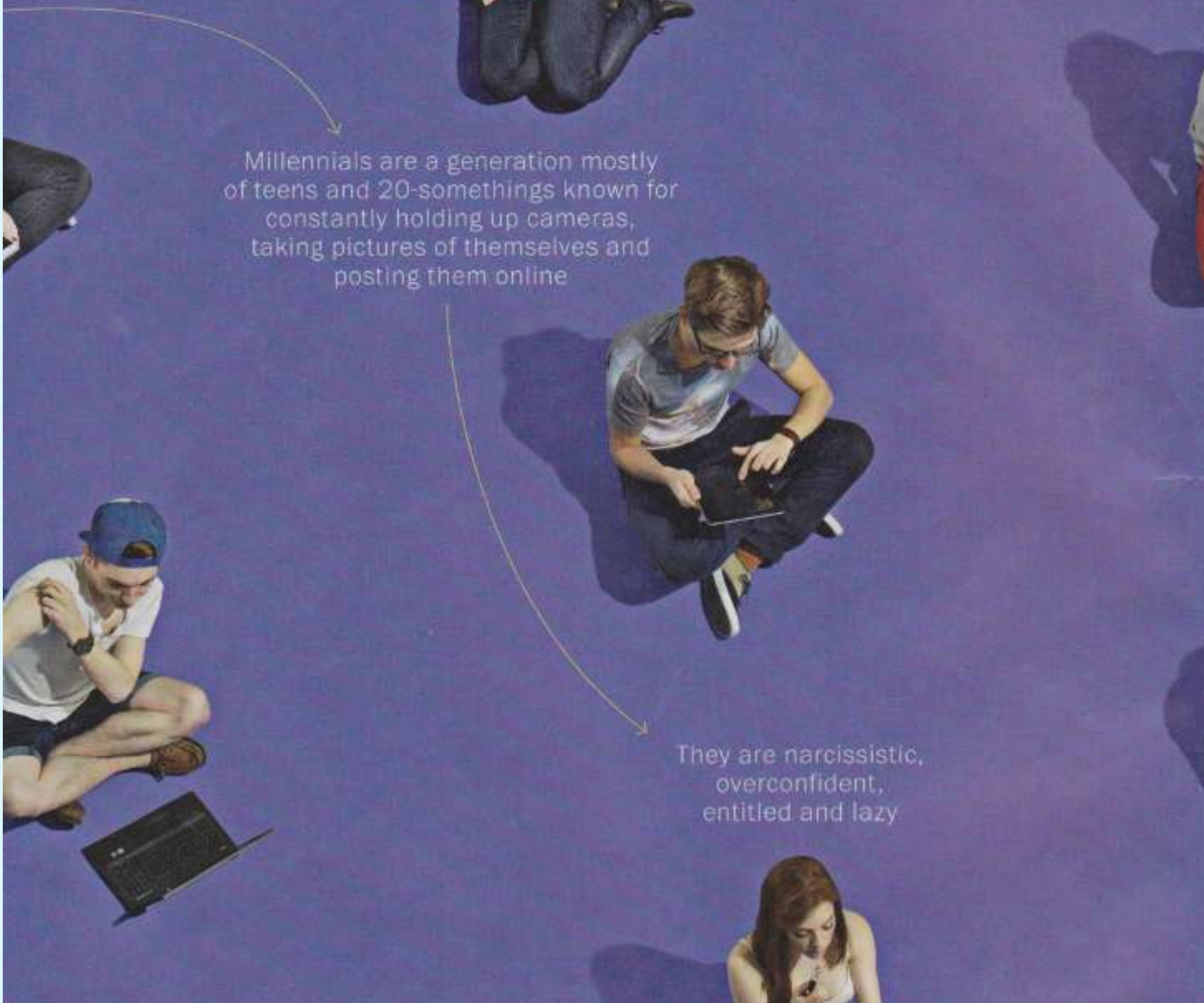
There is, probably, no need for this presentation

Prof. Dr. Jan de Lange
Oxford July 2013


Millennials are a generation mostly of teens and 20-somethings known for constantly holding up cameras, taking pictures of themselves and posting them online
They are narcissistic, overconfident, entitled and lazy

“ Now, imagine being used to that technology your whole life…..
and having to sit through Algebra”

Joel Stein, Time 2013

The educational design community has no communal mechanisms for codifying craft knowledge

Schunn, 2008

Codifying design thinking threatens it’s central value of flexibility

Collopy, 2009

EDUCATIONAL DESIGN :

IS THERE A (NEED FOR A) SYSTEM?

Educational Design:
-to create and execute according to plan
-to conceive and plan out in the mind
-is very ego involving (own mark)
-to make drawing or sketch: process of design

Merrian Webster 2008

In the real world:
Is there a system to the madness of design?

Schunn 2008

And it is hard to reflect on your own system (if there is one): people do not have direct access to the mental processes they follow

Anderson, Lebiere, Lovett 1998

Educational designers have few incentives to codify their reflections and present them publicly

Schoenfeld 2009

Design takes place in the swampy lowlands: problems are messy. The irony is that the problems of the high ground (theory) tend to be relatively unimportant to individuals or society at large, while in the swamp lie the greatest problems.

The practitioner is confronted with a choice: shall he remain on the high ground where he can solve relatively unimportant problems or shall he descend to the swamp of important problems where he cannot be rigorous in any way he knows how to describe?

(Schön, 1995)

PERSONAL REFLECTIONS ON THE DESIGN PROCESS

Slow Design

De Lange 2008

Partnerships:

Researcher/Designer partnership & Researcher/Designer with Teacher/Student partnership.

Process:

-select **subject of choice** (especially as junior designer), duration, level

-design a (mental) **sketch of flow** and educational/didactical vision

-use **intuition**

-**choice of context**: gives meaning to math concept (conc. mathematization) (de Lange, 1979)

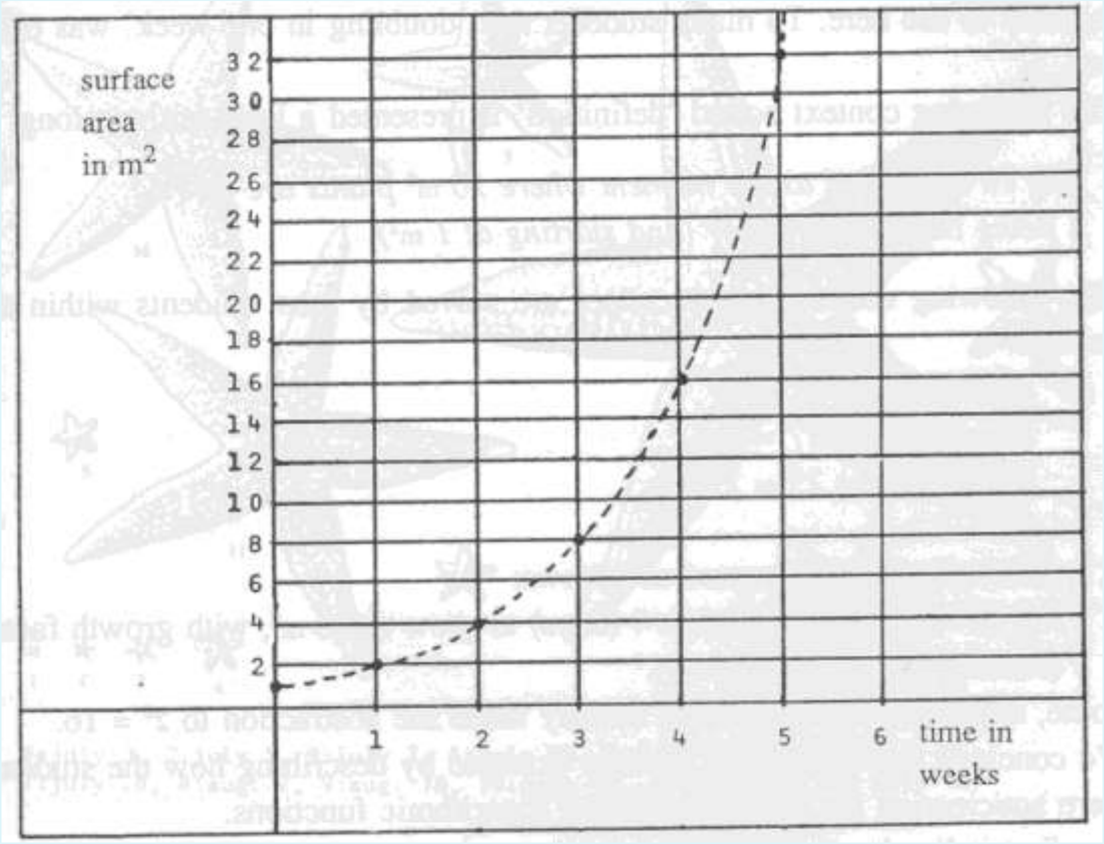
-choice of context: authentic applications (applied mathematization) (de Lange, 1987)

-look for **inspiration** in ‘random’ search library (associative thinking)

-**refine** design, it should have your ‘mark’
-go for a ‘real’ **discussion**, have it ripped apart (very desirable and uncommon)
-write version that’s about ready for **classroom experiments**
-**discuss** this with experienced teacher
-**revis**e, and have teacher teach using your design (NEVER teach yourself)
-**observe** classroom activities, without video
-walk around and checks **students reactions** and understanding
-make **notes** for revision; take discrepancies between ‘intended’ and ‘achieved’ seriously
-concentrate on essential **conceptual** development, not on details
-**start** the cycle again
-designer is part of **every aspect** of process

EXAMPLE:
Exponents and Logarithms

de Lange 1978



1.Estimate, using the graph, after how many days there are about 20 m plants

2.Estimate, using the graph, after how many days there are 40 m plants

Next questions: Time to grow 40 m^2, 80 m^2? 10 m^2 ?

${}^2\log 10$ is defined as the moment where 10 m^2 plants are formed, 2 being the growth factor (and starting with 1 m^2).

Explain:

${}^2\log 16 = 4$ ${}^3\log 27 = 3$ ${}^5\log 25 = 2$

Explain:

${}^2\log 3 + 1 = {}^2\log 6$

${}^2\log 7 + 1 = {}^2\log 14$

${}^2\log 6 + {}^2\log 2 = {}^2\log 12$

Slow Design

Is possible under these conditions
-freedom of choice of what to design
-freedom in time
-freedom of thought (no pressure from publishers, standards, etc.)
-freedom to explore
-restriction: design within the philosophy of realistic mathematics education
-take that restriction with freedom

Fast Design

-Higher degree of separation: designer/researcher/tech development/teacher/student
-Design as a noun: the product
-Starting point: Standards
-Parallel Design of Different Aspects
-Market Driven
-Looks are everything
-Designer is just a part in the whole machinery
-Less coherence

DESIGN AS ART

Design:

Experience,
Intuition,
Inspiration

make it

Art.

Educational design theory incorporates a systemic of knowledge and involves cumulative reasoning and understanding, it is to that extend a science.

And since design and construction involves choices which must be made on the basis of experience, intuition, and even inspiration, it partakes the quality of art.

(de Lange, 2012, inspired by Peter Hilton 1976)

Intuition

Three kinds of Intuition (Duggan,2007)
-Ordinary
Your general gut feeling, feeling, not thinking
-Expert (Gladwell,2005)
Draws from experience; makes it possible to make quick assessments, in familiar situations
-Strategic (Duggan,2007)
Informed by experience, leading to a deep insight that connects seemingly unrelated knowledge to create new insight and 'gestalts'; in unfamiliar, new situations. Thinking, not feeling.

•

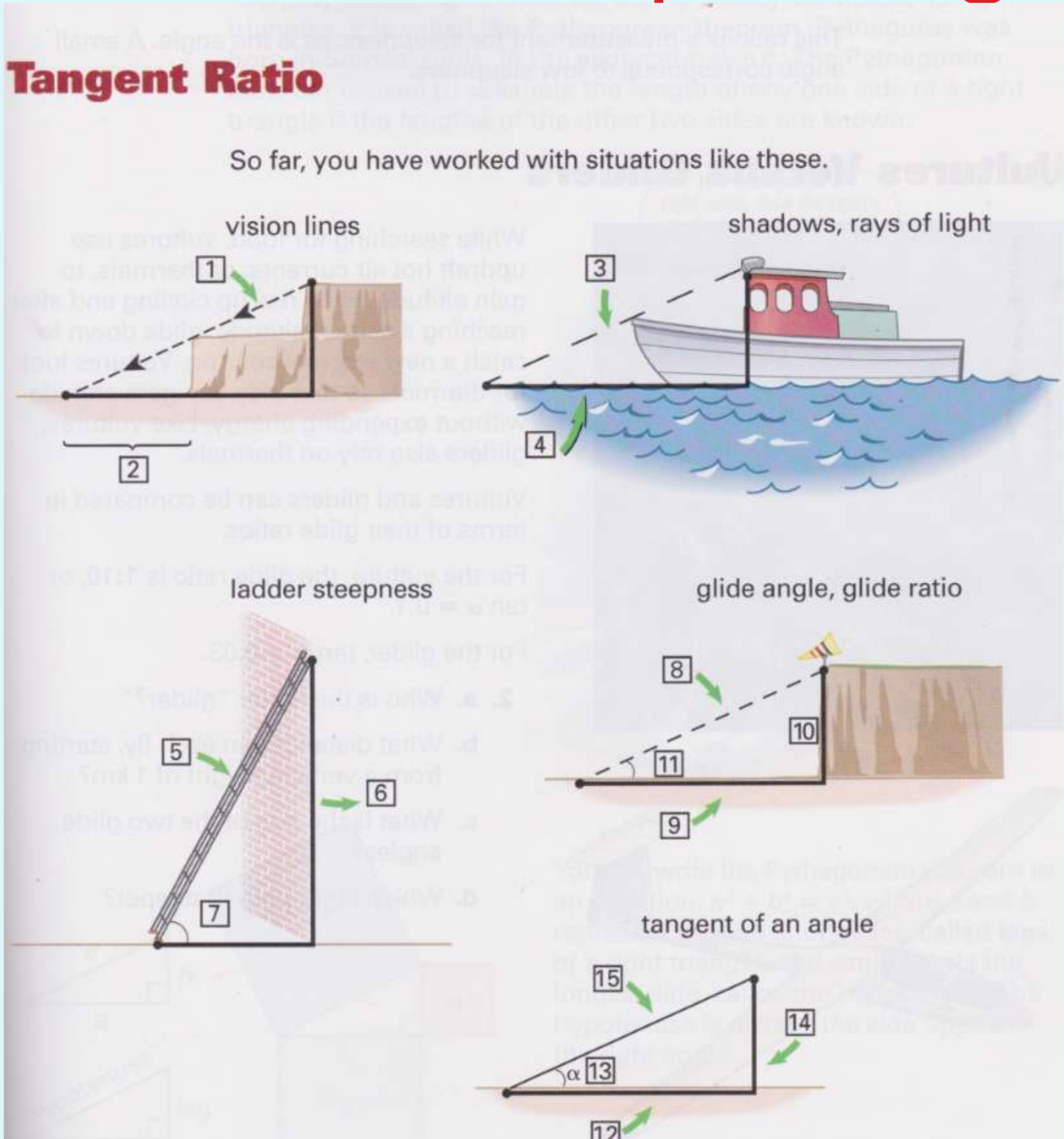
Intuition

The secret of obtaining strategic intuition is ‘time’. Especially: reflective time.
So if you see the design challenges, conditions, constraints, time frames:

Do not go into ‘**reflexes**’
but into ‘**reflection**’.

DESIGN EXAMPLES

Central Concept Design



Central Context Design

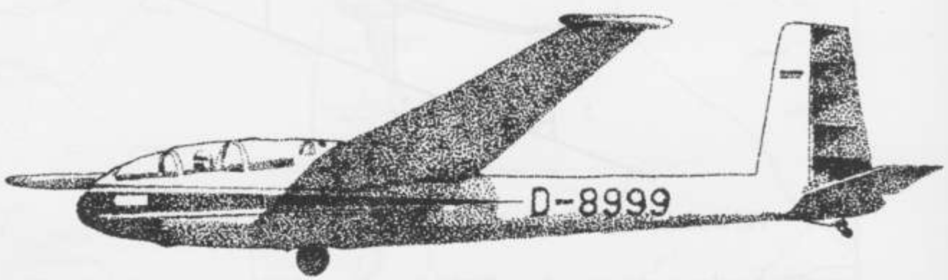
30. a. Make a cross in the middle of a blank page. This represents an airport. Draw the region where the plane can be launched from and still land at the airport, given:

    (scale: 10 km = 1 cm)
    glide ratio 1:30
    altitude 2000 meters
    no wind.

b. What is the glide angle of this plane?

c. The plane flies at a speed of 60 km per hour. One day there is a bit of wind coming from the west at 20 km/h. Indicate in your drawing (started in a) the region where the plane can now be launched from, keeping in mind the effect of the wind.

31.



Blanik L-13

In a book on airplanes it says, "The Blanik L-13 has a glide ratio of 5%."

a. Explain what this means.

b. Compute the glide angle.

Math Vectors

A **vector** has a *direction* and a *magnitude* (length).

Example: $\vec{a}$ = 140°/ 30.
140° indicates the direction, 30 the magnitude.

1. Using grid paper, draw the vector $\vec{a}$ = 53°/ 50. (1 grid unit equals ten km.)

2. Assuming that $\vec{a}$ represents a flight starting at airport A, how many km east of the airport does the airplane travel? How many km north of the airport?

3. Answer the same questions for the vector $\vec{b}$ = 14°/ 41.

4. If the airplane travels a path equal to $\vec{a} + \vec{b}$, how far to the east and north does it travel?

A flight can also be described in the following way:

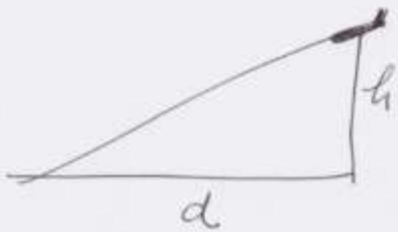
5. a. Draw the vector $\vec{c}$ = 50 east/ 30 north.
   b. Add to $\vec{c}$ the following vector: $\vec{d}$ = 20 east/ 40 north.
   c. Write the solution, using the same notation: $\vec{c} + \vec{d}$.

You can also write vectors such as "$\vec{c}$ = 50 east/ 30 north" as "$\vec{c} = \begin{pmatrix} 50E \\ 30N \end{pmatrix}$."

6. Draw $\vec{e} = \begin{pmatrix} 20E \\ 40N \end{pmatrix}$ and $\vec{f} = \begin{pmatrix} 40W \\ 10N \end{pmatrix}$. Draw $\vec{e} + \vec{f}$ and write the sum.

Design over Time

How about something called the glide ratio:



If a sailplane has a glide-ratio of 1 : 30 it means it flies a distance of 30 km if it is 1 km high. It is really used to compare gliders.
(and just the tangent, right?)

JC

1. Look at the following statements. Put them in order of best ratio.
   a. Herring Gull

Herring gull

The Herring Gull glided from a church tower of 70 meters 700 meters far.

   b. Cessna 150

Cessna 150

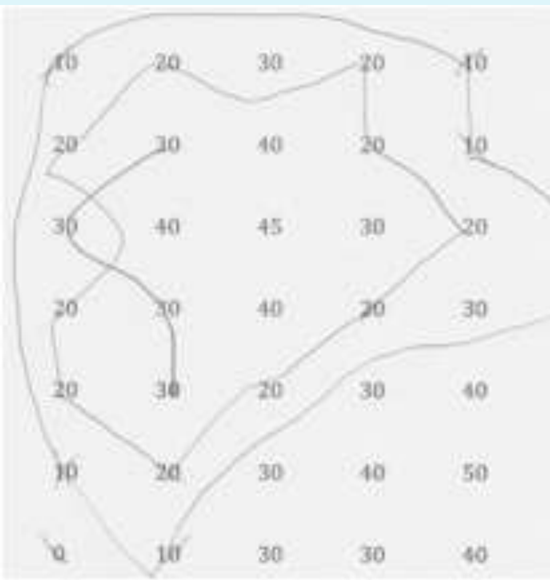
The engine quit when the Cessna was at 1200 feet. It managed to fly 1.6 mile far.

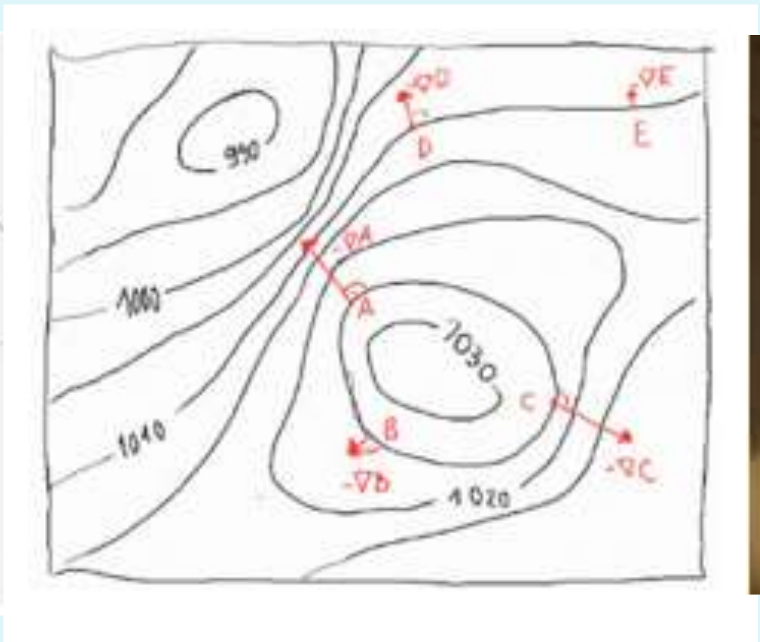
   c. House Sparrow

House Sparrow

The House Sparrow glides from a rooftop at 27 feet and landed 108 feet farther.

Experimental Free Design





RESTRICTIONS

CONDITIONS

CHALLENGES

There are many ways to organize curricula. The challenge, now rarely met, is to avoid those that distort mathematics and turn off students
Steen, 2007

Millennials are lazy, entitled narcissists who still live wit their parents
Stein 2013

Question: are you designing for teachers or students?

Assessments: high stakes or monitoring, summative or formative, portfolios or computer delivered: they are everywhere; should be part of the design

Time, facilities, product oriented

Parallel instead of coherent design: designer lost in multidimensional space

Standards are uniform and everywhere

Children/students are individuals, with a huge variety of capabilities, talents, and needs; in short: they are not standardized & uniform.

Standards: Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. (Etc).(CCSS, 2011)

Example

The ratio of wings to beaks at the zoo was 2 : 1, because for every two wings there was one beak

Grade 6, Ratio 6.RP.

CURRICULA DESIGN

TASK DESIGN

Curricula Design

How complex is it? That depends.

A. If you have been part of or close to the team that designed the ‘standards’: it helps a lot. You know and understand the deeper meaning. You can see behind the words. You know the problem that is addressed. You may have done some pre-standards experiments.

B. If the Standards are rather vaguely or flexible formulated this offers designers opportunities. You interpret the Standards from the perspective of how it solves your problem. You see possibilities, based on your interpretation. You need to do some very ‘fast’ experiments.

C. If the Standards are very strictly formulated, in high detail, and just seem to bother about a discipline, and not about students (children), the designer has some challenges to overcome. The Standards are the problem. The designer is just part of the whole machinery. He hopes some of his ideas will survive.

A. Almost immediately you can identify highlights of sub-strands, and start designing. The design is more or less the end product of a longer thinking process. There is a small team. You need outside 'guidance'.

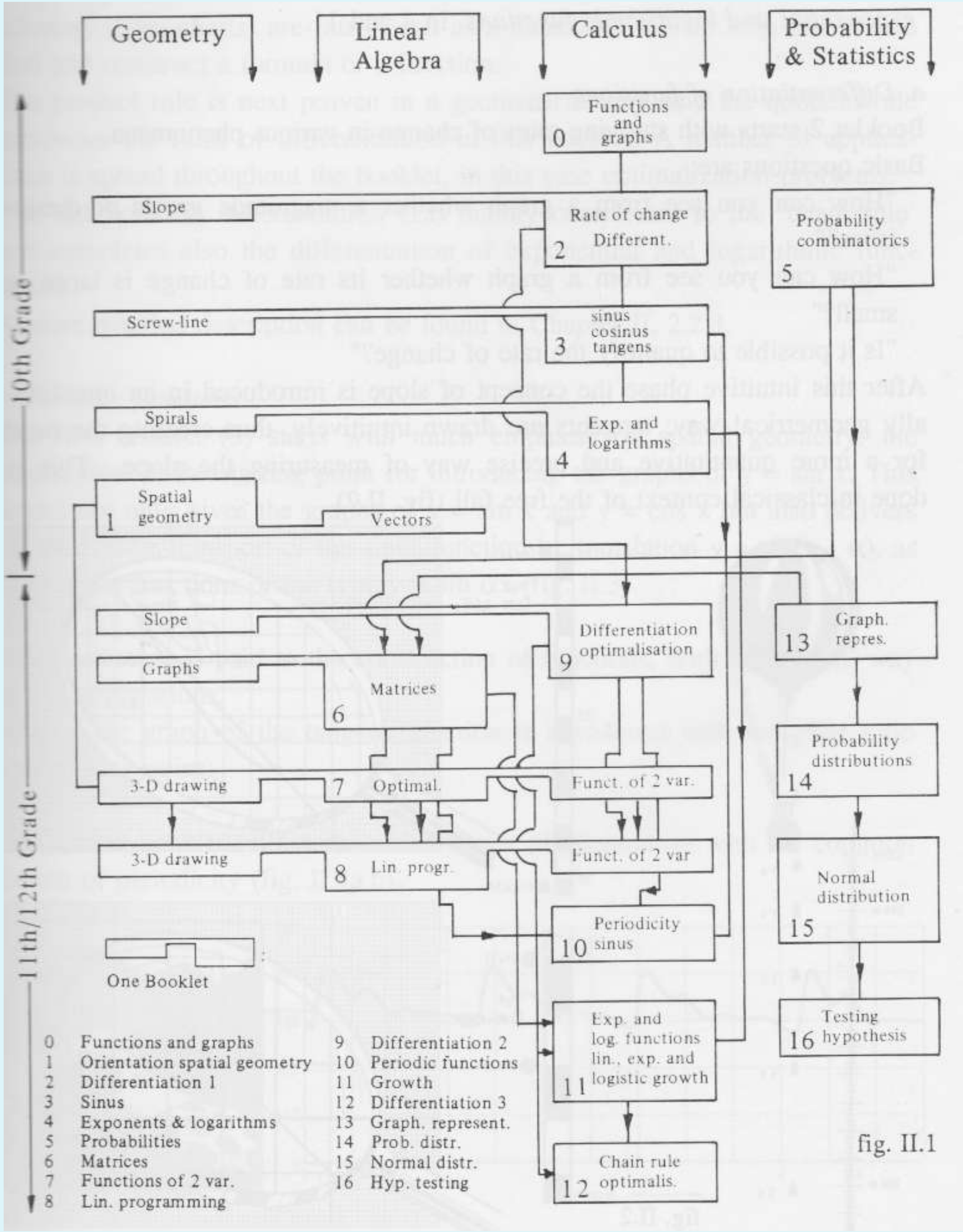
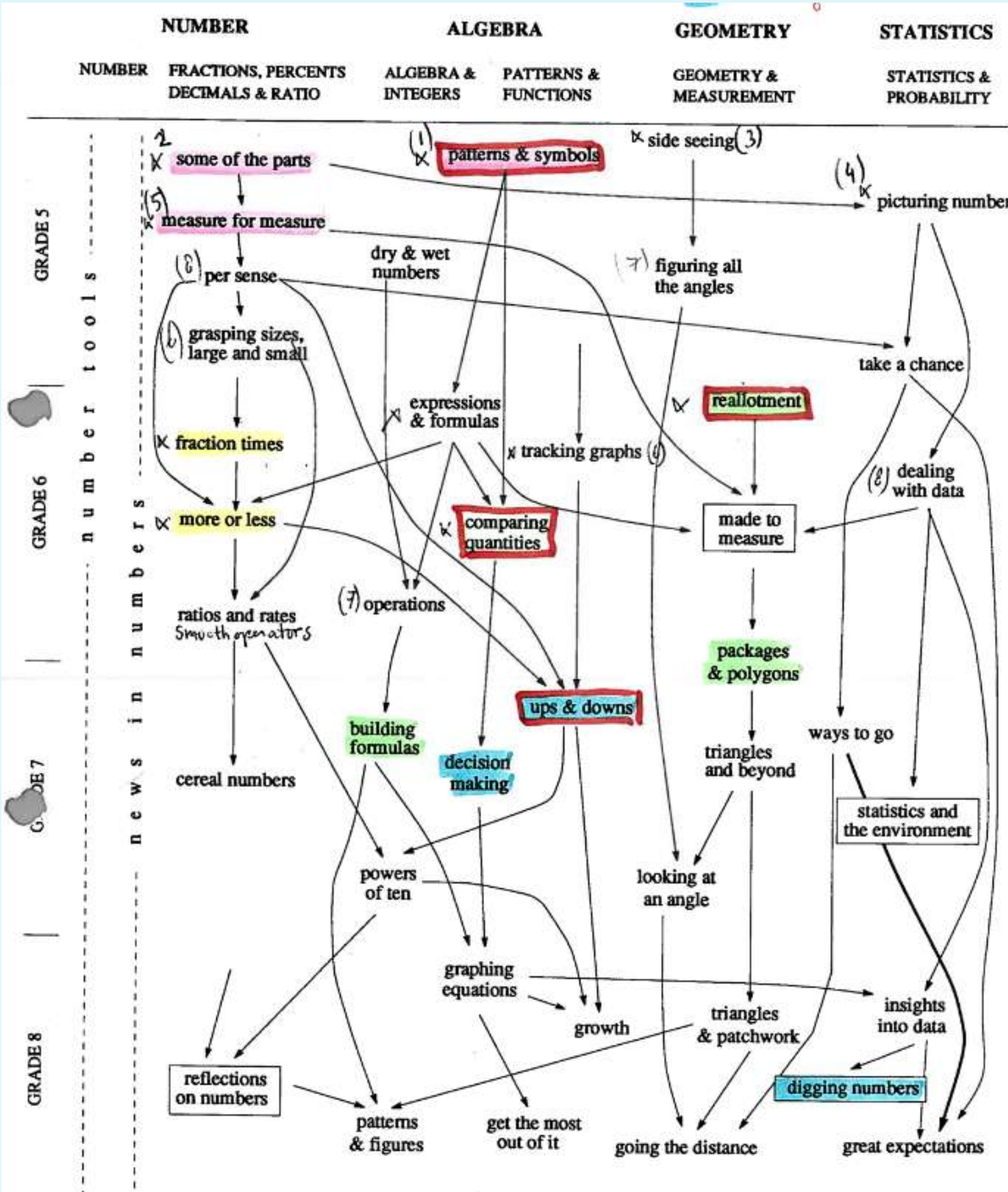
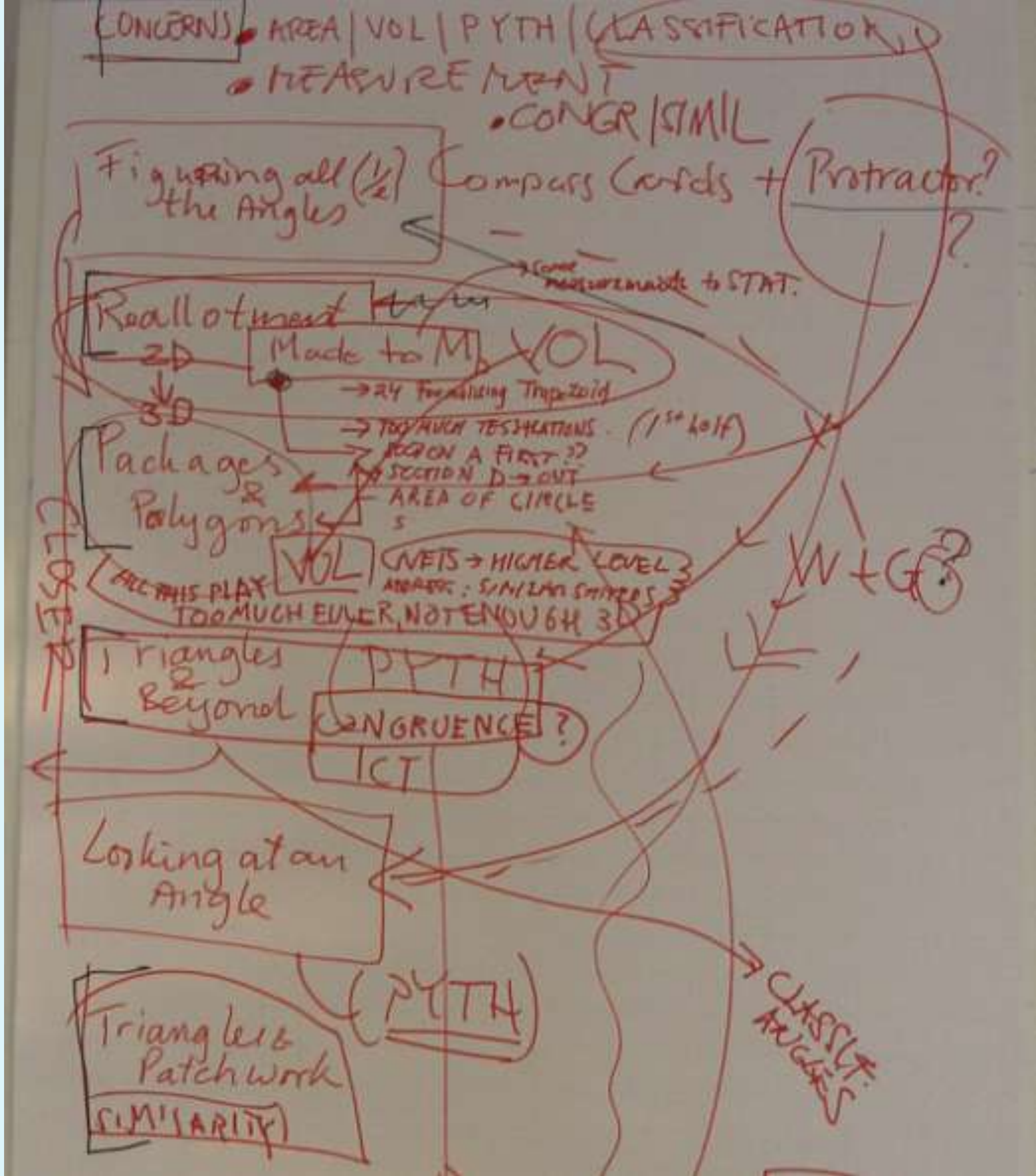


fig. II.1

B. In this situation you need a real team: there is much interpretation, exchange of local knowledge. Brainstorms may give results that look like there is progress.




CONCERNS
AREA | VOL | PYTH | CLASSIFICATION
MEASUREMENT
CONGR | SIMIL
Figuring all the Angles (½)
Compass Cards + Protractor?
Reallotment
2D
3D
Made to M
VOL
TOO MUCH TESSELLATIONS (1st half)
SECTION D → OUT
AREA OF CIRCLE
Packages & Polygons
VOL
NETS → HIGHER LEVEL
TOO MUCH EULER, NOT ENOUGH 3D
Triangles & Beyond
PYTH
CONGRUENCE ?
ICT
Looking at an Angle
PYTH
Triangles & Patchwork
SIMILARITY
W+G?
CLOSER
CLASSIF. ANGLES

C. In this situation there is almost an algorithm: you need to cluster, literally, the standards into clusters. Each cluster will become a module, if the designer is up to his task. There is no outside 'guidance'. You are part in the production chain.

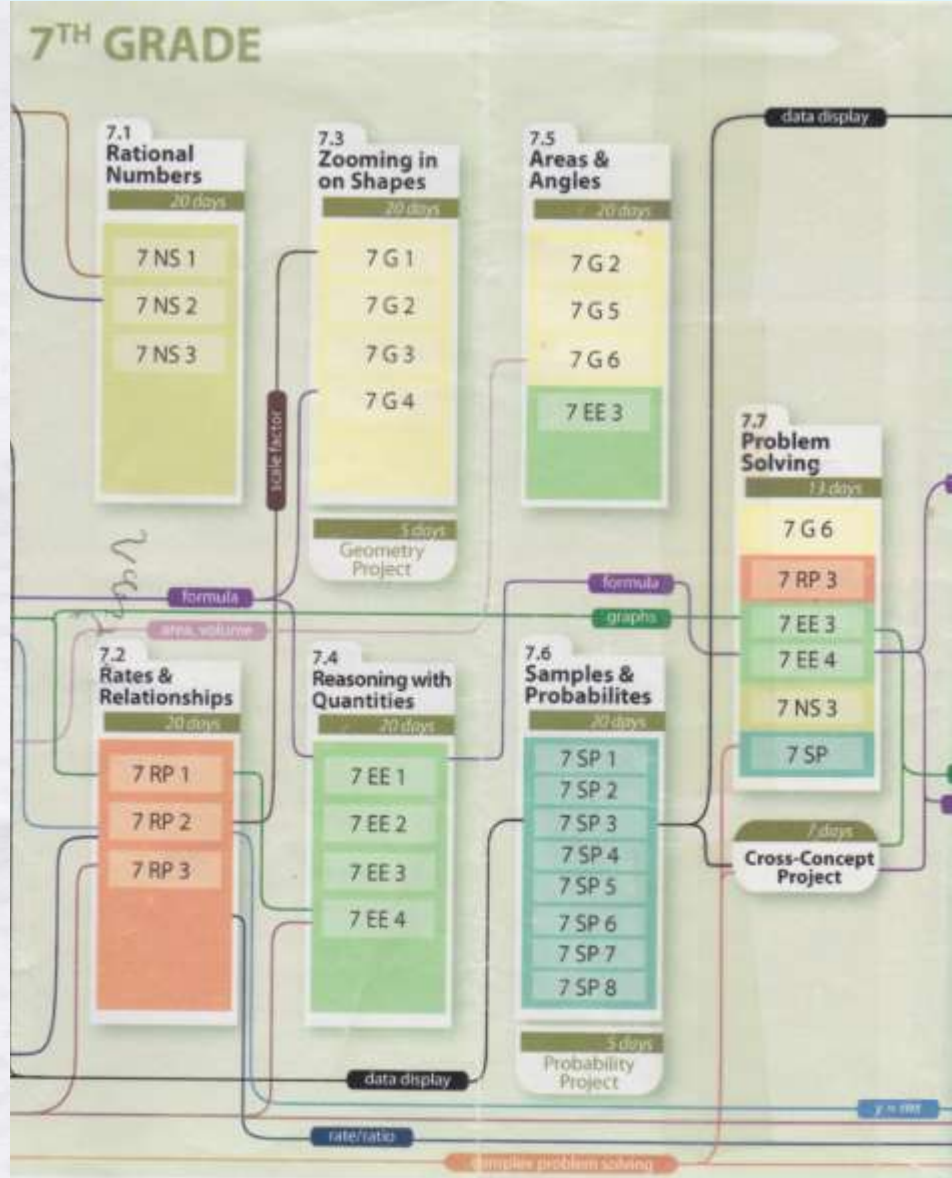
Expressions and Equations 7.EE

Use properties of operations to generate equivalent expressions.

1. Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.
2. Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. *For example, $a + 0.05a = 1.05a$ means that "increase by 5%" is the same as "multiply by 1.05."*

Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

3. Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.*
4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.
   a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. *For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?*
   b. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. *For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.*



The pictures look very similar. But they are not similar at all. The connecting lines are very different in ‘authenticity’.

A golden rule: make sure that for every module or unit there is a real challenging ‘gem’ for the students. A ‘gem’ that addresses the core concept of the curriculum. Challenges for the designer are abundant in scenario C.

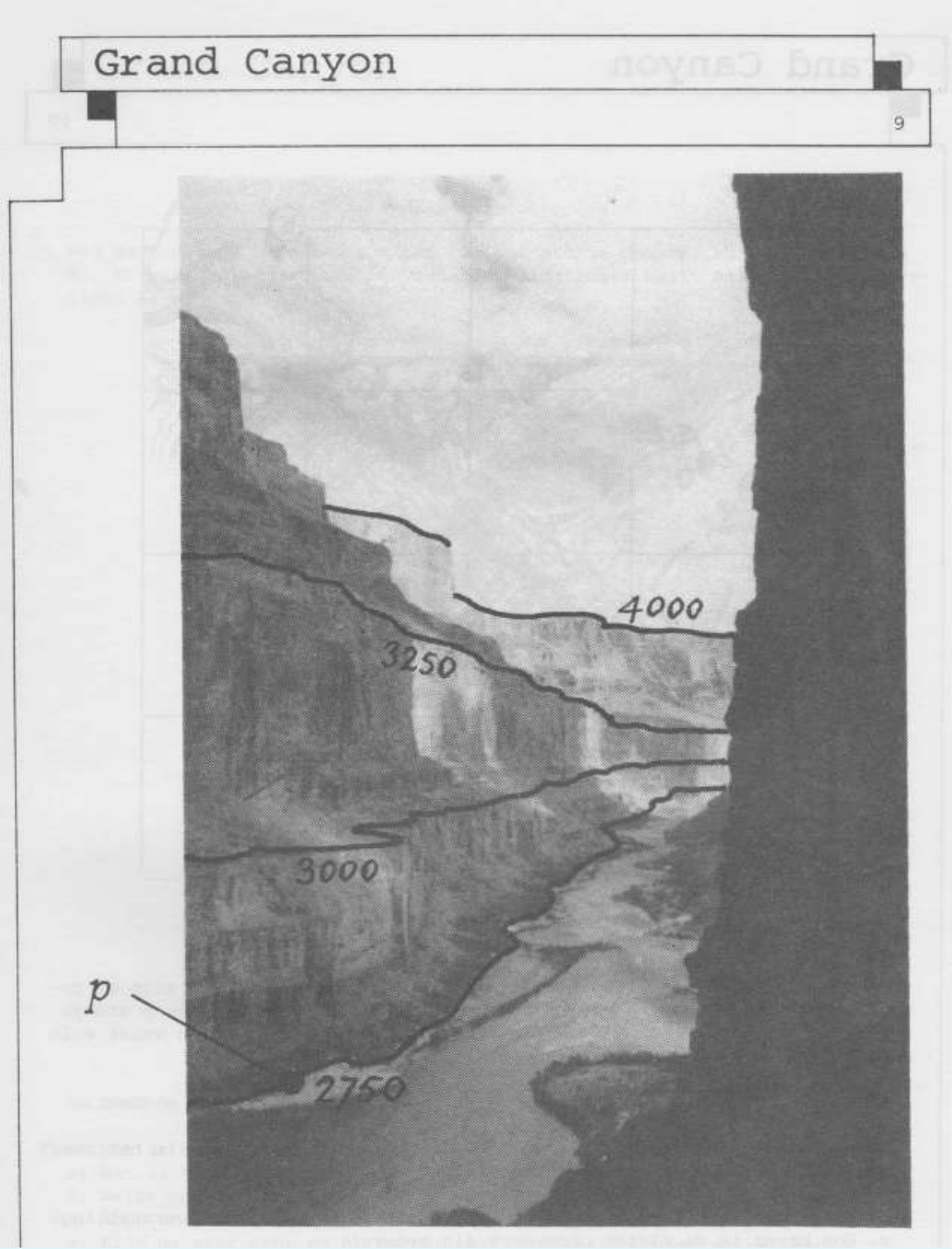
HINTS

for

YOUNG DESIGNERS

Hints for Young Designers in Math Education

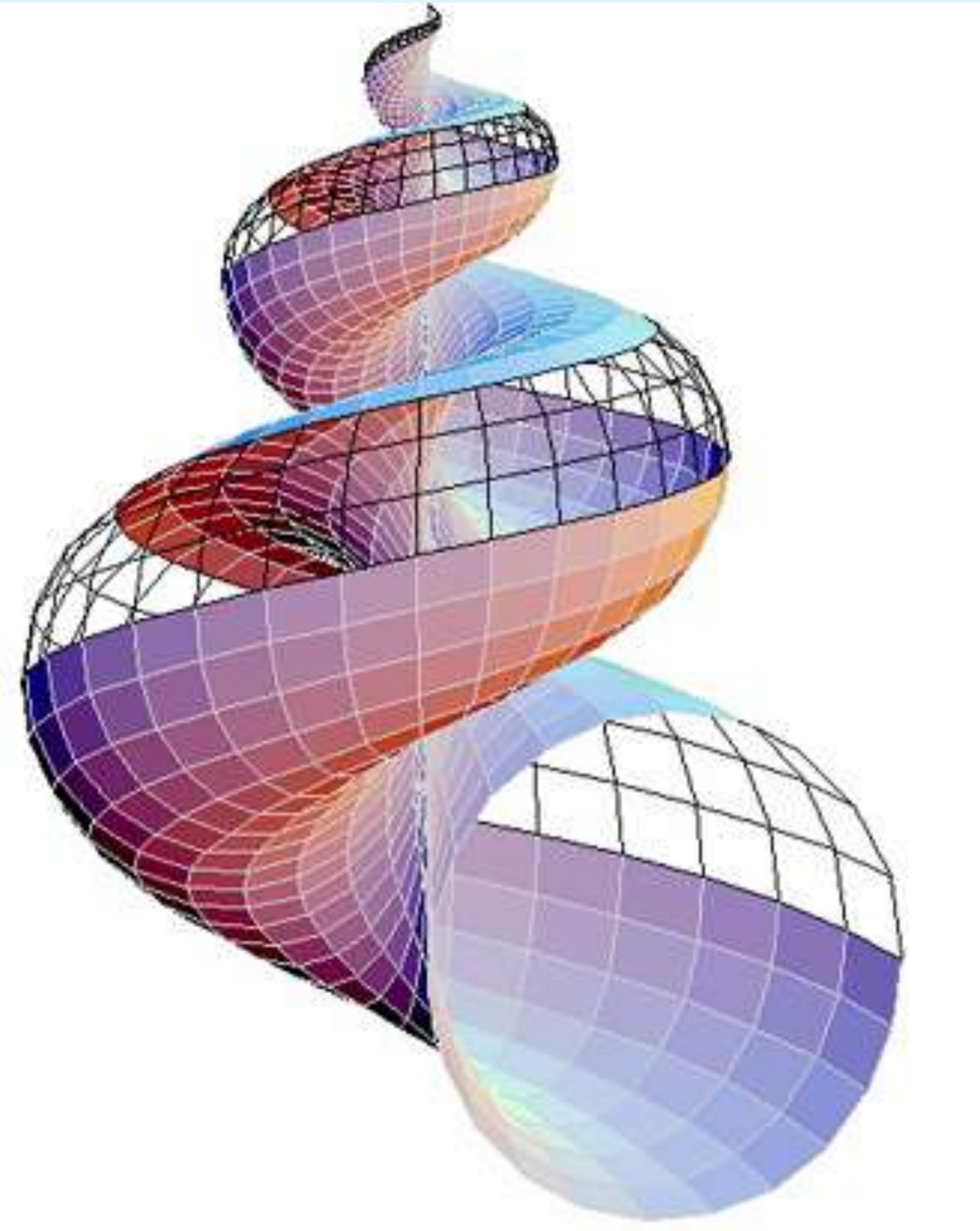
1. Ask yourself: if you have a teaching background: did you teach to the book or where you 'designing' the actual lesson?
2. If you are asked to design: choose your first subject carefully: choose a obscure concept: functions of two variables for 16 year olds or so; have experienced an event that shed new light on this subject; for instance: a visit to the Grand Canyon.



3. If 2 was successful (if not you better look out for a more research oriented job), choose as your next subject your less favourite subject at school (like logarithms or so). Start to love understanding the concept: if so, you might actually design something useful.

4.Insist on slow design whenever you can. Use the argument that you are doing developmental design research including the latest results of cognitive science and brain research.

5. Use your strategic design intuition as much as possible: design is also art. But do not mention it too much, until you're very old.



6. Keep teaching in a classroom yourself, especially for two reasons:
Makes you really feel for what is possible.
Keep your feet in reality (the mud)
7. Do not think primarily about writing articles for refereed journals; think of the students in the classrooms.
8. Accept Standards if you have to, but try to find the degrees of freedom.
9. Take initiatives for Free Design: it can be very rewarding. Especially for the students.
10. Try to reflect on your practices: it may be very helpful for everyone in the process. I failed in that respect. This is actually my first reflection ever. And my feeling:

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probably,
no need
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