 2009a,b). However, the international policy landscape for renewable energy has evolved rapidly over the past 5 years, most notably with the establishment of the new International Renewable Energy Agency. In addition the outcomes of a major Global Energy Assessment, in which ICSU is participating, will be available in 2011. In the light of these developments, it was decided to disband ISPRES in 2008 and to reassess ICSU's potential contribution to this area.

At the regional level, sustainable energy is a priority for all the three Regional Offices, each of which has developed its own science plan. These have different foci, specific to the regions, e.g. biomass in Latin America versus models and energy scenarios in Africa, and also common elements. The main priority for Asia, which is shared by the other regions, is identification of existing research capacity and future needs. There is considerable, and currently unexploited, potential for combining expertise across institutes, countries and regions to address specific priority topics. ICSU can play a leading role in facilitating the development of the necessary interdisciplinary networks and projects at various scales.

In addition to the regional plans, there are a number of energy related interdisciplinary projects being conducted under the aegis of the existing global environmental change programmes and several of the unions are also interested from their particular disciplinary perspectives. The implementation of the Global Challenges framework and associated structural changes provides an opportunity to build on these various activities and potentially develop a more integrated global initiative on renewable energy.

Key partners: IIASA; CAETS; REN21

Overall strategy

To work with existing structures, their co-sponsors and other potential partners, whilst reaching out to the scientific community more broadly, to promote the integrated research that is required to address the five Grand Challenges in Earth System Science for Global Sustainability.

Specific actions

Area/activity	Actions, 2012 - 2017
Global sustainability research	1. Implement new strategic framework for

	<p>global sustainability research, based on the Grand challenges document.</p> <p>2. Co-design and launch a major new 10 year initiative</p> <p>3. Strengthen links with public funding agencies and foundations</p>
Global Environmental Change (GEC) programmes and partnership (ESSP)	<p>4. Merge ESSP into a new structure to implement the new initiative</p> <p>5. Integrate programme activities, as necessary, to respond to the Grand Challenges initiative</p>
Global Earth Observation Systems	<p>6. Work with GEOSS in relation to Grand Challenge 2 - Observing</p> <p>7. Establish World data System role in relation to GEOSS (see ahead section 4.2).</p> <p>8. Review role of ICSU in earth observation systems</p>
Polar research	<p>9. Integrate polar science into global grand challenges framework</p> <p>10. Review future coordination of polar research and ICSU's role (including IASC, SCAR, Union activities etc)</p> <p>11. Monitor IPY legacy aspects, eg data and information and sponsor the polar science-policy conference in 2012</p>
Natural and human-induced hazards	12. Implement IRDR programme (a 10 year initiative) and link with regional plans
Ecosystem services	13. Implement PECS programme (10 year initiative) and link with regional plans
Energy	14. Implement and ensure coordination of regional science plans

2.2 Urban Health and Wellbeing

Over half of the world's population lives in urban areas and this proportion is increasing rapidly, generating new challenges for maintaining and improving human health and wellbeing.

A major stimulus for greater attention from ICSU to health research is the potential to build on the many and varied interests of the scientific unions, which started to develop their own loosely coordinated initiative on science for health and wellbeing (SHWB) in 2002. In 2006, a Scoping Exercise was initiated to identify how ICSU might contribute and potentially add value to these union activities. This exercise eventually identified "a systems analysis approach to health and wellbeing in the changing urban environment" as an area where ICSU was perhaps uniquely qualified

to make a significant contribution. An interdisciplinary planning group was established in 2008 to take this idea forward and develop a science plan for a new ICSU initiative.

The science plan –*Health and wellbeing in the changing urban environment: a systems analysis approach* (ICSU, 2011) lays out a new conceptual framework for considering the multi-factorial nature of both the determinants and manifestations of health and wellbeing in urban populations. A 10 year initiative is proposed to promote trans-disciplinary projects that adopt this framework and aim to generate understanding and products that are useful to policy-makers. The International Institute for Applied Systems Analysis (IIASA, Austria) has been an important partner in the development of this plan and will continue to play a key role in its implementation.

The Regional Offices for Asia and for Africa have also selected human health and wellbeing as one of their initial priority areas. In Africa, this has led to a very broad scoping exercise that describes the health research needs and priorities for the continent – urban health is one of the highlighted areas. In Asia and Pacific, a different approach has been taken, with a regional science planning group being established in 2010 to consider how the global plan for urban health can be implemented in the region. The Offices have a key role to play in ensuring that scientists (and policy makers) from the lesser developed countries, where the challenges of urbanization are often most pressing, are included in the new ICSU initiative.

Key partners: IIASA; WHO (tba)

Overall Strategy and specific actions {subject to final consideration of the science plan}

- To work with the ICSU Unions and key partners to implement a new 10 year initiative on Urban health
- To work via the Regional Offices to facilitate the involvement of lesser developed countries in the implementation of the Urban Health plan

2.3 Exploring New Horizons and future directions

In line with its overall mission ICSU, has an important role in exploring future directions for international science and identifying challenges and potential responses. Building on the expertise of its members, ICSU is also well positioned to contribute to international awareness and collaboration in frontier research at the interface between disciplines (re. selection criteria in Box 2).

In preparation for the 1st ICSU Strategic Plan, 2006-2011, a foresight exercise was carried out to identify priority areas for international interdisciplinary research. This reinforced the continued importance of ICSU's historical areas of interest, mainly focused around the environment, and helped in identifying new programme topics, such as disaster risk and urban health. It also highlighted a number of areas, such as cognitive neuroscience or nanoscience, in which the role of ICSU was less obvious but where ICSU members, and in particular the unions, could make a significant contribution. In order to take some of these 'frontier' topics forward two specific mechanisms were proposed – the ICSU grants programme and joint workshops with the European Science Foundation.

The effectiveness of the former mechanism was severely limited because of cuts in the funding for the grants programme (which was then re-focused on the Regional Offices). Two workshops were jointly held with ESF on molecular medicine and infections (2009) and on social-ecosystem change (2010). These had a particular focus on building links between researchers in Africa and Europe.

In parallel with the development of this strategic plan, ICSU is conducting a second Foresight exercise. This is very different from the earlier exercise in that it uses a scenarios approach to consider potential pathways for international science over the next 2 decades and beyond. It is hoped that this exercise will be useful not only in helping ICSU, but also its members, in assessing longer term choices and options.

However, the question remains as to what ICSU's role might be in identifying and responding to major new scientific developments over a shorter-term time scale. Possible mechanisms include workshops or conferences in frontier science – working with partners such as ESF – or establishing more focused inter-union working groups.

In the first instance, it is proposed that a working group be established, with representation from the Unions and National Members, to define what the needs and mechanisms might be for ICSU to identify and respond to major scientific developments at the intersection between disciplines.

Key Partners: ESF; UNESCO; ??

Overall strategy and specific actions

- To engage the ICSU membership, in analyzing the future of international science via the foresight scenarios exercise. [If successful it is envisaged that this exercise will be up-dated, and the changing international landscape assessed, at 6 year intervals.]
- To consider the implications of the foresight exercise for ICSU's long-term future and, after consultation with the Membership, make adaptations to the organisation's focus and structure as necessary

- With regards to shorter-term responses to key emerging issues, to establish a working group to explore potential needs and mechanisms

3. Science for Policy

Goal

Science and policy - to ensure that science is integrated into policy development at the international and national level and that relevant policies take into account both scientific knowledge and the needs of science.

Progress and achievements, 2006-2011

The World Summit for Sustainable Development in Johannesburg in 2002, and to a lesser extent the World Summit on the Information Society in 2003 and 2005, provided the global policy context in which the first ICSU Strategic Plan was developed. ICSU played a lead role in ensuring input from the global scientific community to these Summits. For WSSD in particular, science featured strongly in the formal political documents and multi-stakeholder commitments that came out of the summit. The Commission on Sustainable Development (CSD) was strengthened as a result of the Johannesburg Summit and has become an important venue for integrating science into policy-thinking at the global level. ICSU had continued to lead the input from the global science community to CSD over the past 6 years and has been invited by the UN to maintain this science leadership role for the UN Conference on Sustainable Development (Rio+20) in 2012.

Another policy area in which ICSU has had a major impact has been the development of an Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES). This is expected to have a similar impact to IPCC in terms of ensuring that the outcomes of rigorous scientific assessments are communicated to, and discussed with, policy makers (see ahead 3.1.3).

Challenges over the next decade

ICSU has traditionally focused its science for policy activities on interaction at the global level with the UN system. In this regard, ICSU has had a privileged status and been recognized by the UN system as the legitimate representative of the global scientific community. However, international governance and policy-making mechanisms are evolving rapidly. At the intergovernmental level a plethora of new regional and multi-lateral fora have developed as important venues for policy debate. And new multi-stakeholder networks are also having an effect on policy making in certain areas. Moreover, ICSU itself is no longer the only body that can

justifiably claim to represent the global science community. There are a number of important challenges for ICSU as it positions itself in the science for policy arena over the next decade

As a global organization with very limited resources, ICSU has tended to focus on global policy fora. However, much of policy development and most of its implementation is actually at the regional, national and local scales. There is potential for the Regional Offices, which have a remit that includes making links with policy, to extend ICSU's reach and better mechanisms could be envisaged for supporting National Members in their policy work (and vice versa). Moves towards a trans-disciplinary research approach, eg in earth system research or urban health, should strengthen the science-policy interface at the local level.

Governments remain the critical decision-makers in most policy areas but they are strongly influenced by the business sector and civil society more broadly. Multi-stakeholder alliances are often the most effective mechanism for influencing both policies and their implementation. ICSU has some experience of working with such alliances at the global level, eg within the Major Groups of CSD and UNEP, but they require considerable resources, can be complicated to manage and difficult to evaluate in term of input versus output. Identifying efficient and effective ways to interact with multiple stakeholders is not straightforward.

ICSU is only one of several bodies that represent global science. Other formal bodies include the Inter-Academy Panel (IAP) and Inter-Academy Council (IAC) both of which have links with the UN system. The Academy of Sciences for the Developing World (TWAS) also has strong links with the UN and intergovernmental systems. And more informal groupings, such as the G8 Group of Academies, are also acting as the 'voice of science' in specific fora. Whilst there are similarities with ICSU, each of these organizations or networks has its own specificities. (ICSU is unique in being able to link the scientific knowledge from its own global programmes to policy). The challenge is to overcome institutional rivalries and develop effective strategic partnerships with these various organizations.

3.1 Inter-governmental science for policy mechanisms

As described above, there are many intergovernmental structures and networks involved in policy making, which would potentially benefit from better scientific input. In the longer-term, ICSU will need to consider whether and how it might usefully interact with some of these. However, choices have to be made now on the basis of limited resources and likely impact and these dictate that for the next 6 years ICSU should continue to have its main focus on key UN fora, where it has a clearly recognised role.

3.1.1 Commission on Sustainable Development

The UN Commission on Sustainable Development was established by the UN after the 'Earth Summit' in Rio de Janeiro in 1992. It was given renewed impetus by the World Summit on Sustainable Development in 2002 and is now an important venue for environment ministers to interact with other key stakeholders. Civil society is organized under nine major CSD groups, one of which is Science and Technology. This group is led by ICSU, in partnership with the World Federation of Engineering Organisations (WFEO).

Topics discussed at CSD over the past 6 years include: energy, air pollution, climate change and industrial development (2006-2007); agriculture, rural development, land, drought, desertification and Africa (2008-2009); and transport, waste management, chemicals and mining (2010-2011). ICSU and WFEO prepare and submit discussion papers for these meetings and organize delegations of scientists to participate in the official ministerial meetings and various side events. There are opportunities for ICSU Members to contribute to these activities, e.g. IUPAC inputted to the debate on chemicals in 2010.

CSD provides a unique multi-stakeholder setting in which to introduce scientific perspectives on sustainable development. It is not a policy-making body *per se* but it provides an opportunity to inform and influence policy makers. It is also closely linked to the preparatory committee for the Rio+20 Conference and is likely to play a key role in ensuring the follow-up to that Conference. It is an important forum in which ICSU can communicate with multiple stakeholders regarding the research on Global Sustainability initiative (section 2.1)

Key Partners: UN; WFEO and CAETS; ISSC; IIASA

3.1.2 UN Summit on Sustainable Development (Rio+20)

In preparation for the UN Conference on Environment and Development in 1992, ICSU organized its own international meeting to develop an "Agenda for Science and Development into the 21st Century". As a result of this, ICSU was invited by the UN to participate in the follow-up, via CSD (see above). And subsequently, when the World Summit on Sustainable Development (WSSD) was organized in Johannesburg in 2002, ICSU was again invited to represent the scientific community. Whilst the direct impacts of these conferences is difficult to assess (despite the production of several lengthy UN evaluation reports) they have certainly contributed to raised general awareness of the state of the planet and the challenges for sustainable development. They have been both a strategic driver and a policy target for many of ICSU's Interdisciplinary Bodies.

In December 2009 the UN General Assembly decided to organize a further UN Conference on Sustainable Development in Rio de Janeiro in 2012 (Rio+20). The focus of this conference, which aims to bring together Heads of State, will include: green economy, poverty eradication, and the institutional framework for sustainable development. These are broad topics that will be further defined in the conference

preparatory process. However, they can clearly be aligned with the 5 Grand Challenges that have arisen out of the ICSU visioning process and the Conference represents a unique opportunity to get broad buy-in and support for the global sustainability research agenda.

For the WSSD in 2002, ICSU was actively involved in the preparatory committee and organized a science forum in Johannesburg. In addition, considerable effort was devoted to producing a 'rainbow series' of reports on specific topics related to science for sustainable development. The science forum was organized at the invitation of the UN and was widely acclaimed and the aim for 2012 is to organize a similar event in Rio. As part of the preparatory process for Rio+20 there will be a series of regional consultations and this regional emphasis is likely to be more significant than for previous summits. It is important that the voice of science is heard strongly at this level and ICSU will work via its Regional Offices to achieve this.

Key Partners: WFEO and CAETS; ISSC; UNESCO

3.1.3 Biodiversity and Ecosystem Services: IPBES

ICSU was an institutional partner in the Millennium Ecosystem Assessment (MA) that was completed in 2005. Under the leadership of the United Nations Environment Programme, ICSU and other organizations have continued to promote the MA findings and explore mechanisms to ensure its follow-up. The new Programme on Ecosystem Change and Society (see section 2.1.5) is one product of this follow-up process. Another important development has been the agreement to establish a new Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES).

ICSU and its global biodiversity programme (DIVERSITAS) and Human Dimensions Programme (IHDP) have played a lead role in the multi-stakeholder discussions that led to the decision of the UN General Assembly in 2010 to establish IPBES. In particular, ICSU has advocated for a strong and independent mechanism for scientific input to IPBES. Whilst the exact role(s) and structure of the Platform have yet be finalised, it is analogous to the Intergovernmental Panel on Climate Change (IPCC) and can be expected to be similarly influential in focusing society's attention on biodiversity and ecosystems. It will provide a focus for science-policy interactions and feed into several already existing international conventions in this domain. As with IPCC, it is likely have a significant influence on future research strategies, structures and support.

Both DIVERSITAS and the new PECS initiative are promoting research that is directly relevant to IPBES. Socio-ecological research is also highlighted under the Grand Challenges and will be incorporated in the proposed new initiative on research for global sustainability (see, 2.1.3). IPBES will provide a critical forum for considering the scientific knowledge generated by these activities and its implications for policy.

ICSU and its programmes clearly have a very important role to play in ensuring the effectiveness of IPBES and vice-versa.

Key partners: UNEP; UNESCO; IUCN

Overall Strategy

- To focus on UN fora, where ICSU has a clearly defined role and real potential to influence policy, whilst at the same time being receptive to new opportunities.
- Work with partners (governmental and non-governmental) whose goals can be aligned with those of ICSU and who can make a substantive contribution to achieving these goals.

Specific Actions

Area/Activity	Actions, 2012-2017
Commission on Sustainable Development (CSD)	1. Continue to provide scientific input on specific topics, working with relevant ICSU Members and bodies and the other UN Major Groups.
UN Conference on Sustainable Development (Rio +20)	2. Represent science in Rio+20. 3. Organise regional science events prior to the Conference and a science forum in Rio.
UNEP and IPBES	4. Provide scientific input to IPBES 5. (Develop stronger links with UNEP in other areas)
Other international policy fora	6. Depending on resources and likely impact, participate on a 'case by case basis' in other key science-policy fora that fit with ICSU's overall goals

3.2 Regional and national policy mechanisms

At the Regional level, there is a clear role for the ICSU Regional Offices to establish links with relevant inter-governmental policy mechanisms. The recent Office reviews identified this as an area in which some progress had been made – notably in Africa and Latin America – and a greater impact could be made in the future. In order to achieve this the visibility of the Offices has to be raised and their reputation established in the policy arena. The planned regional science events and preparatory meetings for Rio+20 provide a good opportunity to achieve this.

At the national level, a number of ICSU's Members are active at the science -policy interface. Political structures and mechanisms for decision-making vary considerably from one country to another but in many countries there is either a defined role or clear opportunities for Academies or other national ICSU Members to promote evidence-based policy. ICSU can assist its National Members by providing information and materials from relevant international policy processes that are also being pursued nationally. Likewise National Members may be able to promote their science for policy agendas internationally by working more closely with ICSU. A good example of these types of mutually enforcing national and international policy activities is Rio+20, where ICSU will be preparing documents to input to the regional and global processes that may also be useful nationally.

Science for policy is an area where ICSU can also act a convenor, bringing together its interested Members and other organizations to compare best practices in specific areas of policy making. For example a number of ICSU's National Members are active in presenting scientific knowledge related to climate change to policymakers; ICSU itself has a significant interest in this topic at the global level. Preliminary discussions indicate that there would be considerable support for a meeting on 'climate change and national policies' that focused on exchange of experiences and practices.

Key partners: UNESCO; UNEP; TWAS

Overall Strategy and specific actions

- To work via the regional offices to strengthen links with Regional policy networks, such as the African Union or the Organisation of American States.
- To work with National Members, on science for policy activities that relate to ICSU's priority themes, eg sustainability research in the context of Rio+20 .
- To ensure that national members are aware of relevant policy issues that are being considered at the global and/or regional level.
- To, work with interested National Members to organize a workshop on 'climate change and policy-making'

4. The universality of science

Goals

**Universality Principle* - to raise awareness and promote responsibility for the principle of Universality of Science – both freedoms and responsibilities- within and beyond the ICSU family.

Data and Information – to facilitate a coordinated global approach to scientific data and information that ensures equitable access to quality data and information for research, education and informed decision-making.

Reaching out to all countries - to ensure the full participation of scientists from developing and transition countries in international science, including both the planning and implementation of the ICSU strategy and activities of the ICSU family.

On Scientific Capacity – to ensure that capacity building, which is integral to all aspects of ICSU's mission, is given the necessary attention in all the activities of the ICSU family and in relevant policy fora.

Science and society - to improve mutual understanding between science and other sectors of society, with a particular focus on ICSU's scientific priorities; to promote trust in science.

Progress and achievements, 2006-2011

A number of changes in direction and new activities were proposed in the first Strategic Plan in order to promote the universality of science and progress in implementing these proposals is detailed in annex 1.

Significant advances have been made in three main areas, which are highlighted here (see ahead 4.1- 4.5 for fuller details):

- Scientific freedom and responsibility – the new ICSU committee in this area has initiated an ambitious work-plan that addresses key aspects of global scientific responsibilities
- Regional Offices – three Regional Offices completed their first five years of work and were favorably reviewed by international expert panels in 2009-2010.
- The development of a new ICSU World Data System that can serve the interdisciplinary research needs of the future has been boosted with the identification of a dedicated and well-resourced International Programme Office.

Challenges over the next decade

The Universality of science – furthering the development of a truly global scientific community on the basis of equity and non-discrimination – is a founding principle for

ICSU. Whilst the traditional obstacles to the Universality of science – ranging from visa policies and religious fundamentalism to neglect of investment in science - continue to exist, the rapid development of information and communication technologies (ICTs) presents new opportunities and risks. ICTs can help to promote the healthy democratisation of science and at the same time they provide a global platform for opposition to science. Establishing and maintaining trust in science, between scientists, policy makers and the public at large, is an increasingly important challenge. In this overall global context there are three areas of particular importance and relevance to ICSU.

Responsibility and research integrity: over the past six years a number of high profile cases of scientific misconduct have served to highlight the importance of integrity in science. The internal pressures and public profile of science are such that ensuring good research practice and an honest and self-critical scientific endeavour requires proactive engagement from scientists and scientific institutions (including ICSU).

Data and information access: science is increasingly dependent on access to and integration of large data-sets from multiple sources. Both the access to and the interoperability of, these data set present major challenges. Maintaining and expanding a quality assured science commons is a multi-faceted challenge that must be addressed if we are to make scientific progress in areas such as sustainability science. This will require global leadership, commitment and resources.

The lesser developed countries continue to present a major challenge in terms of *enhancing scientific capacity and integration* into global research activities. At the same time these are the countries where the generation and use of scientific knowledge could have greatest socio-economic benefits. Fully integrating the perspectives and needs of lesser developed countries into ICSU's agenda is an ongoing challenge

4.1 Principle of Universality

ICSU Statute 5 (revised wording submitted to 30 GA for approval, Sept 2011):

The free and responsible practice of science is fundamental to scientific advancement and societal well-being. Such practice requires freedom of movement, association, expression and communication for scientists, as well as equitable access to data, information and research materials. Just as important, it requires responsibility at all levels to practice and communicate scientific work with integrity, respect, fairness, trustworthiness, and transparency; and to maximize the benefit and minimize the misuse of science for present and future generations.

In advocating the free and responsible practice of science, ICSU promotes equitable access to science and its benefits, and opposes discrimination based on such factors as ethnic origin, religion, citizenship, language, political opinion, gender, sex or age, and statements or actions that prevent the universal application of this principle.

Since the early days, ICSU has had a series of related policy committees charged with defending the freedom of scientists. However, the creation in 2006 of a new Committee on Freedom and Responsibility in the conduct of Science (CFRS) has shifted the focus of ICSU's work in this area from an exclusive preoccupation with defending freedoms to a more balanced approach that incorporates responsibilities. This led to the publication in 2008 of a new handbook – Freedom, Responsibility and Universality of Science and a proposed revision to the wording of statute 5. The committee has also launched a series of workshops focusing on key topics at the interface between science and society, where the rights and responsibilities of science are often unclear. This includes topics such as global health, science communication, access to data, science and war, science and the private sector and science and policymaking.

In 2010 the support to CFRS was strengthened with the provision of dedicated secretariat support from the Swiss Academy of Sciences. This support will enable the committee to continue to implement its ambitious work-plan over the next six years:

- to work with Members and other organisations to promote and defend scientific freedoms in specific cases;
- to consult and advise the Executive Board and Members on issues relating to the Universality of Science, with emphasis on both scientific freedoms and responsibilities, and to promote dialogue and shared understanding on these issues;
- to raise awareness of and promote the Principle of Universality within the global scientific community and with policy makers and the broader public;

Recent CFRS meetings have included representation from the ICSU Regional Offices and committees and this relationship will be strengthened further.

Key partners: International Human Rights Network of Academies and Scholarly Societies; ESF and ORI, re. research integrity

Overall strategy and specific actions

- to support the Committee on Freedom and Responsibility in the conduct of Science in its work with ICSU members and other partners to defend the freedoms of scientists and to promote the responsibilities of science.
- In this context to update and implement the CFRS work-plan, and :
 - co-sponsor the 3rd World Conference on Research Integrity in 2013;
 - expand the series of workshops on rights and responsibilities issues;
 - to develop an interactive web forum for rights and responsibilities issues

4.2 Data and information

The generation of scientific data and information is increasing at a logarithmic rate and it is estimated that by 2020 they will have exceeded by more than two-fold the current global data storage capacity. Much of these data are produced and/or used by ICSU sponsored programmes and/or observing systems and ICSU has a commitment to ensuring the long-term stewardship, quality, availability and usefulness of scientific data and information. A number of interdisciplinary bodies and committees have evolved over time to enable ICSU to ensure this commitment.

Following a series of strategic assessments and reviews, the decision was taken in 2008 to establish a new World Data System (WDS). At the same time an *ad hoc* Strategic Coordinating Committee for Information and Data (SCCID) was established for an initial 3 year period (with the possibility of renewal until 2014). This committee was charged with providing leadership in the field of global data and information for science and linking the various ICSU data policy and management activities (see table 1) with the needs of interdisciplinary programmes, such as the International Polar Year. The committee includes representation from various ICSU Interdisciplinary Bodies and partners involved in this area. Key amongst these is the Committee on Data for Science and Technology (CODATA) and the International Network for the Availability of Scientific Publications (INASP).

There has been steady progress in establishing a World Data System. This incorporates the remnants of two previous ICSU networks – the World Data Centres (WDC) and Federation of Astronomical and Geophysical data analysis Services (FAGS) and expands these to include new state of the art institutions. Strengthened impetus has been given to this development with the establishment of a dedicated International Programme Office in Japan in 2011. One important initial focus for the WDS has been ensuring the data legacy of the International Polar Year and the aim is that the large majority of IPY data will eventually be transitioned into the WDS. Looking to the future, the new ICSU programmes and initiative on research for Global Sustainability will present new challenges in terms of data needs and provision. One measure of success will be how the WDS evolves to meet these needs.

Since, 2008, the new *ad hoc* SCCID has played a role in improving the communication and coordination between the various ICSU structures dedicated to data and information and other key partners. In addition to this important brokering role, it is charged with producing an interim report in 2011 and a final report in 2014 on future strategic directions for ICSU. This will include recommendations on the role of existing structures and will need to be considered by the ICSU membership accordingly.

CODATA was established in 1966 to focus on interdisciplinary data needs, particularly at the data management and policy level. In line with the recommendations from various strategic reviews, CODATA has been actively engaged over the past six years in addressing issues of high priority to ICSU. These

include the development of well-received data access guidelines for the Global Earth Observation System of Systems (GEOSS) and a Polar Information Commons initiative. However, the creation of SCCID – albeit on an *ad hoc* basis – has raised questions about the longer-term role of CODATA, including links with the new World Data System. A dedicated review of CODATA is planned to clarify these issues.

INASP was established in 1992 with a goal to ensure world-wide access to scientific information. Initially, this meant ensuring the provision of scientific journals at affordable prices to institutions in lesser developed countries. This continues to be a priority. However, with the rapid evolution of information and communication technologies, the roles and structures of academic libraries have undergone rapid transition. The remit of INASP has expanded accordingly to incorporate various capacity building and training activities for librarians and scholars. And more recently still, the programme has initiated activities to bridge science-policy interface in lesser developed countries. The ICSU regional Offices also have a major interest in these areas of activity and there is considerable potential for INASP and similar programmes to work with the Offices to extend their activities.

Overall strategy and specific actions

- Building on ICSU's established activities, to play a leadership role in ensuring the long term stewardship and availability of good quality data and information for science:
 - to consolidate and expand the ICSU World Data System;
 - to consult with Members and take forward relevant recommendations from the *ad hoc* Strategic Coordinating Committee on Information and Data;
 - to review the performance of the ICSU Committee on Data and for Science and Technology (CODATA) in 2012-2013;
 - working via INASP and the Regional Offices to expand access to, and use of, scientific information in lesser developed countries.

4.3 Reaching out to all countries

The most significant change in the operations of ICSU over the past 6 years has been the establishment of Regional Offices in Africa, Asia and the Pacific and Latin America and the Caribbean. These Offices are specifically charged with promoting ICSU's global activities in lesser developed countries and incorporating the scientific perspectives and needs of these countries into ICSU's agenda.

The 3 regional offices were each subjected to an external expert review of their performance and future plans during 2009-2010. These reviews were very positive overall but also identified a number of weaknesses. Areas to be addressed include:

- clarification of the remit and realistic expectations from the Offices
- Definition of the processes for implementing regional science plans and integrating them with global activities
- Establishment of databases of regional expertise
- How to more fully engage the Unions?
- Governance (e.g. composition and role(s) of the Regional Committees)
- Communication with ICSU-Paris and between Regional Offices
- Clarification of responsibilities and rules and revision of MoUs

Initial actions have been taken on all of these issues but they will need to be monitored and further actions and/or corrections made as necessary over the next six years. Building on these experiences, a fourth Regional Office in the Arab Region will be established as originally proposed in 2006.

Limited progress has been made over the past six years in promoting the greater involvement of the former 'Eastern Block', including the Commonwealth of Independent States and West Balkan countries. A joint ICSU-UNESCO meetings of Academies from these territories was held in Moldova (2007) and several related meetings have taken place in Montenegro. The latter included a meeting of all ICSU European Members (2009). As a result of these meetings, four new ICSU National Members have been recruited. In addition to these academy activities, various ICSU interdisciplinary bodies and initiatives also have links with the scientific communities in these countries and there is scope for these to be strengthened and expanded over the next six years. This can work at a number of levels, including selection of Scientific Committee members and hosting of workshops.

Key partners: UNESCO Regional Offices; TWAS

Overall strategy and specific actions

- To maintain and strengthen ICSU's presence and activities in those countries where it has historically been strong, eg in North America and Europe, whilst building closer relationship with the lesser developed countries, via ICSU Regional Offices.
- To work with the host organizations to strengthen the activities of the Regional Offices.
- To use the grants programme to strengthen links between the Unions and ICSU Regional Offices
- To consult with members in the Arab region and secure support for the establishment of a fourth ICSU Regional Office to serve this region;
- To strengthen interactions with the CIS and West Balkan countries, via the network of European Members and specific actions and activities of interdisciplinary bodies and initiatives.

4.4 Science education

Science education is an area of great interest to almost all ICSU Members and an area in which ICSU itself has historically been involved. However, it is also an area in which there are many stakeholders and in which most decisions and action are taken at a local level. In 2009 a review was launched to consider ICSU's potential future contribution to this area and, in particular, to assess how any global ICSU activities might add value to what its network of Members and Interdisciplinary Bodies are doing.

The review (ICSU, 2011) concluded that there is a potentially important role for ICSU to play in promoting exchange between active scientists and educators. Over the past 6 years, international science years, such as the Polar Year or the Year of Astronomy, provide good examples of how this can be effectively achieved and of how global initiatives can be translated into local action at the level of schools or Universities. Many ICSU National Members have linked to these global activities and integrated them into their own initiatives, amplifying their benefits.

Several ICSU Unions are active in the specific area of Mathematics education and this is also an area that was selected by the Regional Office for Latin America and the Caribbean as a priority in 2007. The Office has prepared a detailed analysis of education challenges in the region, which can inform the activities of the various ICSU Members and other regional stakeholders in mathematics education.

Overall strategy and specific actions {subject to finalization of the Edcn review}

- To work with the ICSU Membership to facilitate the interaction (exchange of knowledge and materials) between scientists and educators. The Regional offices can play an important facilitatory role for the least developed countries
- To promote science education activities within the context of existing and new interdisciplinary initiatives
- Establish an ICSU working group or committee on science education, whose charge will include organizing conferences to bring together scientists, educators and leaders in science education.

4.5 Science and society

The interface between science and society has a major influence in shaping the world in which we live. Science education and literacy are an important aspect of societal trust in science, without which science cannot thrive. At the same time, research in many areas and in particular where it addresses complex societal challenges, requires the active involvement of citizens.

Over the past 6 years public outreach has been a high priority across several ICSU initiatives, most notably IPY which had a major media impact in many countries. The Commission on Sustainable Development (section 3.1.1) has provided a forum for multi-stakeholder discussion of key scientific issues relating to sustainable development. And the CFRS has initiated a series of workshops addressing key issues of concern at the science-society interface including science communication (section 4.1). All of the more recent ICSU research initiatives are explicitly designed to be trans-disciplinary, involving relevant societal stakeholders in their design and implementation.

Overall strategy and specific actions

- To promote interaction and debate between scientists and other members of society across the breadth of ICSU's activities, including Rio+20.
- To develop new trans-disciplinary initiatives, e.g. on global sustainability and urban health, that actively involve non-scientific stakeholders.
- Under the aegis of the Committee on Freedom and Responsibility in Science, to organize workshops and provide advice to Members on important issues at the science-society interface.

5. Structure-function issues

Goals

To ensure adequate long-term funding to support the planning, coordination and support functions of ICSU and the additional funding necessary to fully implement the new initiatives described in this strategic plan.

**Form and function-* to ensure that ICSU has the necessary Membership, partners, structures and resources to deliver its mission efficiently and effectively.

**Integrating global and regional-* to ensure that ICSU's global and regional structures and activities are synergistic, efficient and effective in fulfilling ICSU's overall mission.

**Visibility and recognition -* to ensure that the contribution of ICSU to global science for society is fully recognized and valued.

5.1 ICSU and its Membership

ICSU is a Membership organization and the support, ownership and involvement of its Members is important for any ICSU initiative. The global environmental change programmes and, more recently, IPY provide good examples of what can be achieved when the network of ICSU Members is active towards a common goal.

National Members are critical in providing links to national science communities. They also, to a variable extent, can help to provide access to policy-makers and science funding at the national level. Connecting global and national policies, and ensuring that these are science based, is an ongoing challenge for ICSU (see section 3.2) as is the link with funders (see ahead 5.6.2)). Rio +20 (section 3.1.2) and the new Global Sustainability initiative (section 2.1)) provide test-beds for ICSU to work with its National Members to strengthen these links over the next six years.

As mentioned at the outset of this document, one of the 3 cross-cutting challenges for ICSU over the next decade is to establish a stronger relationship with its existing disciplinary unions, whilst developing new activities that require a broader range of disciplinary involvement. Meetings every 18 months between the Unions, ICSU Executive Board and Secretariat play an important role in promoting exchange of information and providing a platform for discussion. The grants programme has been modified to promote Union involvement with the Regional Offices. However, the desire of many Unions to be more directly involved in ICSU activities presents a challenge, when the majority of individual scientists involved with ICSU's interdisciplinary initiatives currently have little Union affiliation. Over the next decade, this challenge needs to be taken up within the context of specific initiatives, including Rio+20, Global Sustainability and Urban health. At a higher level, the structure and role of the Unions should also be considered as part of proposed independent review of ICSU (see ahead, section 5.6.3).

Overall strategy and specific actions

- To work with Members (National Members and Unions) to ensure their full involvement in the implementation of the activities laid out in this strategic plan.
- With the assistance of the Regional Offices, to expand National membership and improve the engagement of Least Developed countries in ICSU activities.
- To use the grants programme to catalyse closer interactions between the Unions and Interdisciplinary Bodies and the ICSU Regional Offices.
- To consider the overall scope and role of ICSU's Union Membership as part of the proposed External Review of ICSU (ahead, section 5.6.3)

5.2 *Interdisciplinary Bodies*

Most of ICSU's interdisciplinary bodies are long-established and their structure and constitutions are modeled on ICSU itself. Whilst it has the advantage of providing long-term institutional stability, this traditional model is not necessarily as dynamic and flexible as is required to meet the current and future needs in certain areas. With this in mind, the more recently established ICSU initiatives (2006 onwards) differ from their predecessors in 2 very significant ways: 1) they are time limited from the outset; 2) they are not dependent on multiple Member subscriptions but are hosted by a single country that pays all the costs for the International Programme Office. This model worked very effectively for the International Polar Year but this was a short-term, 2-year, initiative. The viability and effectiveness of the new model for longer initiatives has yet to be tested. However, it is already clear that effective mechanisms have to be developed for linking new initiatives to a diversity of funding sources – national and international research funding agencies, development agencies and private foundations.

ICSU has a statutory obligation to review its interdisciplinary bodies at regular – normally 5 year – intervals. In preparation for the previous strategic plan a number of meta-reviews were that essentially covered all ICSU activities were conducted. And over the past 6 years a number of more specific and detailed performance reviews have been performed on individual programmes. Two bodies (DIVERSITAS and CODATA) have already been identified as a priority for similar reviews during 2012-2014 and a rolling programme of reviews needs to be instigated for other activities.

The links between ICSU's global initiatives and regional activities also need to be developed. This has already begun in areas such as disaster risk, ecosystem change and urban health and needs to be strengthened and expanded. The Global Sustainability initiative, with its emphasis on regional and local scales is important in this regard.

Overall strategy and specific actions

- To closely monitor the new structural model for supporting new initiatives to ensure that they maintain their global remit and focus; to conduct external reviews of each initiative after five years.
- To conduct in depth strategic reviews of CODATA and DIVERSITAS
- To review those interdisciplinary bodies have not been individually reviewed for several years and ensure that they are aligned with ICSU's overall strategy and the interests of the ICSU Members.

- To strengthen the strategic and operational links between Interdisciplinary bodies and Regional Office activities

5.3 Associates

ICSU has over twenty associate Members, who pay a small annual subscription but do not have voting rights. This is a very diverse grouping of international professional societies and Institutions. Some of these are important strategic partners, others have much weaker links with ICSU activities. Yet others have their roots in Union Commissions or associations and may eventually apply to be recognized as full Union Members.

The role of Associates was not considered in the development and implementation of the first ICSU strategic plan. However, as discussed elsewhere in this document, ICSU's current National and Union Membership is deficient in several respects, including disciplinary coverage and links with funders. The associate status offers an opportunity to address these deficits and building stronger institutional partnerships with organizations that do not fit into the traditional membership categories. There are a number of international interdisciplinary science networks and institutions with whom a stronger association would enhance various ICSU activities at both the global and regional levels.

Overall strategy and specific actions

- To conduct a review of the role of associates in ICSU, with a view to strengthening and potentially diversifying the ICSU membership
- To strengthen regional outreach and impact by encouraging important regional partners to become ICSU associates

5.4 Governance and the Secretariat

5.4.1 The Secretariat, Executive Board and Regional Committees

Over the past 6 years, the Secretariat has almost doubled in size with the addition of 2 new core staff in Paris and ~11 new staff in the three Regional Offices. In addition there has been some turnover due to retirements and career progression, which has enabled the introduction of more new faces and ideas into the Secretariat. Most importantly there have been a number of secondments and internships that have supplemented the core staff and been instrumental in enabling ICSU to implement the first strategic plan.

The Executive Board continues to be the body that sets ICSU's overall directions budgets and work-plans between General Assemblies. It is assisted by the Committee on Scientific Planning review and increasingly by the 3 Regional Scientific Committees. Ensuring effective communication and coordination between these various bodies presents an ongoing challenge. To this end an annual meeting of ICSU Officers and Regional Directors and Chairs has been instigated since 2009. These meetings focus on strategic issues and linking global and regional planning and actions.

5.4.2 Policy, scientific and review committees

ICSU has three policy committees: C SPR and CFRS (see previously, section 4.1) and the Policy Committee for Developing Countries (PCDC). This latter committee was established in 2006 as a result of the review that led to the development of the Regional Offices. However, PCDC never really managed to define its niche relative to the Regional Committees and was put into abeyance in 2009. It is now proposed that this committee be formally disbanded.

With regards to ICSU committees more generally, including various *ad hoc* review and implementation groups, there is an ongoing challenge to identify and select high calibre members who are willing and able to give the required time. Significant effort goes into selecting committees that are balanced in terms of disciplines, regions and gender. And there is a delicate balance to be maintained between transparency and openness versus personal sensibilities and confidentiality. Listings and biographies of all ICSU committee members are made available on the web-site as soon as they have been confirmed. And draft reports from these groups are invariably made available for consultation before they are finalized. Nevertheless, processes, including the communication of decisions, can be further improved.

5.4.3 Communication and outreach

Over the past six years considerable effort has gone into improving ICSU's Communication and outreach, with a full time communication Officer being appointed in the Paris secretariat in 2008 and most recently the launching of a new website that incorporates both global and regional activities. However, for many active scientists ICSU remains invisible. Even widely acclaimed ICSU-led successes, such as IPY, are often not universally identified with ICSU. This partly relates to the way ICSU operates and its role as a convenor and facilitator for scientific initiatives, which are subsequently adopted by other institutions and funders who understandably claim their share of credit. However, in a competitive World it is important that ICSU raises its visibility and is more widely recognized for its contribution to global science. The launching of the new ICSU web site in 2011 was very important in this regard.

Overall strategy and specific actions

- To continue to strengthen the capacity of the Secretariat both in Paris and in the Regional Offices, with a particular focus on secondments from Member organizations and short term exchanges between Offices.
- To strengthen the links and communication between the governance and advisory structures at the regional and global level; to formally replace the Policy Committee on Developing Countries (PCDC) with a new strategic coordination group including the Officers and regional chairpersons and directors.
- To increase ICSU's visibility and outreach, making maximum use of the new interactive website and other social networking tools.

5.5 Strategic Partners

ICSU has a number of strategic partners that have been identified in association with various activities throughout this document. These include both Intergovernmental – mainly United Nations – and non-governmental bodies. Partnerships are often, but not always, consolidated in the form of co-sponsorship of activities. However, during the period of the first strategic plan, it has become clear that there are different varieties of co-sponsorship, on a gradient from passive (in name only) to active (significant intellectual and/or financial contribution). Over the next six years the emphasis will be on developing and strengthening active global and regional partnerships, particularly in the context of new initiatives.

Overall strategy and specific actions

- To identify and work with active contributing partners in developing and implementing new initiatives.

5.6 Resources and value for money

5.6.1 Member dues

Starting in 2007, ICSU carried out a review and iterative consultation with Members, on its dues structure. Up until now, this has been based on voluntary contributions but as of 2012 National Member contributions will be index-linked to GDP and Union contributions will be based on their own annual dues income. This restructuring, will mean that several Members will have to pay significantly more than they have been paying to date and a number of Members will be eligible to pay less (although voluntary contributions are encouraged).

5.6.2 Links with research Funding

In the context of the new initiative on research for Global Sustainability (section 2.1), there has been very positive progress in strengthening the links between ICSU's global research activities and research funding agencies. This initiative is being co-designed with the Belmont Group of funding agencies – a sub-group of the International Group of Funding Agencies (IGFA). ICSU was commissioned by the Belmont Group to produce a report on regional needs for science in relation to sustainable development (ICSU, 2010) and the recommendations from this report have been integrated into the global initiative. Several National funding agencies are already aligning their research funding schemes to fit with the Grand Challenges framework. Whilst this has happened previously, eg for IPY, it has mainly been due to unilateral actions. The co-design/joint commitment approach is both novel and exciting. Taking this a step further, a Foundations Forum to consider the global sustainability challenges is being planned with partners for 2012.

Considerable progress also has been made in attracting funding from a diversity of sources to directly support the work of the ICSU secretariat in developing and implementing several of the initiatives laid out in this plan. This includes substantial donations from a number of private companies for Rio +20 activities and for the development of the research for Global Sustainability initiative. It is the first time that ICSU has secured significant private funding and this is clearly an area with potential for expansion during 2012-2017. In order to avoid potential conflicts of interest and ensure transparency, the policies and processes for soliciting and accepting such funding have begun to be developed and this is an area that will need to be closely monitored.

The Regional Offices have also recently begun to explore how they might diversify their funding sources in order to amplify the generous support that comes from their host organizations. There are opportunities with a number of funding sources, including regional funding agencies, national ICSU Members, the European Commission and development agencies. Thus far, initial approaches to each of these sources have been positive and led to some additional funding. The challenge over the next six years is to build on this and establish alternative funding streams that bring extra resources into the Offices themselves and into the activities that are being promoted by the Offices.

Key Partners: IGFA/Belmont forum; ISSC; UNESCO; private foundations and donors;

5.6.3 Evaluation and value for money

Assessment of the overall performance and value for money of ICSU is an important aspect of the organisation's accountability to its Members and other partners. The various components of ICSU – including its Regional Offices and Interdisciplinary Bodies - are subject to performance reviews every 5-6 years. However, ICSU as a whole has not been subject to independent review since 1996 (ICSU, 1996). At the

time, this review led to very significant changes in ICSU's structure and directions; effectively it was the beginning of the transition towards a strategic, mission-driven organization.

It is now timely for ICSU to be re-evaluated, relative to its mission and strategic aims to assess whether the changes that began in 1996 have resulted in an efficient and effective organization to represent the global science community: what has been the impact of ICSU since, 1996? If ICSU had not existed, would anyone have noticed? And, looking to the future, are ICSU's structure, mechanisms and overall strategic directions optimal?

Overall Strategy and specific actions

- to work with Members to ensure a smooth transition to the new index-linked dues structure as of 2012.
- to work with public research funding agencies, development agencies, private foundations and donors to ensure funding for specific ICSU initiatives at both global and regional levels.
- To commission an independent assessment of ICSU in 2013 to report to the General Assembly in 2014

Annex 1: Summary of response to key actions from Strategic Plan I, 2006-2011

Planning and coordinating research

Activity	Proposed actions, 2006-11	Progress and current status
Global Environmental Change (GEC)	Performance reviews of programmes	Reviewed existing programmes (IHDP, IGBP, WCRP) and ESSP. Completed consultation exercise to identify Grand Challenges. New Global Sustainability initiative planned.
International Polar Year, 2007-2008	Programme implementation	IPY successfully implemented and now addressing legacy issues
Natural and human-induced hazards	Develop potential new programme	New programme (IRDR) launched in 2009 and IPO established in 2010
Millennium Assessment follow-up	Develop new research and methodologies	Scoping carried out and new programme (PECS) launched in 2009 with IPO established in 2011
Energy	Establish an International Science Panel	ISPRES established in 2007 and produced 2 reports. Activity ceased in 2009
Human Health	Develop potential new programme	Scoping carried out and new Urban Health programme plan to be presented to GA in 2011
New scientific horizons	Facilitate joint activities by Members and conduct second Foresight exercise	Grants programme reviewed in 2007 and re-launched in 2008. 2 joint ESF Europe-Africa workshops convened (2008 and 2010). Foresight Scenarios exercise to be presented to GA in 2011

Science for policy activities

Activity	Proposed actions, 2006-11	Progress and current status
Global Earth Observation Systems	Advise on implementation of new Global Earth Observation System of Systems	ICSU and its IBs, particularly COSPAR, CODATA and DIVERSITAS, playing lead role in various GEOSS activities
Sustainable Development	Contribute to selected WSSD follow up policy activities.	WSSD recommendations integrated across new programmes and science for policy activities

Commission on Sustainable Development (CSD)	Develop multi-stakeholder science agenda. Provide scientific input on specific topics...	ICSU, together with WFEO, has led S&T Major Group in contributing to annual CSD sessions and now planning for Rio+20
Millenium Ecosystem Assessment	Facilitate interaction among sub-global assessments	PECS programme developed and ICSU, together with DIVERSITAS has been key player in IPBES discussions

Strengthening the Universality of Science

Activity	Proposed actions, 2006-11	Progress and current status
Universality Principle	Establish new Universality of Science Committee	CFRS established in 2007 and workplan approved at GA in 2008. Dedicated Secretariat in 2010.
Data and Information	Restructure ICSU activities and develop new international Framework	SCID report approved by GA in 2008. New World Data System under development and strategic committee to report to GA in 2011
Intellectual property and copyright	Develop mechanisms for effective interaction with WIPO and WTO	Plan for IPR Observatory developed in 2007 and put 'on hold'
Science and Society	Ensure that all new initiatives consider science and society issues	IPY had major outreach and education campaign. IRDR and PECS specifically designed to address science-society issues. CFRS organising workshops in key science-society areas
Regional Offices	Establish 3 further Offices	3 Offices in Africa, Latin America and Asia fully operational and underwent first review in 2008-09. Plans for Arab Office pending.
CIS countries	Strengthen links to national science communities	Several meetings organised with Academies from the region
Capacity Building	Integrate into new initiatives and build up Regional Office-Union/Interdisciplinary Body links	New programmes (PECS, IRDR, Urban Health) have major interdisciplinary capacity building elements. Grants programme restructured in 2008 to promote Union/IB-Regional Office links

Other major activities

Activity	Proposed actions, 2006-11	Progress and current status
Grants	Seek additional funding	UNESCO funding no longer available

programme		and no other funding secured. More modest programme implemented in 2008
Unions meetings	Further meetings in 2007, 2008(G.A.) and 2010	All meetings held as planned
National Member meetings	Organize periodic regional meetings of National Members	Regional Office consultation meetings organised with National Members. European Members convene annually
Membership	Expand representation and ensure better communication	15 new national Members and 1 Union admitted since 2006
Corporate Communication	Recruit new Communication Officer	Communication Officer in place since 2007
Partners	Strengthen strategic partnerships and develop new partnerships on a 'case by case' basis	Strengthened strategic partnerships, eg with ISSC and UNEP. Several new partnerships developed, eg with CAETS, FMSH.
Funding	Review dues structure and attract additional 'external' funding.	Review of dues structure completed and new structure approved at GA in 2008. €500k p.a. special annual subvention secured from France since 2007. Increased grant funding from NSF. Other activities, eg. Young scientist conference (2007) and 'visioning' (2009-011) attracted foundation funding.



ICSU

International Council for Science

ICSU Foresight Analysis

Working Draft of Report 1

Foresight Task Team

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Working Draft for consultation

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1. INTRODUCTION

Purpose of the ICSU Foresight

The purpose of this exercise is to explore the potential development of international science¹ over the next two decades in a changing economic, social, political, and environmental context. From an institutional perspective, it is designed to test the role and mission of ICSU and guide long-term strategic choices aimed at strengthening international science for the benefit of society. To this end, the conduct of the foresight exercise has been closely synchronized with the development of the ICSU strategic plan 2012-2017 and it is expected to have a significant influence on the implementation of this plan.

At the same time, it is hoped that this exercise will have wide applicability beyond ICSU and, for example, that it will be useful to ICSU Members and partners in developing their own longer-term vision and strategic thinking. The process has been specifically designed to engage many stakeholders and the issues and various scenarios presented in this report are designed to be adapted and updated to suit the needs of multiple users.

Key Questions

In its simplest form, this exercise focuses on 2 key questions:

- What will be the key drivers² influencing science in the next 20 years and beyond?
- Two decades from now, how might international collaboration in science help progress in science and benefit society?

and explores the multiple answers to these questions, and their interactions, using a Foresight scenarios approach.

What is foresight analysis? What are scenarios? How can they be useful?

Foresight analysis comes in many forms. Since 2000, much foresight has shifted away from a focus on explicit scientific priority setting and toward developing shared visions, assembling coalitions of actors, and mapping out multiple plausible futures that highlight the uncertainties and underline the need for strategic flexibility. This new emphasis is the approach taken in the ICSU foresight analysis.

¹ It is recognized that “International Science” has been used to describe a broad range of approaches to science—from bilateral to truly global approaches. Fundamentally, such science requires (large scale) international collaboration of scientists in research and in research infrastructures. The evolving nature of international science is one of the key areas to be explored in this foresight. The term “science” is understood to include all domains of science (i.e., natural, social, human, medical, and engineering sciences).

² Key Driver (synonymous with “change driver” or “driving force”): In a world of cause and effect, it is a cause. Drivers can be trends such as population change. They may also be thresholds that, once passed, release a latent trend—such as elements of climate change or environmental degradation [Adapted from Smith and Mason, [2009](#)].

Scenario building is a popular method for describing possible futures. A scenario is a tool for ordering perceptions about alternative future environments in which one's decisions might be played out (P. Schwartz, 1996, in *The Art of the Long View*). Typically, three to five "exploratory" scenarios are developed, each distinguished by unique combinations of key drivers. The process of building these scenarios provides a structure in which to explore and learn from the interplay of key drivers and their attendant uncertainties. The result is a sense of preferences and what should be avoided. In general, scenarios offer a platform to expose and begin to address differing views among a large community about its shared future. For ICSU, such a process will inform collective strategic choices about its future role.

To connect the exploratory scenarios to ICSU's strategic planning and subsequent implementation, an additional, 'visionary scenario' will be built from what is learned while building and testing the initial exploratory scenarios. This final scenario which will be in a separate part II report will explore the ICSU vision of the desirable long-term evolution of international science and of ICSU's role in achieving such a vision. From this will be drawn recommendations for action by ICSU.

The Process

The foresight analysis has been led by ICSU's Committee on Scientific Planning and Review (CSPR) and was conducted from October 2009 to February 2012. On behalf of CSPR, a Task Team of seven advisors has overseen the development and implementation of the process by the ICSU Secretariat. This included foresight experts and additional expertise in scenario building was co-opted as necessary.

The analysis was conducted in four phases. During **Phase 1**, perspectives were gathered on potential drivers of international science over the next 20 years. Three primary sources were used: insights from participants at ICSU-related meetings³; a web consultation of ICSU members, bodies, partners, and early career scientists (-who had participated in a meeting marking ICSU's 75th anniversary in 2006); and a literature scan.

The outcome of the web consultation was 174 separate ideas for key drivers from 82 individuals in 30+ countries. The Task Team distilled these and the other submissions into a set of approximately 20 key

Implementing the Foresight Analysis

Phase 1 (October 2009 to April 2010):
Gather perspectives on the key drivers influencing international science in the next 20 years—from individuals in ICSU's membership, bodies, partners and other stakeholders, including young scientists.

Phase 2 (April 2010-early 2011):
Build exploratory scenarios from the key drivers and conduct a broad consultation with the same range of parties identified for the previous phase. The first Foresight report on the outcomes of Phases 1 and 2 will be published in early 2011.

Phase 3 (March 2011-June 2011):
Develop the draft 'visionary scenario' of where ICSU should be going—and the draft implications for ICSU, which CSPR will use to finalize the draft Strategic Plan.

Phase 4 (June 2011-February 2012):
Consult broadly on the draft 'visionary scenario' and its implications, in particular utilizing the ICSU General Assembly (Oct 2011) as a forum for Member opinions—including views on regional differences.

³ [list meetings here]

drivers and further refined this list after a discussion with CSPR in February 2010. The final list of key drivers is presented later in this document. A facilitated workshop of the task team was held in April, 2010 that launched the process into phase 2

During **Phase 2**, the emphasis of consultations shifted from seeking individual perspectives to those of organizations—especially ICSU Members. In preparation for this second major consultation, the Task Team developed four exploratory scenarios over the course of April to August 2010 and sharpened these in consultation with CSPR in September. Each scenario was shaped and distinguished by plausible forecasts for each of the key drivers. The sharpened scenarios were broadly distributed for comment by ICSU members and other stakeholders in January 2011. [With the feedback from this second consultation, the Task Team intends to refine the scenarios and publish these in a first report in mid 2011].

Phase 3 shifts the focus from the exploratory scenarios to the `visionary scenario` that will help create a vision for the long-term direction of ICSU. This normative scenario, which will be constructed using the insights gained from the development and use of the exploratory scenarios, will have clear implications for ICSU action. These implications will be considered by CSPR in a workshop dedicated to developing the `visionary scenario` (in April 2011), and as CSPR finalizes the draft ICSU Strategic Plan 2012-2017 in its 21st meeting. During the months leading up to the October 2011 ICSU General Assembly in Rome, the views of the ICSU membership will be sought on the draft `visionary scenario`. In addition, there will be a dedicated discussion of this topic at the General Assembly. This final phase—**Phase 4**—of the foresight analysis will result in a second report—with recommendations for ICSU action during and after implementation of the Strategic Plan 2012-2017—that will be delivered in February 2012.

2. KEY DRIVERS OF INTERNATIONAL SCIENCE OVER THE NEXT 20 YEARS

Many drivers will influence the evolution of the international science landscape over the next 20 years. During Phase 1 of this project, ICSU consulted widely on ideas for such drivers. These suggestions were organized and refined into a manageable set of highly influential factors. These were subdivided into two categories —(1) the megatrends for which trends over the next 20 years are more or less clear at least in their direction of evolution, if not in their precise impacts, and (2) the key drivers for which trends are much more uncertain.

The first category of megatrends includes:

- **Demography:** e.g., changes in global population size, spatial and age distribution, urban-to-rural balance.
- **Natural resource availability:** including water, food, energy, ecosystems, materials.
- **Global environmental change:** from oceans to ecosystems to the cryosphere and atmosphere, the forecasts are consistently for broad changes with major impacts on society over the coming two decades.
- **Human health and wellbeing:** e.g., trends in communicable and non-communicable diseases, mortality.
- **Technological change:** while we cannot know the nature and implications of the breakthroughs in advance, there is a high degree of certainty that these will occur over the next two decades, probably in several fields.
- **Enabling information and communication technologies:** affecting almost all aspects of society

These megatrends help paint a picture of the world in which international science will operate 20 years from now. Such a picture is elaborated in section 4 of this report prior to the exploratory scenarios.

With the backdrop of the general context provided by these megatrends, a set of 13 Key Drivers, that will directly or indirectly shape the future of international science with greater uncertainty in their direction of evolution, were identified from information gathered in Phase 1. Several forecasts were defined around each of these drivers, and the forecasts were used to develop the scenarios in section 4.

The 13 Key Drivers are:

1. Expansion of global agendas and arenas: the scope and scale of international relations are set to expand and become increasingly complex as non-state actors influence the international political and policy agenda. How will arenas for interaction evolve, and how will this affect how international science engages and informs decision-makers?

- 2. States and markets:** what will be the future preferences of States with respect to approaches to socio-economic development—whether market-based, strong state intervention, or other?
- 3. State sovereignty, regionalism and globalism:** the scale at which policy (such as that on the environment) and action are determined. What is the future of the UN system? Will global approaches or regional action be most prevalent? Will several strong individual nations shape a multipolar world?
- 4. Science and society:** How will science engage with society—from the public to policymakers? What will be the balance of scientific autonomy with factors of accountability and transparency, for example? How will science appreciation and education evolve? How will public trust in science evolve?
- 5. Private sector/military science:** What proportion of science will be conducted in non-academic settings where market, economy, or national military or strategic advantage are the dominant driving forces—and how will this affect scientific progress? How will security concerns affect access to science?
- 6. Scientific integrity and self regulation:** How will integrity in the conduct of science be protected and ensured in the light of external pressures? Can science continue to effectively self regulate and satisfy the demands for public accountability? What will be the effect of high profile cases of scientific misconduct on the public perception of science?
- 7. Spatial organization/conduct of science:** To what extent will the “center of gravity” for international science shift towards Asia? Will there be several “poles”? How will approaches to science evolve within the new “scientific powerhouses”? What will be the balance of national-scale versus international-scale science? What will be the trajectories of science in less developed nations?
- 8. International collaborative research infrastructures:** what is the future of international collaborative scientific infrastructures? How will they be balanced with other science investments? What will be the international participation in such infrastructures?
- 9. Epistemic organization/conduct of science:** how will science be organized within universities, companies, and elsewhere? How will interdisciplinarity and disciplinarity evolve?
- 10. Nature of the scientific record:** what will be the role of open access publishing? How will journals and the peer-review process evolve in general? What role will non-traditional channels of scientific communication play? What will be the quality controls on the published record and also on scientific data? Who will generate data and how will these data be archived and accessed?

11. Values, beliefs, ethics: how will knowledge-based and faith-based society interact? How will science handle ethical issues and controversy in areas of high public interest?

12. Science education and skills: where will scientists be educated (in universities, remotely, etc), what will they be taught (balance of disciplinary and interdisciplinary courses; theoretical and applied experience), how will they interact, and what will be the paths into scientific careers?

13. Scientific careers: what will be the pressures on scientists? How will they be evaluated and what incentives will exist?

3. THE CURRENT INTERNATIONAL SCIENCE LANDSCAPE (to be completed)

In order to build plausible and useful scenarios for the future of international science the mega-trends and key drivers identified above need to be complemented by an understanding of the current science landscape: its key actors and what influences them. This enables the identification of key questions to be considered in the exploratory scenarios.

The landscape of where, why, how and by whom science is being carried out constantly evolves, and the patterns of international collaboration with it. The key features of the current international science landscape in terms of **agenda-setting, resourcing, performing and utilizing**, are briefly mapped out below.

Agenda-setting

Key actors include: Inter governmental organizations (IGOs); non-governmental organizations (NGOs); national governments; regional bodies, eg EC; funding agencies and foundations; professional societies.

Key influencing factors include: economic and strategic interests; societal problems; resource availability; natural disasters;

Key questions to be answered: Rational for doing something internationally? Groups involved in agenda-setting? Formation and operation of international forums?

Resourcing

Key actors include: European Commission; some national funding agencies, eg major US agencies ; private foundations and big international science NGOs.

Key influencing factors include: political, strategic and social priorities and needs;

Key questions to be answered: Rationalities for resourcing? Groups involved in resourcing decision-making? Instruments used?

Performing

Key Actors include: international science programs, national research institutes, universities, military and private companies.

Key influencing factors include: funding and infrastructure availability, societal concerns, curiosity;

Key questions to be answered: sites of research and development performance? Organization of Research and Development?

Utilizing

Key actors include: governments, NGOs, private companies, the public and scientists.

Key influencing factors include: access, science literacy and trust in science;

Key questions to be answered: Rationalities to utilize science outputs? Mechanisms of access and use?

4. EXPLORATORY SCENARIOS

General Context for the Exploratory Scenarios – Societal megatrends

Many factors shaping the future remain highly uncertain. Major uncertainties influencing international science are explored in the four scenarios that follow. First, the general context in which all the exploratory scenarios should operate will be sketched by exploring a number of societal megatrends for which the trajectories on a timescale of 20 years are considered more predictable and which are relevant for international science (see p6).

Within 20 years, an increasingly urban world of more than 8 billion inhabitants is projected. Population growth will be concentrated in the less developed regions that are struggling to provide for their current populations. The soaring world population will put further pressure on already scarce resources of water, food and energy, potentially leading to increasing levels of poverty and conflicts. New technological advances will assist in overcoming limitations in food production, in providing sustainable energy resources, and in meeting the medical needs of the growing and aging population. However, in spite of medical advances and vaccination campaigns, infectious diseases and global pandemics are likely to remain a serious threat while chronic diseases associated with aging and sedentary lifestyles will certainly be more prevalent. Climate change mitigation and adaptation, fighting pollution, and preserving natural habitats and biodiversity will require urgent and concerted action. On a positive note, the rapid technological advances over the past 20 years have successfully responded to many challenges, and science and technology retains its promise to do the same in over the coming decades. How the aspiration turns into real capabilities in the inherently unpredictable economic and political context of the future remains to be seen.

The trends in **population growth** and urbanization can be predicted fairly well over the next 20 years. By 2030, the world population is projected to surpass 8.3 billion people¹. Most of the total growth will enlarge the population in less developed regions, with a rise from 5.6 billion in 2009 to 7 billion in 2030 projected, assuming continued decline in fertility¹. Sub-Saharan Africa, which contains most of the poorest countries in the world, is projected to experience more than a 50 percent increase in population. In contrast, the population of more developed regions is expected to change minimally, further widening the gap between poor and rich nations.

The 2030 population will be more urban than ever before. In 2010, half of the global population is living in cities, although there is considerable variation in the levels of **urbanization** across the world². While the more developed regions are mainly urban, major parts of the world in the less developed regions, in particular in Africa and Asia, have remained largely rural. Over the next two decades, the urban population is projected to grow steadily to around 60 percent of the world population, with most of the growth in the less developed regions. Generally, the urban areas are expected to absorb all the global population growth, and to draw in some of the rural population. Rapid urbanization, in particular fast growth of large cities and the associated slum areas, poses specific challenges including transportation, unemployment, poverty, access to clean water and sanitation, environmental degradation and pollution, and related health issues.

Globally, the population aged 60 years or over is the fastest growing¹, and the prevalence of age-related health challenges is on the rise. In the more developed regions, the population aged 60 years or over is expected to increase by 40 percent over the next two decades, rising from about 21 percent of the population in 2009 to almost 29 percent in 2030. The older population of the less developed regions is projected to more than double, with a rise from about 8 percent of the population in 2009 to more than 14 percent in 2030. Although the population of all countries is **aging**, the population will remain relatively young in countries where fertility is still high. The youngest populations will be found among the least developed countries, mostly in Sub-Saharan Africa. Rapid population growth coupled with a youthful age structure pose challenges for the provision of education, employment, and health and social security services. However, youthful age structure also presents a resource to be utilized for economic growth when the age structure matures and a larger share of the population enters the workforce.

On average, the global population is **healthier** and people **live longer** today than ever before³. Over the coming decades, the general trend of improving health will continue. However, the substantial progress in health has been, and will continue to be, unevenly distributed. While health conditions and life expectancy have improved in most countries, gaps between different social groups have widened and a considerable number of countries are falling far behind. In low-income countries, we are still fighting against a number of widespread and deadly **communicable diseases**³, including acute respiratory infections, diarrhoeal diseases, tuberculosis, malaria, measles and AIDS. Over the coming two decades, large declines in maternal and perinatal mortality are projected and reduction in deaths are also expected for nutritional conditions, and for all of the principal communicable diseases, provided that there is continued improvement in the access to treatment. For example, in 2008, there were an estimated 33.4 million HIV infections worldwide, causing an estimated 2 million of AIDS-related deaths⁴, mostly concentrated in the least developed regions. With increasing availability of antiretroviral therapy, AIDS-related deaths are projected to decline to 1.2 million in 2030⁵.

Overall, the **nature of health problems will change**. Aging and the effects of ill-managed urbanization increase the burden of chronic conditions. Population aging will result in significant increases in most **noncommunicable diseases**, in particular cancers. The four leading causes of death globally (including low-income countries) in 2030 are projected to be ischaemic heart disease, cerebrovascular disease (stroke), chronic obstructive pulmonary disease and lower respiratory infections (mainly pneumonia)⁵. However, widely spread epidemic diseases and global pandemics remain a threat, in part due to ill-managed population growth in the urban environments of the developing world.

Population growth and land-use change will heavily increase pressure on **ecosystems**. Numerous **ecosystem services**, that we depend on, are already being degraded or used unsustainably, including fish stocks and water supply⁶. As of today, species are becoming extinct at the highest rate since the last global mass-extinction event^{6,7}. The **conversion of land to agricultural uses** continues to be the main factor threatening **biodiversity**, but other factors, such as **the buildup of nitrogen** in rivers and coastal waters, **ocean acidification** and potential effects of **climate change**, are becoming increasingly important. Most published environmental change scenarios project continuing high levels of **extinctions** and **loss of habitats**, with associated decline of ecosystem services important to human well-being^{6,7}. If ecosystems are pushed beyond certain **thresholds or tipping points**, there is a high risk of dramatic biodiversity loss and accompanying degradation of a broad range of ecosystem services^{7,8}. Changes in

policy can decrease many of the negative consequences but more drastic interventions are required also to reverse degradation.

On the credit side, total **food production** has increased by a factor of about two-and-a-half while the number of people in the world has more than doubled since 1960. However, this has partly been at the cost of other ecosystem services. Despite increased food production, we are struggling still to feed the global population. In 2009, a little over one billion people were undernourished worldwide⁹. To feed the ever growing population, food production needs to increase by 40 percent by 2030¹⁰ and food processing, storage and delivery systems need to be improved. This creates a major challenge over the coming decades. In an increasingly urban world, new technologies will be needed to grow more from less land, with fewer hands¹¹. At the same time, climate change¹² and increased biofuel production represent major threats for long-term food security. To ensure access to food for the lowest-income population, the increase in food production and improved processing must be combined with efforts to erase poverty.

Inadequate and polluted **water supplies** remain pressing concerns, in particular in the less developed regions. Today, 13 percent of the world's population live without access to safe drinking water, and 39 percent without access to adequate sanitation¹³. In the absence of new environmental policy actions, almost half of the global population is projected to live in areas of high water stress in 2030¹⁴. Agriculture is the largest consumer of freshwater; 70 percent of all freshwater withdrawals go to irrigated agriculture. As over the coming decades the food demand further increases, improved water use efficiency will be needed to ensure adequate food production and supply.

Global population growth and urbanization, combined with the needs of emerging economies and the large scale adoption of certain new technologies, increase demand for commodities from the **mining and metals** industries. For example, demand for gallium for use in emerging technologies, such as thin layer photovoltaics, is projected to rise 20-fold from current use of almost 30 tons to about 600 tons by 2030¹⁵. Demand for neodymium, a rare earth element used in the strongest known permanent magnets, is projected to rise 7-fold from the current use of 4000 tons to some 28000 tons by 2030. Over the coming two decades, geological scarcity is not considered the critical issue; technological developments in exploring, mining and processing mineral raw materials will be the key in keeping up the supply with demand¹⁵. The critical issue is the geographical distribution of resources. For example, the worldwide production of a number of critical raw materials needed for mobile phones and emerging technologies, such as solar panels and synthetic fuels, is currently concentrated in just four countries: Brazil, China, Congo and Russia. Other major reserves of raw materials are located in developing regions with unstable political climates and where a lack of infrastructure poses challenges for extraction, processing and transportation¹⁶. The supply of such materials is particularly vulnerable to changes in geopolitical-economic frameworks. Not surprisingly, the exploitation of natural resources in the Polar Regions is a topic of increasing economic, political and scientific interest and considerable concerns.

Currently, approximately 2.4 billion people worldwide lack access to natural gas, propane or other modern fuels, and rely on traditional biomass for meeting their basic **energy** needs for cooking and heating¹⁷. Over the coming two decades, ensuring global energy security, meeting the growing energy needs of the rising economic powers of the developing world, as well as facing climate change and other environmental issues will be the main concerns in the energy sector. In the absence of policy changes

and energy supply limitations, the world energy demand is projected to rise by 40 percent by 2030, with non-OECD countries accounting for over 90 percent, with China and India alone representing about a half, of the incremental demand¹⁸. The current energy systems of most industrialised and transition-economy countries are heavily (more than 80 percent) dependent on fossil fuels, with nuclear and renewable sources (such as wind and hydro power, biomass and solar photovoltaics) contributing only small amounts to the total energy consumption. There are some exceptions but for next two decades fossil fuels are projected to remain the dominant source of energy worldwide. However, with current technologies, continued reliance on fossil fuels is likely to have serious consequences for climate change, acidification of land and water and human health. It is widely accepted that a sustainable long-term energy future will require increased energy efficiency and reliance on clean renewable energy resources, as well as new low-carbon fossil-fuel technologies. However the rate at which such an energy transition is likely to occur is very uncertain..

Population growth over the next twenty years will create massive new demands for **transportation**. At the moment, aviation is the fastest growing means of transportation¹⁹. Over the coming two decades, personal and goods transport will grow rapidly, driven primarily by rapid economic growth in the emerging economies of the developing World. The development of the necessary transport infrastructure is often lagging behind economic development, generating traffic congestion, pollution and high accident rates. Road traffic accidents are expected to rise from the ninth leading cause of death globally in 2004 to the fifth in 2030⁵. In the absence of policy changes, the total number of light-duty vehicles is projected to increase from an estimated 650 million in 2005 to about 1.4 billion by 2030¹⁹. Most of this increase comes from non-OECD countries, with China alone accounting for almost one-third of the global increase in cars. Currently, transport accounts for nearly one-quarter of global energy-related CO₂ emissions. Given the current trends, transport energy use and CO₂ emissions are projected to increase by almost 50 percent by 2030. To avoid undesirable consequences, cleaner fuels and more efficient vehicles will be critical in the shift towards sustainable transportation.

The future is **warmer**. For the next two decades, a warming of about 0.2°C per decade is projected for a range of emissions scenarios²⁰. Beyond 2030, temperature projections are increasingly dependent on specific emissions scenarios^{20,21}. Warming is expected to be greatest over land at high northern latitudes, and least over the Southern Ocean and northern North Atlantic, continuing recent trends. Warming will shrink glaciers further in every continent, will result in sea level rise, aggravate stress on water and food resources, reduce the resilience of many ecosystems, increase the risk of species extinctions - and possibly increase the number and intensity of extreme weather patterns. The less developed regions are particularly vulnerable and Africa is likely to be the most vulnerable continent, partly because the adaptive capacity in Africa is relatively low due to limited resources and fragile governance, with conflicts exacerbating the situation. While at mid- to high latitudes the food production might even increase, at lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases. Over the coming two decades, in some African countries, yields from rain-fed agriculture could be reduced by up to 50 percent²⁰. This, combined with rapid population growth in the already energy and food-insecure areas, could have disastrous consequences with a number of climate change related conflicts and refugees. Policies for mitigation and adaptation are urgently needed to reduce long-term climate change risks, impacts and damages.

Even in the absence of global warming, **natural hazards** present a persistent and continuous threat to human health and wellbeing and economic development in many parts of the World. When this threat is amplified by the effects of environmental change it is likely that such hazards will present an even greater threat over the next two decades. Hydro-meteorological hazards may be more extreme, deforestation and sea-level rise will increase the vulnerability of certain populations. The extent to which such hazards become disasters cannot be predicted but depends, to a large extent, on the effectiveness of strategies for prediction, mitigation and response.

Technological advances have been perhaps the most important driver of change in the modern era. Such change is mostly gradual and incremental, but occasionally major transitional breakthroughs happen. While we cannot know the nature and implications of the breakthroughs in advance, there is a high degree of certainty that these will occur in several fields over the next two decades. Areas of potential technological breakthroughs include *environmental and energy technologies, materials science, medical advances, genetic engineering, geo-engineering, robotics, artificial intelligence, nanocomputing, space exploration, complex system science and military applications*^{22,23}. The convergence of *nanotechnology, biotechnology, information technology, and cognitive sciences* is expected to rapidly accelerate in the coming decades^{24,25}. These **Converging technologies** will make substantial *improvement of human performance* possible. Nanoscience has the potential to revolutionize medicine, materials and manufacturing, electronics and information technology, environmental remediation applications, water purification, energy production, and other fundamentals of everyday life in the 21st Century²⁶. By 2030, the pervasive influence of life sciences on engineering, e.g. synthetic biology and molecular motors, will be a major feature. And over the coming decades, *Global Sustainability Research* will be an area of increasingly integrated research focus, with natural and social sciences pulling together to develop new technological (and social) innovations in response to pressing sustainability issues. Overall, we will see increasingly rapid dynamics of technology phase out and adoption.

Over the coming decades, *tools to acquire, generate, store, exchange and protect information will be further improved*, and increasingly distributed data banks and processing techniques will enhance the ability to tackle large and complex tasks. In particular, **high speed and parallel computing** will profoundly affect all aspects of society and the conduct of science. With the development of media to store data and high speed networks to exchange information, **data mining** is already opening up new approaches, in which hypotheses emerge from data itself. Some areas of science will see a significant shift from hypothesis-driven to data-driven research.

The effects of new **information and communication technologies (ICT)** are many-fold and pervasive. For example, mobile cellular connections in the developing countries have more than doubled since 2005, reaching an estimated 57 percent of the population at the end of 2009²⁷. Rapid further increase in connections is expected. As a result of the development of ICTs and **fast growth of Internet**, social networking has been taken to another level. These changes are fundamentally affecting scientific practices. For example, the Internet has revolutionized the production of, and access to, academic journals. Within 20 years, paper publications might well be eliminated. Remote operation of infrastructures through the Internet, as is already done in fields such as astronomy, is making it possible to be present in localities otherwise not easily accessible. Within 20 years, international conferences, education and collaboration in general will be fundamentally changed by the use of affordable virtual-

presence capabilities. The internet will allow the expansion of citizen science. Opportunities for **distance learning** and **e-collaboration** will increase, with potentially significant benefits for developing countries in particular. At the same time, parts of the less developed world that do not have the necessary ICT infrastructure are in danger of getting increasingly isolated and practicing cutting edge science in these countries will become very difficult. Elsewhere, the increasing dependence on ICTs may have its own unwanted consequences ... ensuring **cyber security** presents a major challenge.

Economic, political and social developments over the next twenty years represent a major area of uncertainty; yet they set the arena for international science. As the world struggles to overcome the global economic crisis, a multi-polar system is emerging. The balance of power is shifting towards the East but we do not know exactly how, or on what time scale, this will affect the established world order. The evolution in the roles of different international players, including non-state actors, remains to be seen. Future directions will be, to a large extent, determined by economic developments, which are highly uncertain. Rapid globalization and increasing interdependence of all aspects of society further complicate the picture. But it is reasonable to assume that progress in science and technology will continue to be a major force shaping social and economic development.

The general context sketched above represents a “business as usual” world, assuming little change in current trends. However, in the long-term this world is not sustainable and it can be expected that measures will to be implemented to avoid and/or respond to undesirable consequences. Thus, this general context does not reflect what will necessarily happen if, and when, action is taken. The four exploratory scenarios that follow explore plausible alternative future set in the context of current trends and taking into account some of the potential responses to these trends and major uncertainties that will shape these responses.

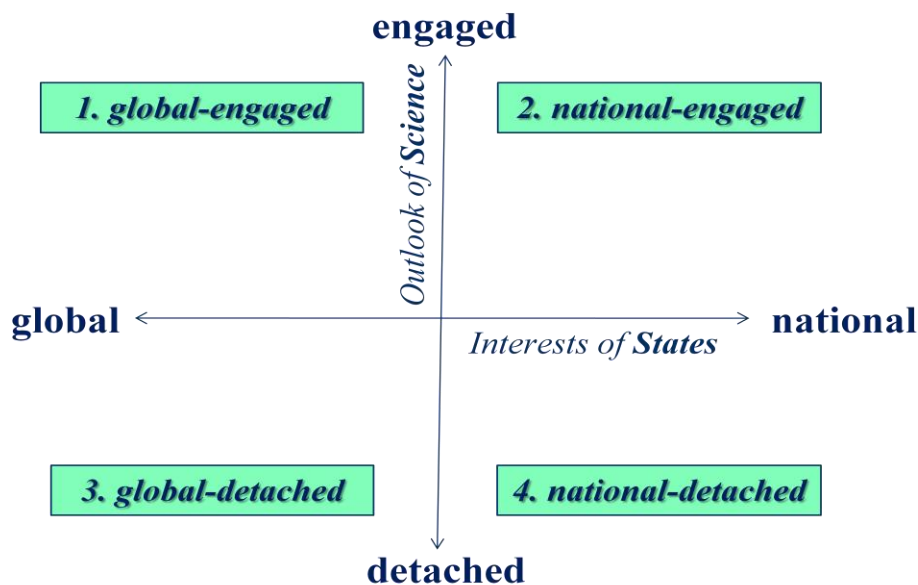
Structure of the Exploratory Scenarios

In order to develop plausible and useful exploratory scenarios, these have been framed within four distinct “scenario spaces” defined by two axes. These two axes were selected from the list of key drivers in section 2.

Characteristics of axis drivers:

- highly influential (even over many other “key” drivers);
- their forecasts have a plausibly large range of uncertainty;
- they should be as independent of each other as possible;
- they should generate distinct scenario spaces that are interesting, useful, and relevant with regard to the future of international science; and
- all the resultant scenario spaces should plausibly be able to include positive and negative traits and thus be presented in a balanced manner.

Using these criteria, the first selected scenario axis is based on “State sovereignty, regionalism, and globalism” (key driver 3, p6). At one end of this axis, countries have a nationally oriented outlook and they tend to look inward and address issues unilaterally. At the other end, countries have a global outlook and favor international cooperation and problem solving. Thus, the axis toggles between “national” and “global” outlooks. The second selected axis is based on “Science and society” (key driver 4, p7). At one end of this axis, science acts fairly independently from society (e.g., in terms of scientists setting the agenda and the lack of strong engagement of science and scientists in decision making processes). At the other end, science is highly engaged with society. These are called the “detached” and “engaged” modes.



Exploratory Scenario 1: “The Triumph of Globalism”

Global outlook of nations and science strongly engaged with societal needs

In the face of common global challenges and concern about the sustainability of the planet, the leading nations have found the will to balance their interests. **Global governance** has received new lifeblood and leadership with the full support of the traditional world powers and the newly industrialized countries. While states have taken the lead in establishing this new global order, the emergence of an **active global citizenry**, together with a **newly invigorated UN system**, has played an important role. Participatory democracies, with scientists playing a prominent role, reflect society’s trust in science. Flexible IPR regimes have enabled the establishment of **an effective global science commons** and the greater inclusion of the lesser developed countries. However, as science rallies to the global cause and public funding for science is directed accordingly to a few selected strategic priorities, there is growing concern from industry that the basic scientific disciplines are being neglected. The balance between the ‘social ‘role of universities and ‘unfettered knowledge generation’ has shifted significantly away from the latter. **‘Blue skies’ research is being squeezed**, both financially and due to organized societal pressure. In many countries research and innovation at the frontiers of life sciences is being retarded by the adoption of **precautionary approaches and regulations**. Science academies and professional societies are struggling to maintain the balance between their dual missions to ensure that science influences policy and to maintain academic freedom and scientific excellence.

Influential global environmental assessments have been followed by successful international action, international cooperation is seen as an effective way to address the pressing global challenges and **science is harnessed** to lead the way to a sustainable future. **New issue-focused networks** have been formed **by global alliances** of governments, multinational companies and NGOs to tackle a range of pressing global challenges, including energy, food, environment, health and poverty. **Alternative development pathways**, involving more active industrial policies with sustainability at their core, have taken over the traditional economic growth models and **global sustainability research** is a winner in science funding. In the more globally conscious atmosphere, developing countries are better compensated for their resources and more capacity-building opportunities are available. Though inequalities between nations still remain, they are decreasing, and overall potential for conflict has declined, in part due to technological developments. For example, markedly improved desalination technologies have provided nearly global access to clean drinking water. There is an effective and widely accepted global order, with **science acting as a global stabilizing agent**.

Social needs strongly influence science agendas. Science is an integral part of a functioning global society and helps to drive global political agendas. With strong engagement to societal needs, science is **policy relevant** and provides influential inputs to societal decision making, at global and national level. **“Activist scientists”** play prominent roles in shaping global views and promoting the essential role of science. The concept of scientific **integrity** has expanded to encapsulate the wider societal role that

scientists are expected to play. With this increased engagement, science becomes a much more distributed and **socially-embedded** activity and is increasingly practiced outside of the traditional institutes of state research systems. This partly **undermines some of the institutions of science**, including peer review and publication routines. The overwhelming emphasis on the need to tackle urgent global challenges provides much less room for research outside of a few **favoured strategic areas**. The strong societal engagement with science also has its down-sides, for example in Europe the broad adoption of the precautionary principle and associated rules and regulations have led to an embargo on research at some of the most exciting scientific frontiers – GM foods, nanoscience, human stem cells.

Both global and national funding sources are available, and investments in science are on the rise in sectors of high societal interest and concern. **International networking** has become the dominant model for conducting science. Research is increasingly conducted using **large-scale networks of smaller and decentralized facilities** that have been strategically organized for global unity to address pressing global challenges. National barriers to collaboration have declined, with greater **mobility of researchers** and **ICTs** playing increasingly prominent roles, which also enables a fuller participation in global science by developing countries. **Internationally agreed data standards** are an essential element of the new organization of science, and global data collection and monitoring systems, such as the Global Earth Observation System of Systems (GEOSS), form powerful motors for international research. **Integration of natural and social sciences** has been crucial for the proper framing and answering of problems in society. New reward structures and **online interdisciplinary journals** (e.g. Nature Interdisciplinary) provide incentives for interdisciplinary science to flourish.

A strong emphasis on pressing and complex societal challenges has led to reduced investment in curiosity-driven and disciplinary research. As also the educational systems put further emphasis on interdisciplinary programs through the establishment of **interdisciplinary institutes** at the expense of disciplinary programs, the result is an emerging **world of generalists** with a **lack of disciplinary depth**.

At the level of international governance for science, the 'S' in **UNESCO has been given new lifeblood** with a particular focus on science for sustainable development and capacity building in the less developed countries. The World Bank and other international donors have realized **the importance of higher education** and are providing major funding to support the policy directions of UNESCO, OECD and various GX (G8, G20, G77 etc) groups of nations all of whom are prioritizing science. The spirit of cooperation and global solidarity is also reflected at the non-governmental level, with academies and funding agencies pushing for **a single strong organization to represent the independent voice of global science**. The notion of a global strategic science funding body, combining 2% of each nation's allocated public research funding is being actively discussed.

Exploratory Scenario 2: “Science Supplying National Needs”

National outlook of nations and science strongly engaged to societal needs

After a series of major global economic crises over the preceding two decades, the developed and emerging nations have retreated from prior commitments to a global free market and adopted **more protectionist positions**. There is more state ownership and direction of economies reflecting **public disenchantment with globalization**. A variety of national science and innovation systems have developed in response to specific concerns over employment, energy and food security, ageing and health care costs. The goal is to be self-sufficient, to increase **local production** for internal and regional markets, and to improve quality of life and societal satisfaction, rather than growth per se. In most countries science is considered to have an important role to play in delivering domestic goals and **increased investment in science is closely linked to specific national priorities**. In the emerging and less developed countries this investment is integrated with a growing **exploitation of traditional knowledge**, in areas such as environmental management and health care. The lesser developed countries depend on wealthier regional neighbours for technology transfer and investment and **regional science organisations and new South-South networks are flourishing**. The global governance of science at the intergovernmental level is fractured, although a variety of non-governmental organisations strive to link the various national and regional efforts.

As the Western nations have put **national interests before global**, efforts to build effective **global governance structures have largely failed**. Instead, complex **national and supranational regional alliances** have formed among states, businesses, and civic groups to address pressing challenges. **Diverse national and regional solutions** prosper. Less developed countries are dependent upon traditional and new alliances with richer nations, and private companies and non-governmental organizations promote these relations. There is a growing South-South development nexus but, in the absence of a global mediating structure, **potential for conflict has increased**. As the stronger nations are generally more concerned about building national well-being, the emerging conflicts are geographically limited in range and often related to lack of resources within the poorest countries.

Bold science investments in the newly industrialized countries have provided an engine for their economic success and resulted in effective local solutions to pressing domestic challenges. Partnerships between academia and small and local small and medium sized enterprises have led to breakthroughs in renewable energy technologies and the development of effective vaccines and new contraceptives. Other countries have followed in their footsteps and **national investments in science** and science education are rapidly rising, in particular in larger countries. Nations have adopted a **strategic approach** to science and **domestic socio-economic needs strongly affect the science agenda**. Science is **policy relevant**. In this context, **scientists are celebrated** for their contributions to society, and this attracts more interest in science as well as funding. **Public-private partnerships** thrive, and generally science is

more **problem-oriented** in nature. **Locally engineered solutions** flourish in response to pressing societal challenges (including mitigation of the effects of climate change, healthy ageing, etc.), with **traditional knowledge** also being valued in these place-specific solutions.

Countries have different strategies towards science. While countries emphasize the role of science for national interests, how this is fulfilled is different. Generally, in smaller countries science is focused on specific national needs, while in larger and wealthier countries, nationally (or regionally) defined 'grand challenges' provide the directions for science. Overall, there are fewer opportunities for curiosity-driven research without clear short-term benefits for the society. For example, within Europe political support for the European Research Council has dried up and the resources have been re-directed back into the problem-oriented EC Framework Programme. The global science landscape is diverse. National science strategies vary, but a common feature across nations is an **increased dominance of government policy on the priorities and organisation of science.**

There is general disappointment with broad international collaboration given negative perceptions of its effectiveness. This extends to the scientific community. Where global research programmes do exist, they are strongly supported and driven by **non-governmental organizations** which increasingly shape and coordinate international scientific agendas focused around pressing societal needs. In the absence of large-scale global collaboration, **bilateral and regional alliances** are strong players in the international science arena. Aside from national science centers, **regionally shared research infrastructures** and educational institutions in new regionally defined key areas have become a norm. International governance and coordination structures for science reflect the regional and local focus of most research collaborations and the related scales of policy interest.

Exploratory Scenario 3: “Ivory Towers in a Global Market place”

Global outlook of nations and science detached from societal needs

The global free market economy reigns and intense levels of interaction occur between economic agents across national borders. **Thousands of multinational companies** constitute powerful international players and drive the ever faster pace of **globalization**, with a new generation of **ICTs** enabling instant spread of ideas and information worldwide. However, the **strengthened global IPR regime** ensures that full and open access is only available to those who can pay. Countries have increasingly specialized in supplying only certain products to global markets, and by doing so become more dependent on the global system. As each nation struggles to establish its place in the global marketplace, the world is effectively divided into service and/or resource providers and the innovators. Science mirrors, and to some extent strengthens, this divide. Companies locate their research facilities in the developed and emerging economies, which **invest strongly in knowledge creation**; service facilities and technology transfer dictate the lesser scientific strength of other countries. **Trust in science is low** and science is seen as part of the uncaring globalisation package for a largely disenchanting and disenfranchised public. This is exemplified in some parts of the World by the growth of **religious fundamentalism and anti-science** movements. There is **little demand for global science assessments** and science for policy more generally but industry is pushing for the **development of international nomenclature and standards** in emerging areas, such as converging technologies. Global science governance and coordination structures adapt to respond to these interests and to defend the cause of science.

With globalisation largely driven by multinational companies, states compete for investments by offering ever more attractive inducements. Among these is a strong science base, which countries use to compete vigorously in efforts to host multinational companies' R&D facilities. But multinational companies have mixed research needs from different countries. For example, in the leading scientific powerhouses, their agendas advocate public investment in curiosity-driven (and largely disciplinary) research that they would not otherwise perform themselves. This is deemed important for the generation of new ideas and the training of outstanding researchers for employment in flagship corporate labs. Accordingly, governments in these countries fund large amounts of curiosity-drive research, public-private partnership flourish and scientific communities enjoy considerable autonomy. By contrast, in more scientifically peripheral countries, multinational companies pressure governments to provide facilities and manpower to suit their more immediate experimental development needs. In both instances, science remains largely detached from societal agendas and is aligned with national economic goals only insofar as these coincide with the activities of multinational companies.

Converging technologies (nano, bio, info and cognitive sciences) and **medical sciences** represent the novel frontiers of science. Rapid advancements in these fields have resulted in the establishment of a number of new multinational companies that have played a major role in leading the world out of

economic crises. This has further demonstrated the considerable socio-economic benefit of an independent science acting as a well-spring of new high-technology innovations. As with product markets, countries specialise in particular fields of research. For example, the newly industrialized countries with less strict regulating regimes have taken the lead in converging technologies. With the success of the European Research Area, EU countries have taken a leading position in certain areas of medical science, such as those relating to ageing.

Certain problems, such as those relating to sustainable development, are recognized to be global in nature and are addressed as such. However, solutions are sought through political compromise and driven by short-term economic interests with scant regard to scientific considerations. In this regard, science contributes to solving global challenges and **informs policy decisions**, but has no lead role and policy decisions tend not to be driven by science.

For the most part, scientific communities accept these arrangements, at least in the main scientific powerhouse countries, since they provide for their autonomy on relatively generous terms. Public science in these countries has become increasingly globalised in its organization and governance, and **networking** between scientific groups is the dominant model for conducting science. The potential for scientific advance is enhanced by the development of **larger and more collaborative research infrastructures**, with a larger critical mass of scientists working on specific problems. The strong autonomy of science has kept much of the organization and governance mainly **disciplinary**, with **curiosity-driven research** being given a strong emphasis. By contrast, the situation in more scientifically peripheral countries is somewhat different. With many research groups tightly linked to individual multinational companies, global linkages are more confined and tend to be mediated through corporate channels.

Higher education is part of the global market place, with private universities dominating, particularly in the emerging and less developed countries. **Global universities** accept students worldwide and e-training has become an essential, and less expensive, means of education in the less developed world. While hailed as progress by many, the global availability of such services serves to stymie the development of indigenous tertiary education and associated research capabilities and contributes to further **'brain drain'** towards the more economically advanced countries.

The **widening gap between rich and poor** and the emphasis on short-term economic gains, leads to a certain degree of disenchantment with globalization. A variety of well organized and active anti-globalization movements have emerged, some of them rooted in religious fundamentalism and extreme forms of nationalism. Societal disenchantment with science prevails and is not confined to fundamentalists. While breakthroughs in new key areas are widely celebrated, particularly in the medical sciences, the rapid development of science and its **detachment from society** means that the public lacks a deep understanding of these new discoveries and **trust in science** is on the decline.

There is **little demand for science at the policy level** and the intergovernmental bodies with responsibility for science have limited financial and political support. Scientists tend to be entrenched in their disciplines and the professional societies, with support from industry, have adopted as their main function ensuring the links between pure and applied science.

Exploratory Scenario 4: “Rise of Aggressive Nationalism”

National outlook of nations and science detached from societal needs

This world is characterized by **strong competition** between nations. With the rise of the new and emerging economy nations there is an ongoing **power struggle for global leadership and resources**; the final outcome of which remains to be seen. Economic powerhouses, including the USA, Germany and a number of the newly industrialized countries, act as leadership poles and dominate the international decision-making structures. Preoccupied by their own national rivalries and interests, they effectively exclude their poorer counterparts and frequently fail to reach their own consensus. While some European countries have remained strong, the European Union as an entity has declined to a loose economic alliance – still recovering from the collapse of the Euro more than a decade earlier. In the uncertain geopolitical environment, **barriers between countries have been raised** and nations aggressively look after their own interests. The battle over finite global resources is fierce and Nation states are the key actors. There is a **culture of secrecy and lack of transparency and openness** affecting all walks of life and science is not immune to this. The **less developed countries are isolated** from the scientific endeavor and maintaining the Universality of science is a major challenge. Whilst richer countries invest strongly in science, this is almost exclusively for **national economic advantage or prestige**. The same technologies that rival countries are developing for inter-planetary exploration are also being used in new and more deadly weapons. It is a **divided and dangerous World** but one that is characterized also by **exciting advances in scientific understanding** and technology.

The geo-political struggle between nations over the previous decade has left its scars and efforts to work together to address major global challenges have failed, leading to further entrenchment behind national interests. Unable to compete economically or access technologies from richer counterparts, the less developed countries are largely left to their own devices, unless they possess exploitable resources. Developing countries with reserves of rare metals and nuclear fuels become sought after targets, creating an increasing divide with the developing countries without such resources. Inequalities between nations have grown and potential for conflict has increased, with the rapid **development of weapons** of high destructive capacity shadowing international relations. Largely unresolved sustainable development issues present a potential trigger for war.

After a number of high-profile cases of scientific misconduct and unfulfilled forecasts from the scientists, **trust in international assessments and predictions has eroded**. Generally, socio-economic needs do not have a strong influence on the science agenda and science **lacks policy relevance**. Policy making is driven mainly almost exclusively by national economic interests, often satisfying short-term political goals, and is weak on evidence. Willingness to join forces in addressing global climate change and sustainable development challenges has disappeared. Where science is supported, it is seen as a measure of national strength and prestige; nations compete to demonstrate their scientific

achievements. With stronger nations convinced that letting science run its own course is actually the best way to reap its benefits, outside the military complex, **scientists are largely allowed to determine their own agendas**. There is a strong institutional emphasis on translational research and technology transfer and any new scientific discoveries are effectively exploited to promote the national interests. This has led to several exciting breakthroughs and a respect for science, if not necessarily a deeper trust.

International coordination and global funding sources are scarce, but national investments in science and technology are increasing in the economic powerhouses. Other countries have fallen far behind. Driven by the geopolitical situation, the **military sector** is a particularly strong research hub, and space exploration has gotten new lifeblood. While many major societal challenges remain unresolved, nations are racing to get new machines to Mars and beyond. Public funding is available for **curiosity-driven research** projects. This has resulted in establishment of **national excellence institutes**, with a strong emphasis on **disciplinary research**. However, only a few countries are in a position to fund across all areas of curiosity-driven research and most countries have had to concentrate their resources on a selection of disciplines and centres. As countries have placed heavy barriers to the exchange of knowledge between nations, **parallel research efforts flourish** within **nodes of strong national science**.

In the atmosphere of tension and intense competition, large nations like China, the Francophone world and the Spanish speaking countries have begun to promote **the use of national languages for scientific communication**, with the ability to speak English becoming less of an advantage and bond within the global science community. The mobility of researchers and students has declined, and nations mainly rely on their own educational resources to train the next generations. While prestigious national universities attract the brightest minds of the leading nations, the education divide has left others without opportunities.

In the absence of a functional inter-governmental system, the international governance of science falls to non-governmental bodies, whose major preoccupation is ensuring the Universality of science in face of very real security concerns. This is manifest in many areas, including difficulties in ensuring visas for scientists, access to information and data and very real concerns about the dual use potential of breakthroughs in life sciences. The lack of interest and shortage of funds for international cooperation in science, has led to a rationalisation and consolidation of the multiple science bodies that used to populate the international arena.

5. USING THE SCENARIOS

These explorative scenarios offer four distinct, yet plausible images of the future `world order` and of international science cooperation twenty years from now. They are not intended as predictions of the future; indeed, it is a near certainty that none of these scenarios will come to pass as currently articulated. Instead, the four scenarios offer subjective storylines that are intended to stimulate creative thinking and to expand the `possibility space` on future courses of action. They put more emphasis on the multiplicity of futures and encourage the development of strategies that are appropriate to a variety of circumstances, an orientation that should help ICSU develop `agility` to manage future uncertainties.

The process of generating the scenarios has already provided useful inputs to the current ICSU strategy updating process. But the scenarios are likely to have their largest immediate impact in the development of a longer term vision for international cooperation in science and the role ICSU will need to play. This will be achieved through the development of a `visionary scenario` with a 20-year time horizon outlining the contours of a desirable state of international cooperation in science in 2031 and ICSU's role in its achievement. Through `backcasting`, a number of practical steps will be identified as milestones along the way to achieving this desirable outcome. The process of generating this `visionary scenario` will involve organisation of a CSPR workshop dedicated to the task (in April 2011) and wide consultation among ICSU members. The four exploratory scenarios set out in this report will provide useful stimulus for more creative thinking on a desirable `visionary scenario` and should encourage a more rigorous treatment of the key drivers of change that are likely to impact on the future state and directions of international cooperation in science over the longer term.

It has always been intended for the scenarios to have a wider appeal beyond the immediate planning needs of ICSU and the expectation is that Members will find them useful in their own planning and visioning activities. In this regard, the scenarios are intended to attract attention to the issues highlighted and provide a starting point to stimulate creative thinking around possible future courses of action. ICSU members and other users will need to elaborate and evaluate the scenarios in ways that are tuned to their particular needs, though it is possible that ICSU could provide more prescriptive guidance – possibly as an annex to this report – on using the scenarios and/or on running scenario-based workshops.

It should be noted that major shocks or extreme events (commonly known as `wild cards`) have, for the most part, been excluded from the scenario storylines. They can, however, be introduced during strategic planning processes, as is often done in business environments. Shortlists of relevant wild cards can be readily assembled through a mix of group brainstorming and desk research – a lot of existing information is already readily available from various horizon scanning activities going on around the world. The impacts of each wild card can then be analyzed by running them through each of the four scenarios.

6. ACKNOWLEDGEMENTS (to be completed later)

[include a list of key driver submitters]

7. ANNEX(ES) (to be completed later)

[consider online annexes]

FOOTNOTES (of general context section)

¹United Nations Department of Economic and Social Affairs/Population Division *World Population Prospects: The 2008 Revision*

Note: If fertility were to remain constant at the present-day levels, the total world population would increase to approximately 8.8 billion by 2030. The future population growth is highly dependent on the path that future fertility takes; the projected population ageing mainly results from the decline in fertility.

²United Nations Department of Economic and Social Affairs/Population Division *World Urbanization Prospects: The 2009 Revision*

Note: There are major disparities in the levels of urbanization between regions. Currently, in more developed regions the urbanization level is 75 percent, as compared to 45 percent in the less developed regions. Major differences occur also between countries. For example, in 2009, Burundi, the least urban country in Sub-Saharan Africa, was only about 11 percent urban.

³World Health Organization *World Health Statistics 2010*

⁴World Health Organization *AIDS epidemic update 2009*

Note: Sub-Saharan Africa has remained the region most heavily affected by the HIV virus, accounting for two-thirds of an estimated 33.4 million of worldwide HIV infections.

⁵World Health Organization *The global burden of disease: 2004 update*

⁶Millennium Ecosystem Assessment

Note: According to the Millennium Ecosystem Assessment, 15 out of 24 ecosystem services examined are already being degraded or used unsustainably.

⁷Convention on Biological Diversity *Global Biodiversity Outlook 3 (2010)*

Convention on Biological Diversity Technical Series No. 50 *Biodiversity Scenarios: Projections of 21st Century Change in Biodiversity and Associated Ecosystem Services; A Technical Report for the Global Biodiversity Outlook 3*

Note: This work focuses on synthesizing information from a broad range of models and scenarios.

⁸J. Rockström et al. (2009), *A safe operating space for humanity*, Nature 461, 472-475.

⁹Food and Agriculture Organization of the United Nations *The State of Food Insecurity in the World 2009: Economic crises – impacts and lessons learned*

Note: This is the highest number estimated since 1970, the earliest year for which comparable statistics are available. The recent increase in food insecurity is not a result of decreased food production but because high food prices and lower incomes have reduced access to food.

¹⁰Food and Agriculture Organization of the United Nations *World agriculture: towards 2030/2050– Interim report*

Note: Growth rates are based on 2005/07 average historical data.

¹¹Food and Agriculture Organization of the United Nations *How to Feed the World in 2050, Discussion paper 2009*

¹²D. B. Lobell et al. (2008), *Prioritizing Climate Change Adaptation Needs for Food Security in 2030*, Science 319, 607-610.

¹³World Health Organization *Progress on sanitation and drinking-water 2010 update*

Note: Improved drinking water sources and sanitation facilities are defined in terms of the types of technology and levels of services that are more likely to provide safe water and to be sanitary than unimproved technologies.

¹⁴Organization for Economic Co-operation and Development *Environmental Outlook to 2030 (2008)*

¹⁵European Commission *Report of the Ad-hoc Working Group on defining critical raw materials (2010)*

¹⁶World Economic Forum *Mining & Metals Scenarios to 2030 (2010)*

¹⁷International Institute for Applied Systems Analysis *Global Energy Assessment*
Report in preparation

Note: Some other sources (UNDP and WHO) estimate that more than 3 billion people lack access to modern fuels.

¹⁸International Energy Agency *World Energy Outlook 2009*

Note: Reference year 2007. The World Energy Outlook presents two projections. One is their "Reference Scenario" (used here) which simply continues current trends in the absence of policy changes. The other one is their recommendations for policy and technology use changes that target a 450 parts per million of CO₂ equivalent in the atmosphere.

¹⁹International Energy Association *Transport, Energy and CO₂: Moving towards Sustainability 2009*

Note: The Baseline scenario (used here) follows the IEA World Energy Outlook 2008 Reference Case to 2030, and then extends it to 2050.

²⁰International Panel on Climate Change *Fourth Assessment Report: Climate Change 2007*

Note: The report links increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level to anthropogenic greenhouse gas emissions (CO₂ is the most important anthropogenic greenhouse gas).

Here the emissions scenarios refer to the SRES scenarios described in the IPCC Special Report on Emissions Scenarios (SRES, 2000). The SRES scenarios explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting greenhouse gas emissions. These scenarios do not include additional climate policies above current ones. The emissions projections are widely used in the assessments of future climate change, and their underlying assumptions with respect to socio-economic, demographic and technological change serve as inputs to many recent climate change vulnerability and impact assessments. Baseline emissions scenarios published since the IPCC Special Report on Emissions Scenarios (SRES, 2000) are comparable in range to those presented in SRES.

²¹R. H. Moss et al. (2010), *The next generation of scenarios for climate change research and assessment*, Nature 463, 747-756.

²²George Washington University *TechCast*

²³UK's Horizon Scanning Centre *Sigma Scan*

²⁴US National Science Foundation (NSF) and Department of Commerce *Converging Technologies for Improving Human Performance NANOTECHNOLOGY, BIOTECHNOLOGY, INFORMATION TECHNOLOGY AND COGNITIVE SCIENCE*

²⁵European Commission *Converging Technologies – Shaping the Future of European Societies*

²⁶The Royal Society and the Royal Academy of Engineering *Nanoscience and nanotechnologies: opportunities and uncertainties (2004)*

²⁷International Telecommunication Union *Measuring the Information Society 2010*

Note: While in the developing countries mobile cellular connections reach an estimated 57 percent of the population, in the more developed regions, mobile cellular penetration exceeds 100 percent. Internet use has also continued to rise, but at a slower pace. In 2009, four out of five people in the developing world still didn't have an access to the Internet, and China alone accounted for one-third of the Internet users in the developing world. As a comparison, 64 percent of the population in the more developed regions were using the Internet.