The Cornerstones in Engineering Education have been moved

- Curricula at the Engineering schools around the world are based on an assumption on what an engineer does. The curriculum should prepare the person for coming engineering tasks. So what is an engineer and what does he/she do? Some official definitions read like this:

Engineers apply the theories and principles of science and mathematics to research and develop economical solutions to technical problems

or

Engineering is about the application of mathematics and science to those practical ends which affect our daily lives.

Changes in engineering practice that should have affected the Engineering education

From

- The slide rule
- From the lonely ingenious inventor
- Slow development of technology
- Technological solutions, cut and try, and individual planning

To

- ✓ The integrated design support systems
- ✓ The talented team player
- ✓ Technology development “at the speed of light”
- ✓ Customer focused engineering, rigorous design, and strict toll-gated processes

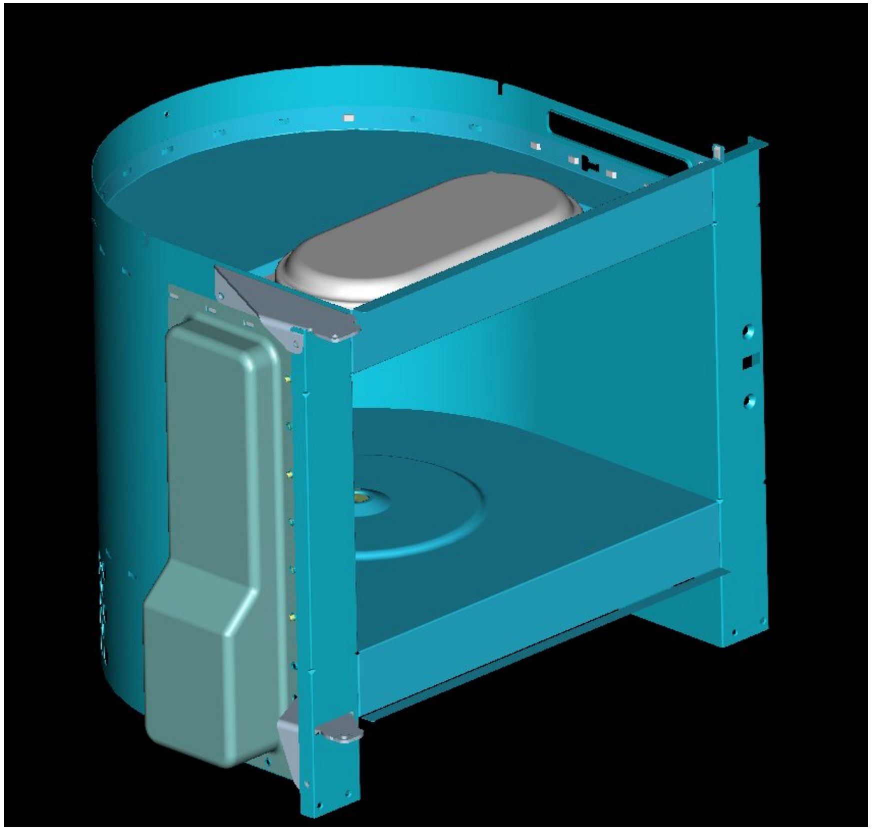
From the slide rule to integrated design support systems

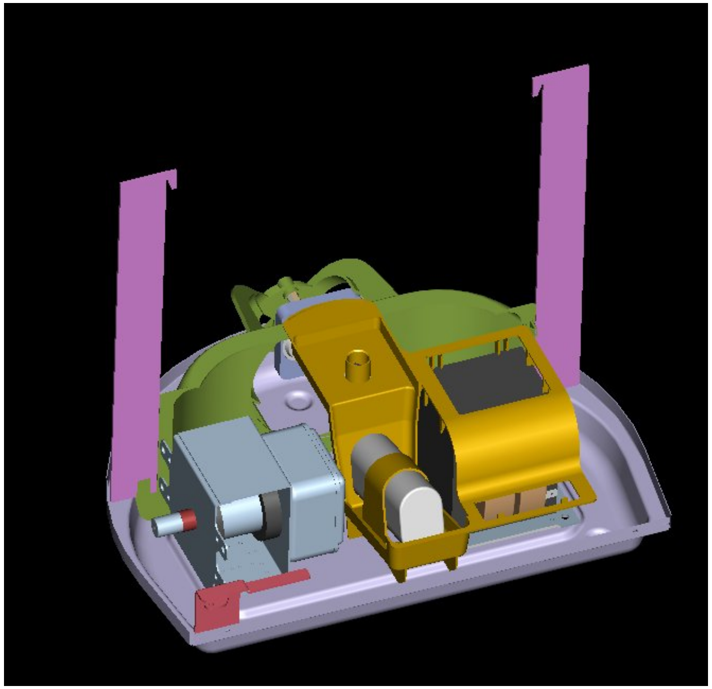
- One generation ago, engineers were trained to use slide rule, five-place mathematical tables and engineering handbook to determine appropriate choice of components in a system design context. The design of buildings, bridges, cars, amplifiers, computers, etc. were typical tasks for an engineer, and for each component, the numerical values had to be determined by means of formulas and principles. Most of the calculations had to be repeated for each, bridge, building, car, amplifier etc. Today such things are totally automated. Tools like AutoCad, MatLab, PSpice, and LabView, have enabled the design and development engineer to work at a higher level. To define system structures and leave the detailed calculations to the computer tools. Despite this, at most places the math courses in engineering curricula have been mainly unchanged, and so have the basic courses in electronics, solid mechanics, and programming (even if new programming languages are used in the latter case).

? Can the computer systems be used to support the development of understanding at a higher level, or do the basic courses still have be bottom-up, and contain all the traditional steps?
Are the traditional courses in math there because of tradition only, or are they really there because they are supporting the development of analytical thinking and basic reasoning?

? Should the amount of mathematics in the curriculum be reduced and replaced by for example, philosophy, logic or something else

Cavity/Chassis





From the lonely ingenious inventor to the talented team player

- Today situations and systems are so complex that understanding from many persons with a diversity of backgrounds need to be combined to find the best solutions. Often, there is initially no precise definition of the problem to solve and no simple criteria for the solutions. The ability to communicate with persons from different disciplines and with different cultural backgrounds is as important as is the individual brilliance and expertise. The widened scope is not only applicable to the finding of the solutions. In the global market it may be difficult for a mono-ethnic or mono-national development team to understand the problem, or the customer needs and expectations in general.
- The need for high speed in engineering work is driving in same direction.
- Fragmentation of the total engineering task is the consequence.
- The need for coordination of the total work has increased considerably and asks for new skills from all team members,
  - Skill to describe own job
  - Skill to communicate
  - Skill to understand interdependences and interfaces

? Is there any reason to believe that "the lonely ingenious inventor" is normally not also "the talented team player**"?**

? Are these skills developed at the engineering schools?

? Is the movement from individual understanding to shared understanding reflected in the curriculum?

From slow development of technology to development "at the speed of light"

- If the situation is the same from generation to generation, it may be natural to think of schools as the place where the accumulated knowledge and experience is conveyed from one generation to the next one, and that is what is needed during the rest of the life. Major technology and paradigm shifts have occurred in history many times. If such shifts occur seldom such that the lifetimes of methods, models and tool usage are hundreds or thousands of years, the basic model is still useful. If significant shifts take place several times during the lifetime of the person, the capability to discover and manage the transitions may be more important than the capability to manage stepwise refinements of existing methods.

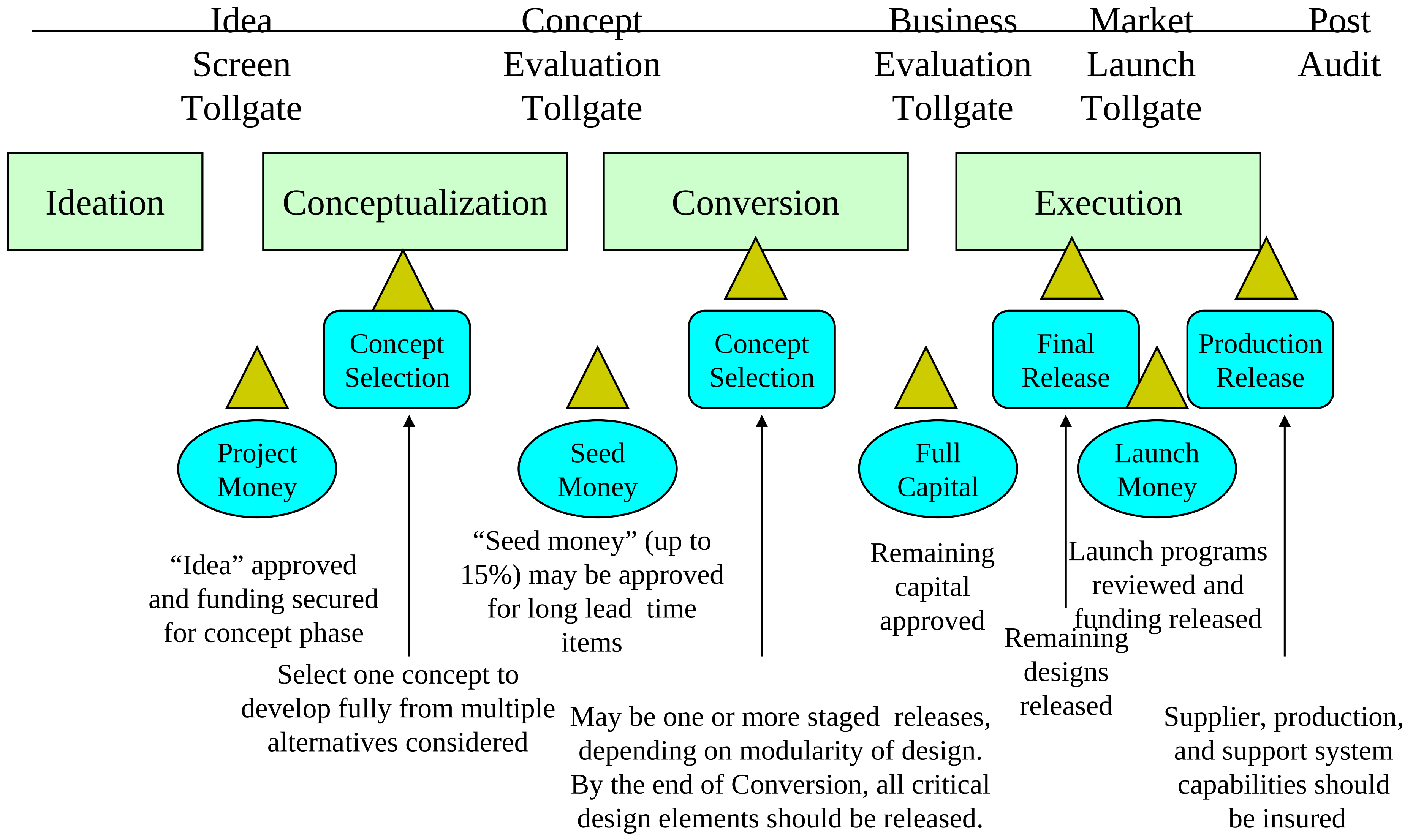
? How much of the models, concepts, methods and tools used by a professional engineer today were known 20 years ago? Five years ago?
Consider mechanical engineering, chemical engineering, bio-engineering, electrical engineering, software engineering, and civil engineering.

From technology solutions, cut and try, and individual planning to Customer focused engineering, rigorous design, and strict toll-gated processes

- The development projects of today have to be on time and deliver excellent financial result. Unique and valued customer solutions will make the customers loyal to the company.
- The engineer needs to know more than technology and above all understand the customer language, methodologies and tools and know how to translate needs into requirements on the new product.
- The engineer needs to ensure that his part of the system works as planned long before he/she has a chance to test it in the complete product and must master the methodologies and tools for challenge the design, like
  - Variation Reduction, Design Optimization; Y=f(x) , Engineering physics of design , FMEA, Engineering Simulations…
- The new requirement: "Sufficient time equals given time" is frustrating for many engineers but it can not be neglected due to heavy competition everywhere. The strict toll-gated processes help the designer and management to assure delivery on time.

? Are the engineering students being prepared for these challenges at the engineering schools?

From individual planning to tollgate process



Please work on the following three questions

1. Do you agree to the presented movements and the facts supporting them?
2. Which movements do you miss from the list?
3. How can the curriculum change/has been changed to support the new cornerstones?