Towards Competence based Portfolio

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Outline

- ◆ Challenges in educating future IT engineers
  - – Change in competence recuirements
  - – "An engineer meets a human"
  - – From technical substance to the other substances
  - – Multicultural and multidisciplinary co-operation
- ◆ M.Sc in IT Engineering education at University of Turku
  - – Learning outcome approach for building M.Sc education
    - » From course centric to degree and module centric approach
  - – Our process towards our multidisciplinary implementation of CDIO
  - – Programme structure and integrated learning
- ◆ The other substances as a part of student competence portofolio
  - – Working life readiness and co-operation skills
  - – Human element as a part of engineering process in IT
    - » Case study: Information security
  - – Thematic competencies
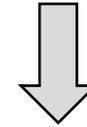
Challenges in Education

Only part of learning is easily "visible"

Wide competence engineer

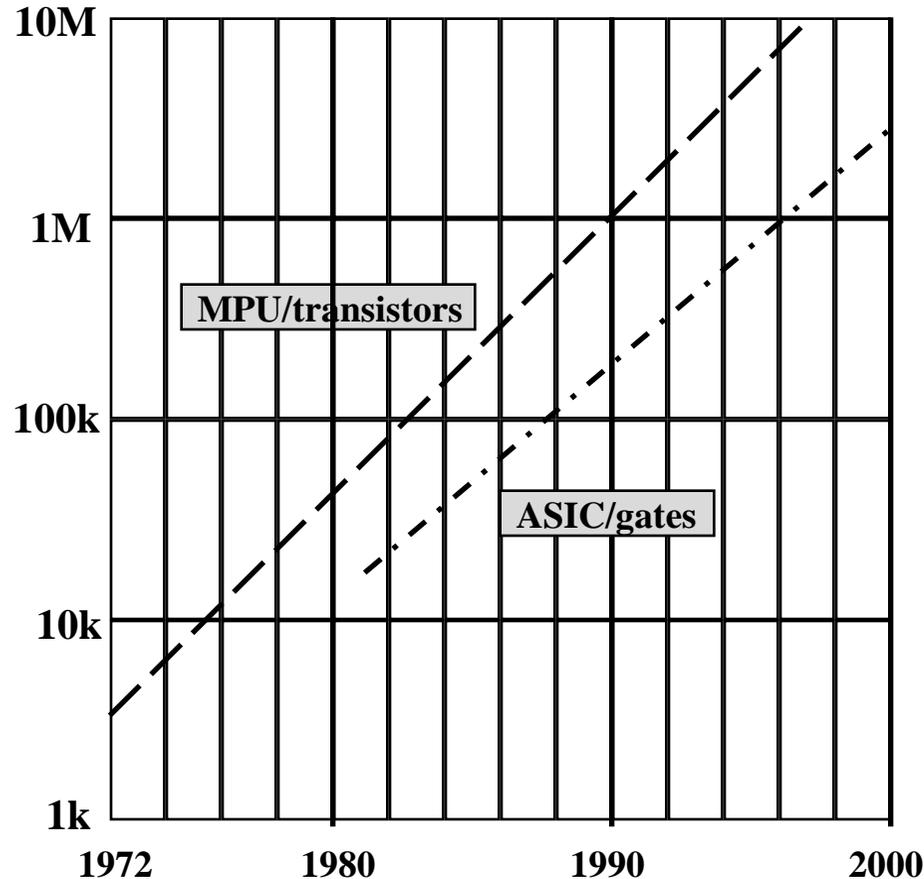⬇
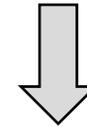
Highly profiled expert

⬇

System engineer with multicultural and multidisciplinary challenges
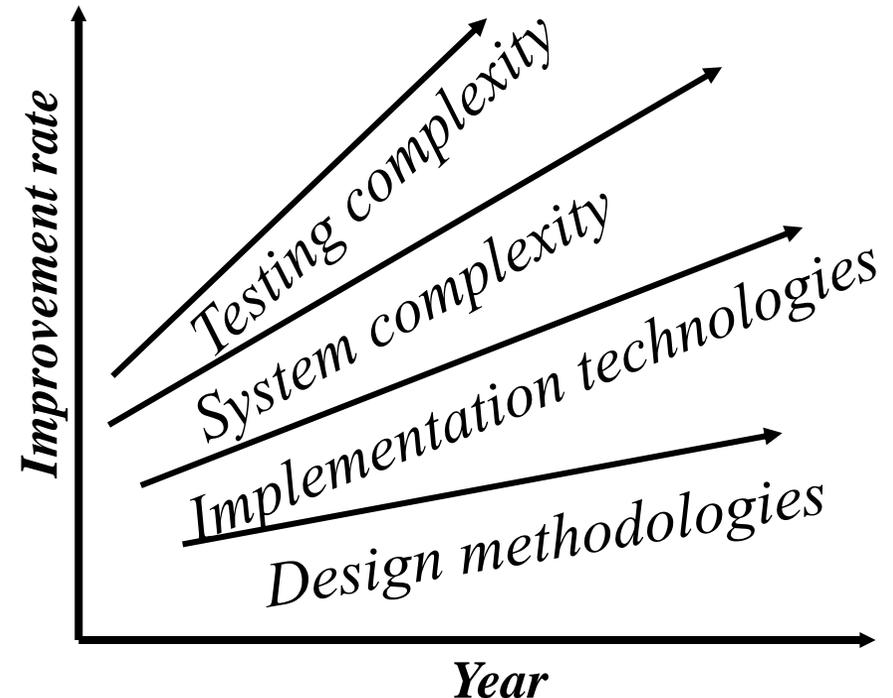
Trends in Electronics Technology

Circuit Capacity

◆ **Moore's law**: Integrated Circuit (IC) capacity doubles approximately every 18 months

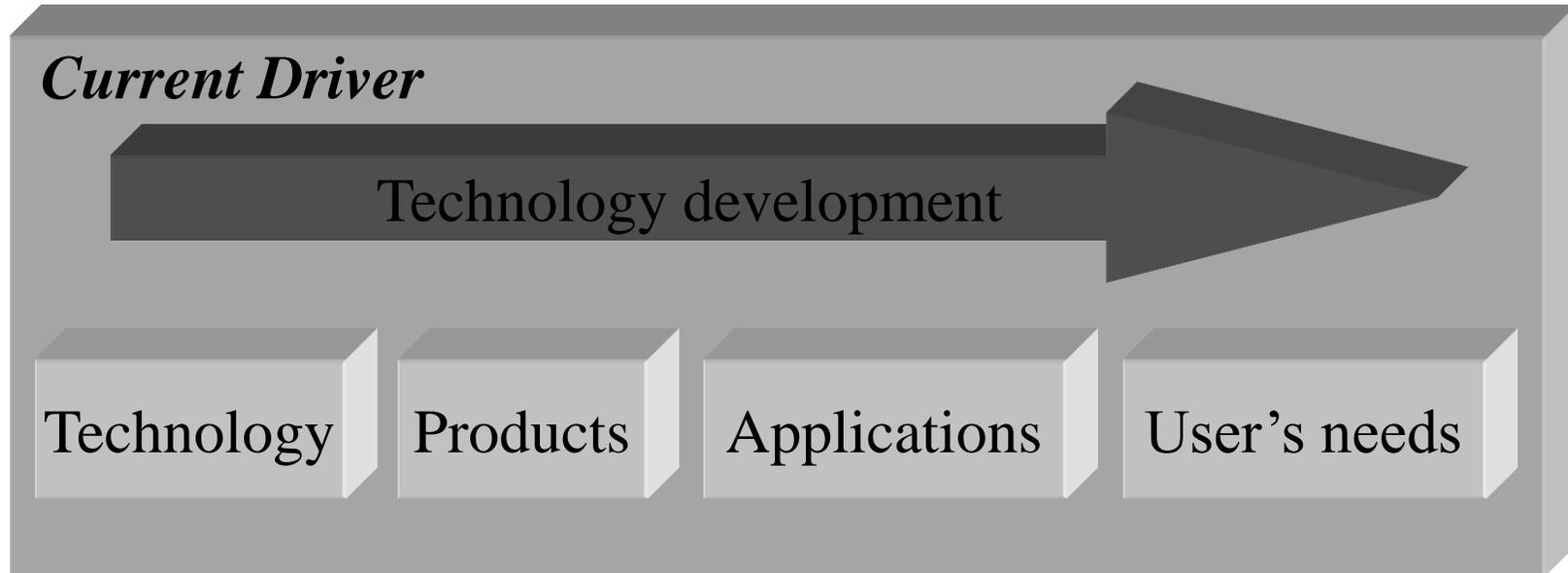## Design Problematics

◆ Life-time of products and standards are shortening

◆ System and testing complexity is increasing

◆ Price level is quite "fixed" (e.g. PC's, IC's, mobile phones)

Integration of Development Drivers

Current Driver

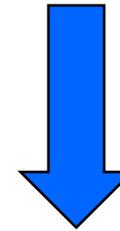Technology development

| Technology | Products | Applications | User's needs |

User's needs / applications

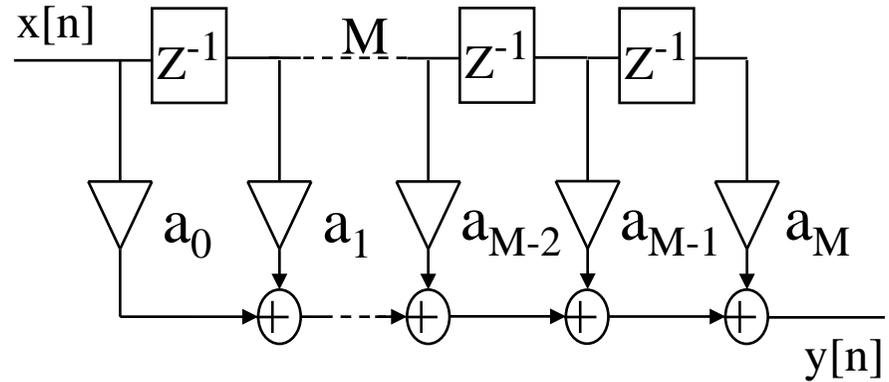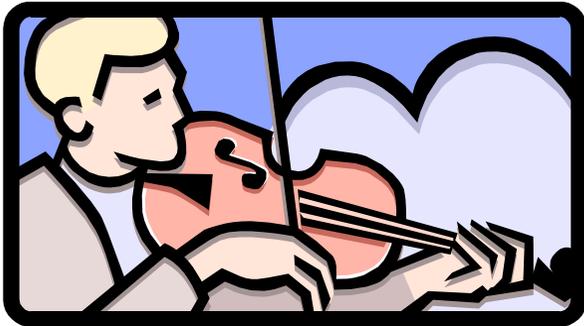**???**

Multimodal Interfaces

Everything Cannot Be Measured

$x[n]$ ... Z^{-1} ... M ... Z^{-1} ... Z^{-1}

a_0 a_1 a_{M-2} a_{M-1} a_M

$y[n]$

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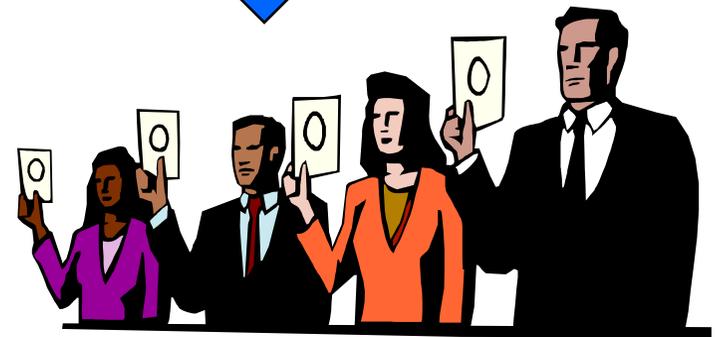
Human Element (An Engineer meets A Human)
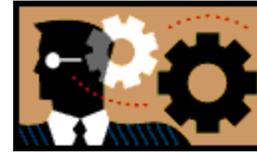
Learning Outcome Approach for Building M.Sc Education
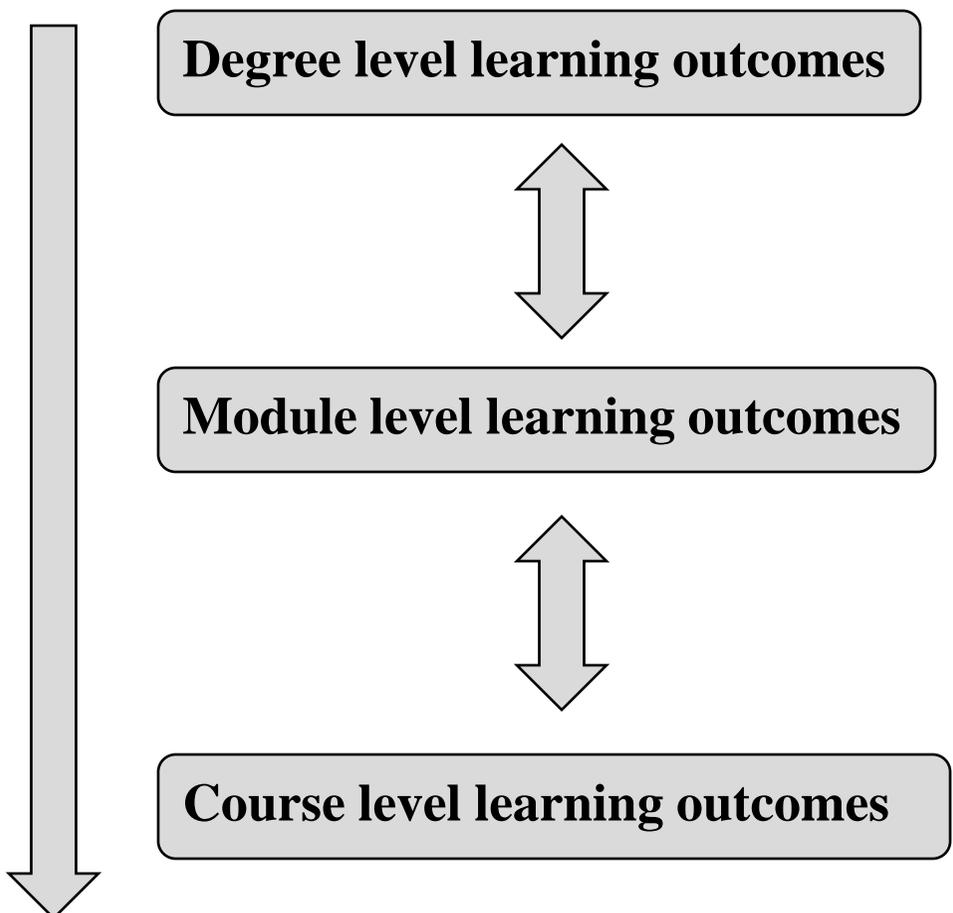
Degree level learning outcomes

- Is able to work in a responsible position as a part of a multicultural group (M.Sc)
- Is able to identify, formulate and solve simple engineering problems in IT (B.Sc)

Module level learning outcomes

- Can specify and design the communication and information security solutions for relevant applications (M.Sc)
- Is able to work in a multicultural environment in English with an understanding of various cultures, practices and manners (B.Sc)

Course level learning outcomes

- Is able to specify systems so that the information security risks arising from human activity are minimized (M.Sc)
- Understanding of Shannon's information theory and its implications. (B.Sc)

UTU IT Engineering Education 2012

Thematic Profiles 20 ECTS

Health Technology

Game and Educational Technology

Global Information Society

Master's thesis 30 ECTS

Capstone project & related courses 30 ECTS

Major 30 ECTS — Software Engineering

Major 30 ECTS — Communication Systems

Major 30 ECTS — Embedded Electronics

Management of Technology

Working life readiness 10 ECTS
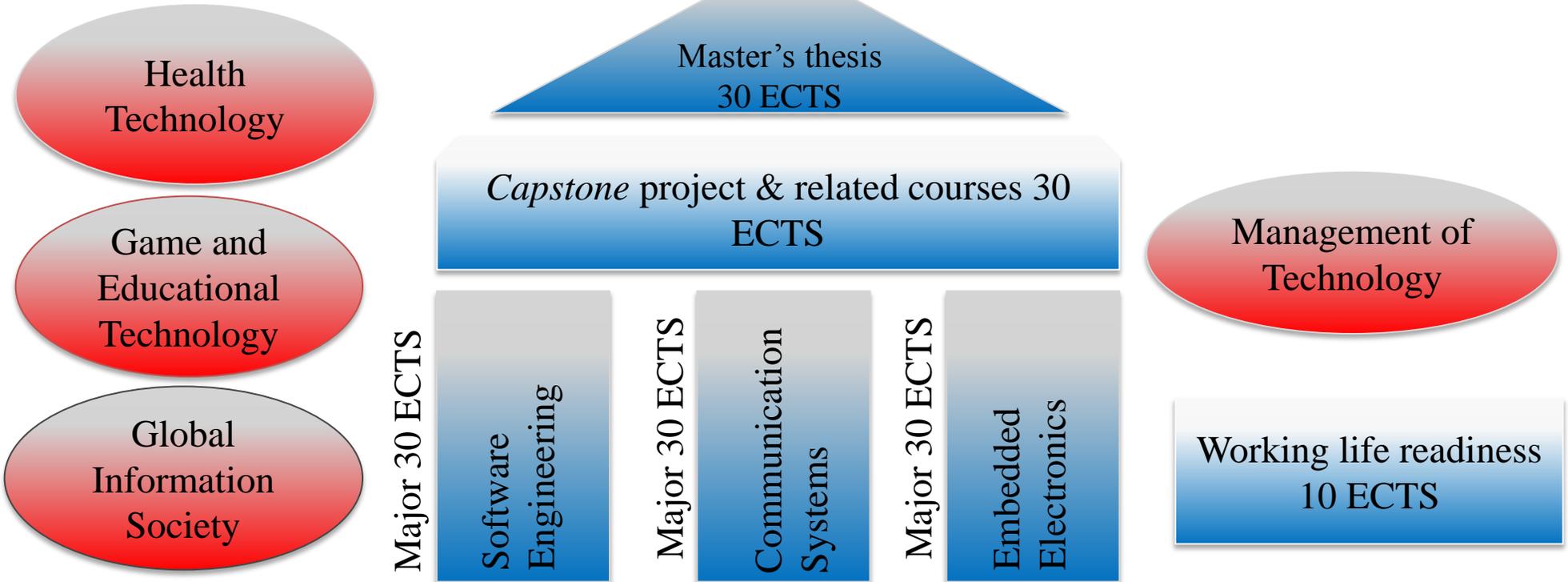
Bachelor studies 180 ECTS:
- Polytechnic basic studies + languages 100 ECTS
- Major + BSc thesis 50 ECTS
- Minor 20 ECTS (e.g. Science, Business, Humanities,…)
- Working life readiness 10 ECTS

Integrated Learning

Working-life readiness

Natural sciences	Language & cultures

Minor studies

IT basics

Basic theories

Major studies -Software engineering -Embedded electronics -Communication systems -Project

B.Sc thesis
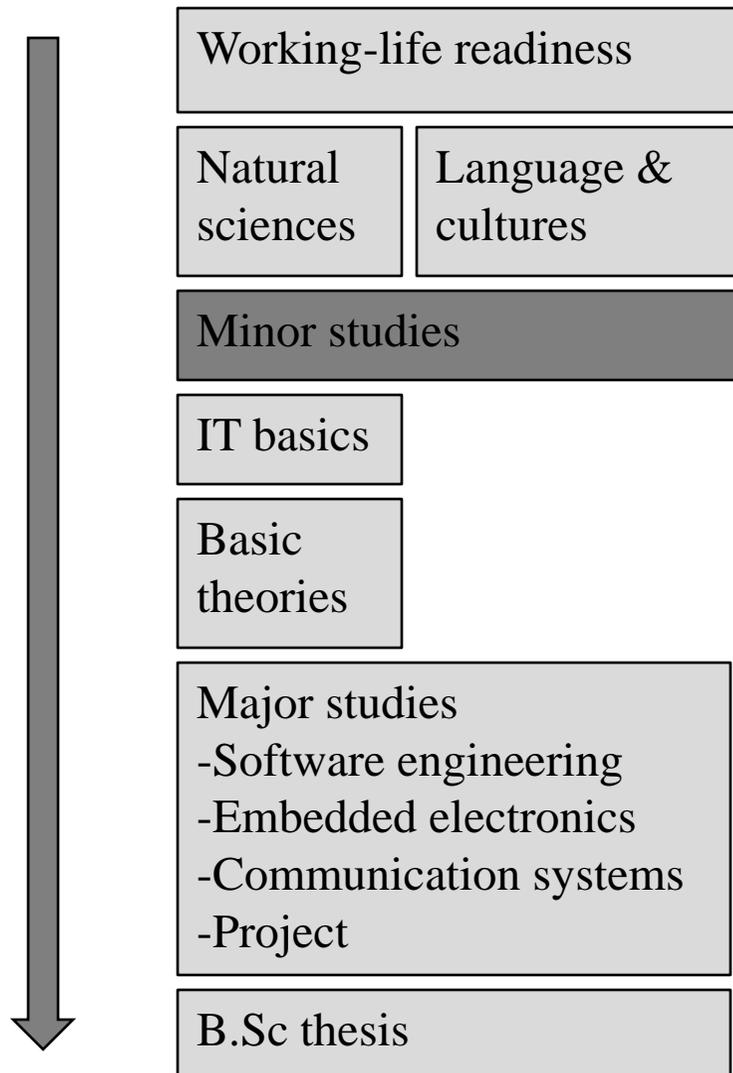
- ◆ Learning is not a course wide issue, it's a coherent process through the curricula
- ◆ Learning is not only technical issues
- ◆ Example items for integrated learning

1. Development of portfolio
2. Engineering processes
3. Interpersonal skills
4. Mathematics

Towards Multidisciplinary Engineering Education

- Utiliziling CDIO (Conceive – Design – Implement – Operate) thinking towards multidisciplinary IT engineering curricula
  - The CDIO™ INITIATIVE is an innovative educational framework for producing the next generation of engineers.
  - It provides a framework of their curricular planning and outcome-based assessment. [http://www.cdio.org]
- One year process for the complete change in curricula
  - Process started Aug. 2011, renewed education starts Sept. 2012
- The key password "An Engineer Meets A Human"
- 5 working groups (all teachers included)
  - IT core competences
  - Strategic thematic profiles
  - Working-life readiness
  - CDIO
  - Study plan
- Strategic partnerships within University of Turku and other universities (KTH and Fudan)
- Capstone implementations together with business, industry and other societal key actors

Working-life Readiness (1)

- Communication skills and using IT

- Interpersonal skills: Distinct skills needed to effectively communicate and develop successful interpersonal relationships (work-related and personal)

- Might look like a simple thing at the first glance, but actually much of this is learned at work; nowadays it may take up to two years for a recently graduated employee to get all the skills needed to be really productive.

- This time naturally includes the substance-knowledge needed in the specific firm

- There is a huge difference between students who have working-experience and the ones that do not have this advantage; this should be recognized in the studies (case: "Human Element in Information Security")

- Interpersonal skills are integrated in the courses as working-methods; courses are developed in a way that the working is as close as possible to the real working-life.

- Starting working in a small native groups towards working in a multidisciplinary, international, demanding and organized projects

- This includes understanding the roles in a group (those taken naturally or given by the organization): which is the most natural for oneself for ex.

- Management skills

Working-life Readiness (2)

♦ One example of an interpersonal list of skills:

- **Look**: People give us a wealth of information as we engage in an interpersonal encounter; first impressions, facial expressions, body language etc. To skills to consistently look for this information

- **Listen**: provides critical information; missing one piece may change the perception

- **Ask**: Open ended questions; utilizing opportunity to extract even more information

- **Learn**: Processing the information quickly

- **Understand**: The information must be applied to the individual / group engaged with

- **Acknowledge**: Critical to really understand the needs of the individual / group

- **Identify**: Skills to see where one can provide value; the skills to see if and when there is an opportunity for the other/s to bring value to you

- **Commit**: Only by making commitment to effective interpersonal communication will you achieve results. Commitment is value to all of us

- **Contribute**: Mutually beneficial relationships are successful

- **Follow Up**: Do what you say; builds trust

Human Element (Case Study) (1)

◆ How to acknowledge different people in information security (and the applications in general)

◆ How will these differences affect the security

◆ Should there be developed some kind of monitoring systems?

◆ What are the differences: normal and abnormal human behavior (for ex.)

- Normal differences in personalities; traits (using personality test to demonstrate these underlying, basic traits: PRF) humans make errors by nature, are careless..

- "The Physical Layer of Differences" = Brain Plasticity

- Abnormal behaviors: Mood Disorders, Personality Disorders (for ex. Anti-social personality is prone to commit crimes), Neuropsychiatric disorders (ADHD; Asperger)

- Teenage behaviors; Social Media

- Conditions causing dementia, Alzheimers used an example; the elderly are a proportionally growing population in Finland, and the amount of people suffering from these conditions is growing. They should be able to function in the IT-society as long as possible. This is a challenging task for the engineers.

Human Element (Case Study) (2)

- 1. Individual task, 2. Lecture, 3. Group task 4. Group meeting 5. Individual interviews

- In the beginning some of the students wondered what this has to do with anything, but then said it had been a real "eye-opener" for them. In general engineer students think only the technology, not the humans who end up using the products and applications..

- In real life engineers should develop things for humans, not only for other engineers.

- Information Security consists of three elements:
  - Technology
  - Processes in the organization in question
  - Human behavior

- Students with working experience had a great deal of understanding, knowledge and real-life examples in human behaviors in IT. This should be recognized and assessed, tools will be developed

Thematic Competences

- ◆ IT is problem based methodology development
  - – IT at UTU: technology (software engineering, embedded electronics and communication systems) and natural sciences (algoritmics, intellicent systems, and bio/health informatics)

Natural sciences
Health sciences
Human sciences

Societal relevance

Basic and applied research

Society
Industry
Economy

- ◆ Now we have focused our IT engineering education to strategic focus areas at University of Turku, but in principle thematic area can be everything where IT development is needed
  - – Students have plenty of possibilities to create a unique competence portfolio
  - – Minor / B.Sc (20 ECTS), Thematic profile / M.Sc (20 ECTS) and part of capstone (0-30 ECTS)
- ◆ The target is also to help in mapping University of Turku to IT society