Stakeholder meeting

CHEM

23.09.2022

Aalto University
School of Chemical Engineering

Agenda

12:00 – 12:30 Lunch and networking

12:30 – 13:00 Introductions and summary of the objectives

13:00 – 14:30 Working in stakeholder groupings

1 The future of the industry from your point of view

2 Future skillsets and core competencies

14:30 – 14:45 Coffee break

14:45 – 15:15 Presenting a summary of workshop remarks/outcomes

15:15 – 15:30 Your feedback and conclusion of the event

Introductions: Clusters

- Biomass refining and advanced lignocellulosic materials
- Molecular bioscience and Industrial biotechnology
- **Chemical engineering and circular processes (CMET)**
- **Chemistry for renewable energy and functional materials (CMAT)**

Introductions: People

- Industry representatives;
- Heads of Departments;
- Heads of Programmes and Majors;
- Cluster Leaders;
- Student (Guild) representatives;
- Learning Services (Planning Officers and Pedagogic Specialists);
- Other members of personnel following conversations via Zoom

CHEM Portfolio renewal

- **Rationale**
- **Findings so far (summary of in-house and stakeholder contributions)**
- **Objectives for the day:**
    - Identifying business/industry sector of the future;
    - Mapping skills sets and core competencies of the future;
    - Other industry feedback
- **First student intake for revised curricula in 2024**

Rationale - Why?

- Clearer portfolio and programme profiles and differentiation within the portfolio (conclusion from TEE 2020 evaluation)
- Increasing size of student cohorts affects the master programmes and majors in 2024. The resourcing (personell and space) must be well planned by that.
- Need to use teaching resources more efficiently and scale up when possible the number of participants in courses. Teacher workload uneven.
- Role of minors in portfolio is unclear

Master’s portfolio renewal goals

Applicants

Clear and attractive view for applicants to studies and future work opportunities

Number 1 choice in Chemical Engineering

Educational offering is understood nationally and internationally

Students

Clear and understandable study paths

Clear view and support on the employment opportunities

Flow of studies

Teachers

Workload

Synergy

Managing growing student numbers

More clear and transparent processes and leadership structures

Stakeholder

Future workers

Necessary skills, knowledge and competences

Educational offering is understood nationally and internationally

Competencies for future engineers

1. Disciplinary knowledge	
1.1	know ledge
1.2	core engineering fundamental know ledge
1.3	advanced engineering know ledge, methods, tools

2. Personal and professional skills and attitudes	
2.1	Analytical reasoning and problem solving
2.2	Experimentation, investigation and know ledge discovery
2.3	Systems thinking
2.4	Attitudes, thoughts and learning
2.5	Ethics, equity

3. Interpersonal skills: Teamwork and communication	
3.1	Teamw ork
3.2	Communication

4. CDIO in the enterprise, societal and environmental context	
4.1	External, societal, and environmental context
4.2	Entreprise and business context
4.3	Conceiving, systems engineering and management
4.4	Designing
4.5	Implementing
4.6	Operating
4.7	Leading engineering endeavors
4.8	Entrepreneurship

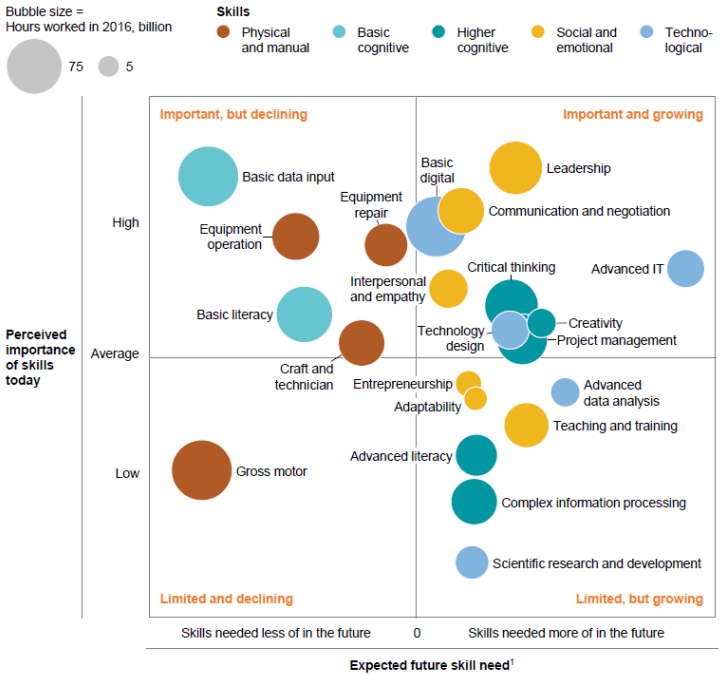
2.1 ANALYTICAL REASONING AND PROBLEM SOLVING
2.1.1 Problem Identification and Formulation
Data and symptoms
Assumptions and sources of bias
Issue prioritization in context of overall goals
A plan of attack (incorporating model, analytical and numerical solutions, qualitative analysis, experimentation and consideration of uncertainty)
2.1.2 Modeling
2.1.3 Estimation and Qualitative Analysis
2.1.4 Analysis With Uncertainty
2.1.5 Solution and Recommendation

CDIO Syllabus v2.0

An Updated Statement of Goals for Engineering Education

Members: e.g. DTU, KTH, NTNU, RWTH Achen, Delft Tech. U., U. Turku, TAMK, Metropolia,…

Skills of today vs skills of tomorrow:



Four specific groups of skills stand out.

- leadership
- advanced communication
- advanced IT and programming
- critical-thinking skills

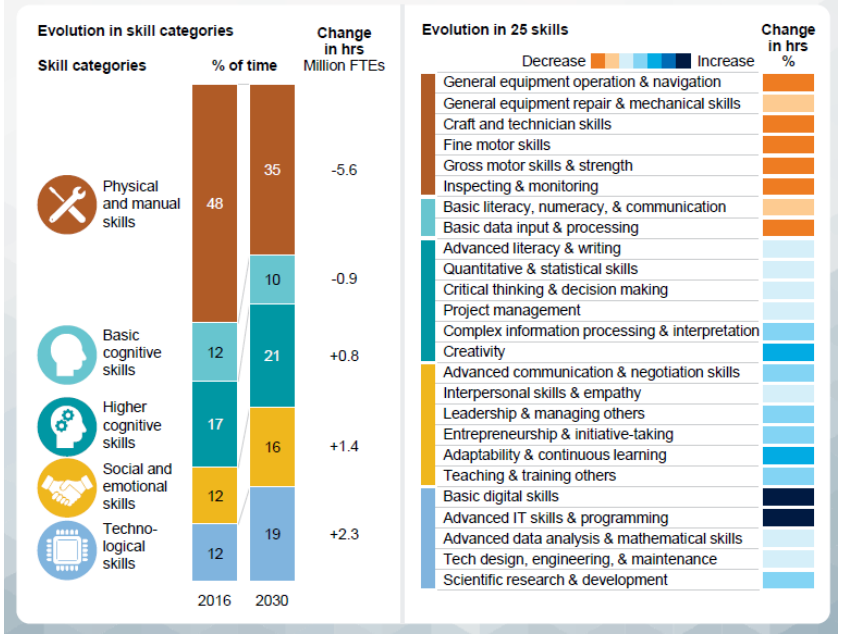
skills that are ranked as less important today but growing strongly in the future:

- advanced data analysis,
- complex information processing,
- adaptability
- teaching and training

Aalto University
School of Chemical Engineering

McKinsey Global Institute

Estimated skill shifts by 2030 in the manufacturing sector



McKinsey Global Institute

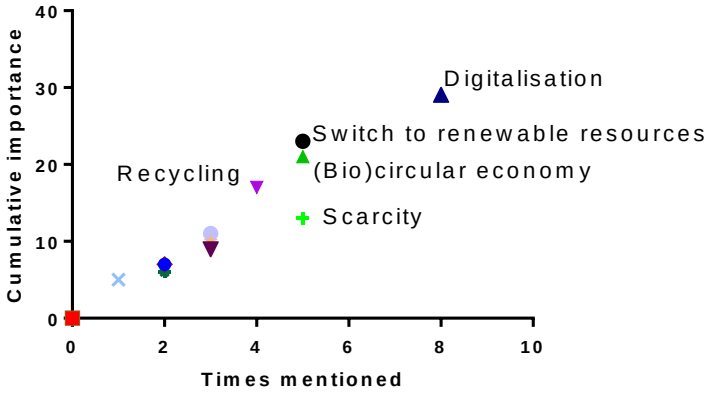
wave of automation and AI in manufacturing will continue to disrupt production functions in factories through better analytics, predictive maintenance, and increased human-machine collaboration.

AI will also have an impact on product development and on marketing and sales.

need for social-emotional and higher cognitive skills, such as communication and negotiation, adaptability and continuous learning, and leadership.

need for technological skills will also increase, both for advanced IT skills for technology professionals and basic digital skills

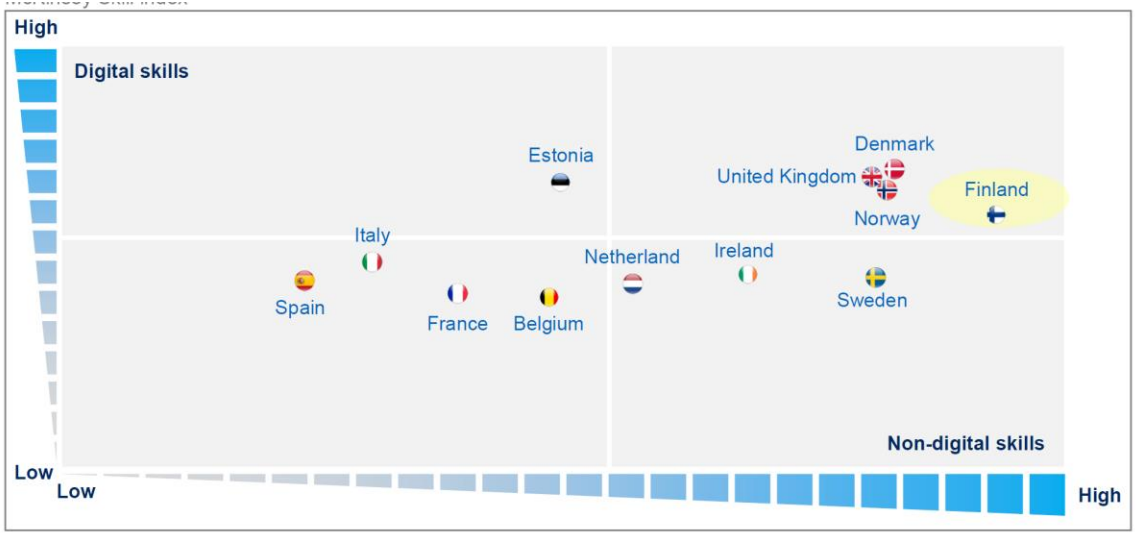
5 most significant changes that are likely to happen within (your field of) chemical engineering by 2035



- Biotechnological processes will partially replace chemical processes
- Biotechnological processes will be used in food production
- Substituting fossile-based with renewable ones using sustainable energy sources
- Utilisation of novel organisms as hosts
- (Bio)Circular economy and reusing/recycling
- Digitalisation will develop further, incl. automatisation, AI, machine learning, simulation…
- Recycling of increasingly complex material combinations
- Computational methods and numerical modeling will become increasingly important
- Processes for upgrading of "more difficult" feedstocks (e.g. biowaste)
- Energy storage and conversion
- Electrification of chemical industry, e.g. batteries, electrocatalysis
- Sustainability and responsibility will guide decision making
- Scarcity: having to make business with less resources or for a higher price
- Fragmentation of job market into small companies and entrepreneurs (start-ups)
- Other:
  - The circular economy of textiles
  - Deeper scientific and fabrication knowledge of chemistry is needed in order to fabricate smaller and smaller semiconductor devices
  - Regulations to reduce harmful chemicals

Aalto University
School of Chemical
Engineering

Skill gap – digital vs non-digital skills

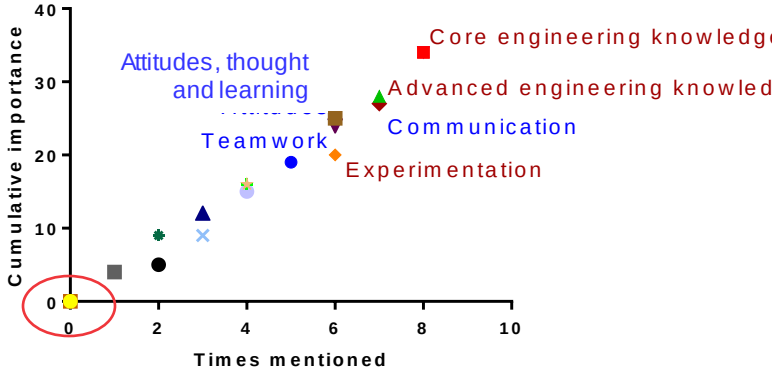


SOURCE: OECD; Eurostat; PIACC; CEDEFOP McKinsey analysis

Free-form answers: Future of field

1	• Replacing raw material base from fossils to more inhomogeneous biomaterials will have a huge change (capex investments, process engineering, R&D and competencies development) needs in our manufacturing sites and sourcing & operations. • Digitalization will develop further both at customer interphase and internally operations.
2	• Polarization of industrial actors related to climate change and sustainability. Some will be forerunners and some tries to survive with old way.
3	• Biggest obstacle for growth of Finnish MEMS industry is lack of talented engineers • Companies will need engineer with deep knowledge of their field + new skills etc. sustainability, AI, new materials • Environmental issues will become as important as performance of the device
4	• This affects to the industry as a whole, starting from sourcing of new biobased raw materials, ethics & compliance team to consider biodiversity, re-thinking manufacturing sites, R&D, new positioning & opportunities in value chain.
5	• Need for biomaterials and circulated materials will increase (customers) • Security of supply drives towards bio and circulated materials (regulation)
7	• Circular economy will considerably impact forest industry processes, products and business models • Substituting fossil-based products with wood-based products is driving new business development
8	• Circular economy will provide a lot of different opportunities for innovation • Transfer from fossil to renewable will necessitate also new business model thinking, in addition to research. • Digitalization is an opportunity, but also a challenge to get it incorporated successfully into the business cases. • Finding and engaging future oriented and broadly capable researchers has already become challenging. • Having highly skilled resources in small companies opens up new possibilities for collaboration.
9	• There might be more strict regulations to design products for easier recycling • Process automation based on AI and automatic data collection will become more important • Material modelling and simulation will develop to enable virtual prototyping • Rare metals and gases in sensor process will become more expensive and reduction of their consumption is needed • Some chemicals (e.g. containing fluorine) which are harmful for environment and humans may become forbidden

What kind of employees you will need to respond to these changes



LEADING ENGINEERING ENDEAVORS
Creating a Purposeful Vision
4.7.1 Identifying the Issue, Problem or Paradox
4.7.2 Thinking Creatively and Communicating Possibilities
4.7.3 Defining the Solution
4.7.4 Creating New Solution Concepts Delivering on the Vision
4.7.5 Building and Leading an Organization and Extended Organization
4.7.6 Planning and Managing a Project to Completion
4.7.7 Exercising Project/Solution Judgment and Critical Reasoning
4.7.8 Innovation – the Conception, Design and Introduction of New Goods and Services
4.7.9 Invention – the Development of New Devices, Materials or Processes that Enable New Goods and Services
4.7.10 Implementation and Operation – the Creation and Operation of the Goods and Services that will Deliver Value

Attitudes: Ethics, equity

ENTREPRENEURSHIP
4.8.1 Company Founding, Formulation, Leadership and Organization
4.8.2 Business Plan Development
4.8.3 Company Capitalization and Finances
4.8.4 Innovative Product Marketing
4.8.5 Conceiving Products and Services around New Technologies
4.8.6 The Innovation System, Networks, Infrastructure and Services
4.8.7 Building the Team and Initiating Engineering Processes
4.8.8 Managing Intellectual Property

Entrepreneurship

Aalto University
School of Chemical Engineering

Questionnaire based on the CDIO Syllabus v2.0
An Updated Statement of Goals for Engineering Education
Members: e.g. DTU, KTH, NTNU, RWTH Achen, Delft Tech. U., U. Turku, TAMK, Metropolia,…

Future of the industry from your point of view

Looking at the list of changes that many identified as important, please write on a post-it note:

- **Most significant for your industry in future (please select 1)**
- **Least significant for your industry in future (please select 1)**

Future challenges

- Biotechnological processes partially replacing chemical processes
- **(Bio)circular economy, reusing/recycling +2 (3)**
- Recycling of increasingly complex material combinations
- Upgrading of "more difficult" feedstocks
- Substitution of fossil fuels with sustainable energy sources
- **Digitalisation evolving furthe**r +7 (1)
- Computational methods and numerical modeling increasing their importance +3
- **Energy storage and conversion +2 (2)**
- Electrification of chemical industry +1
- Sustainability and responsibility guiding decision-making +1
- Operating with scarcity or higher prices +1

Particularly important skills in your field in future

-
-
-

Competences (skills, knowledge & attitudes) of ideal graduate in your field in 2035

-
-
-

Aalto University
School of Chemical Engineering

Future skillsets & core competencies 1

While looking at the list, please reflect on skills and competencies to address these issues.

Please write down:

- What skills will be needed most in future?

- Biotechnological processes partially replacing chemical processes
- **(Bio)circular economy, reusing/recycling +2 (3)**
- Recycling of increasingly complex material combinations
- Upgrading of "more difficult" feedstocks
- Substitution of fossil fuels with sustainable energy sources
- **Digitalisation evolving furthe**r +7 (1)
- Computational methods and numerical modeling increasing their importance +3
- **Energy storage and conversion +2 (2)**
- Electrification of chemical industry +1
- Sustainability and responsibility guiding decision-making +1
- Operating with scarcity or higher prices +1

Future challenges

- **Core disciplinary knowledge 3**
- **Core engineering fundamental knowledge 7**
- Advanced engineering knowledge, methods, tools 2
- **Analytical reasoning and problem solving 5**
- Experimentation, investigation and knowledge discovery 2
- Systems thinking 2
- Attitudes, thoughts and learning 1
- Ethics, equity
- Teamwork 1
- Communication 1
- External, societal & environmental context 2
- Entreprise and business context
- Conceiving, systems engineering & management
- Designing
- Implementing
- Operating
- Leading engineering endeavors 1
- Entrepreneurship

Particularly important skills in your field in future

-
-
-

Competences (skills, knowledge & attitudes) of ideal graduate in your field in 2035

Aalto University
School of Chemical Engineering

Future skillsets & core competencies 2

While looking at the two lists, imagine hiring a fresh chemical engineering graduate in 2035.

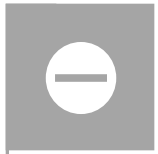
- What competences (skills, knowledge and attitudes) would an ideal candidate possess?

- Biotechnological processes partially replacing chemical processes
- (Bio)circular economy, reusing/recycling
- Recycling of increasingly complex material combinations
- Upgrading of "more difficult" feedstocks
- Substitution of fossil fuels with sustainable energy sources
- Digitalisation evolving further
- Computational methods and numerical modeling increasing their importance
- Energy storage and conversion
- Electrification of chemical industry
- Sustainability and responsibility guiding decision-making
- Operating with scarcity or higher prices

Future challenges

- Core disciplinary know ledge
- core engineering fundamental know ledge
- advanced engineering know ledge, methods, tools
- Analytical reasoning and problem solving
- Experimentation, investigation and know ledge discovery
- Systems thinking
- Attitudes, thoughts and learning
- Ethics, equity
- Teamw ork
- Communication
- External, societal, and environmental context
- Entreprise and business context
- Conceiving, systems engineering and management
- Designing
- Implementing
- Operating
- Leading engineering endeavors
- Entrepreneurship

Particularly important skills in your field in future



-
-
-

Competences (skills, knowledge & attitudes) of ideal graduate in your field in 2035

Aalto University
School of Chemical Engineering

Summary of workshop remarks/ outcomes

Main future trends

- (Bio)circular economy, reusing/recycling
- Energy storage and conversion
- Digitalisation evolving further

Top three skills needed to address them:

- Core engineering fundamental knowledge
- Analytical reasoning and problem solving
- Core disciplinary knowledge

Findings

- Core engineering skills continue to be a fundamental requirement
- Digitalisation identified as fundamental for operations: now and in future
- Problem-solving and openness to life-long learning will help engineers to adapt to new challenges
    - Openness to change
- Importance of soft-skills: Communications and team working skills

Questions for you

- Digitalisation: what exactly is it?
- Adding requirements is fair enough.. But what could we take out?

Your feedback and concluding the event