EFCE Spotlight Talks
Working Party on Education
Section on Sustainability
13 November 2024
09:00-11:15 CET
EFCE

GRuppo di Ingegneria Chimica dell'Università

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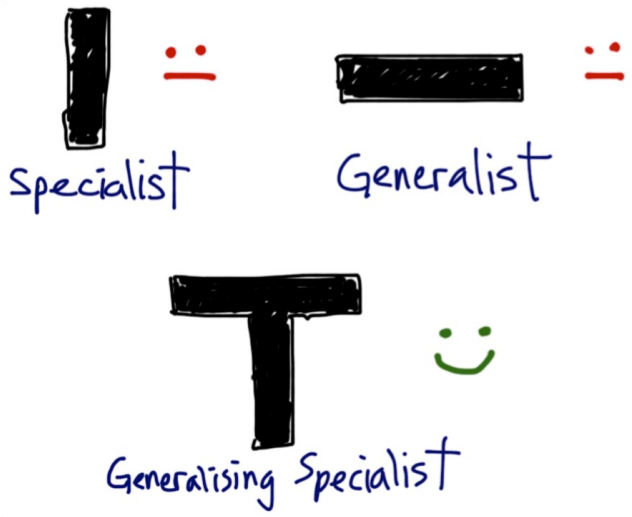
Teaching sustainability for T-shaped chemical engineers

Experiences from the Italian university system

Piero Salatino
Chairman, GRICU

The T-shaped cultural paradigm

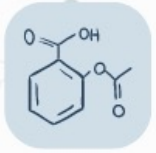
- the vertical bar represents depth of competencies in the core field
- the horizontal bar represents the ability to cooperate across disciplines.



...locating the core of Chemical Engineering







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New Directions for

CHEMICAL ENGINEERING

National Academies of Sciences, Engineering, and Medicine. 2022. *New Directions for Chemical Engineering*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26342.

As the only engineering field with **molecules and molecular transformations at its core**, chemical engineering represents an area of intellectual inquiry and commercial applications that is profoundly important for society's future advances in such vital areas as energy, food, water, medicine, and manufacturing.

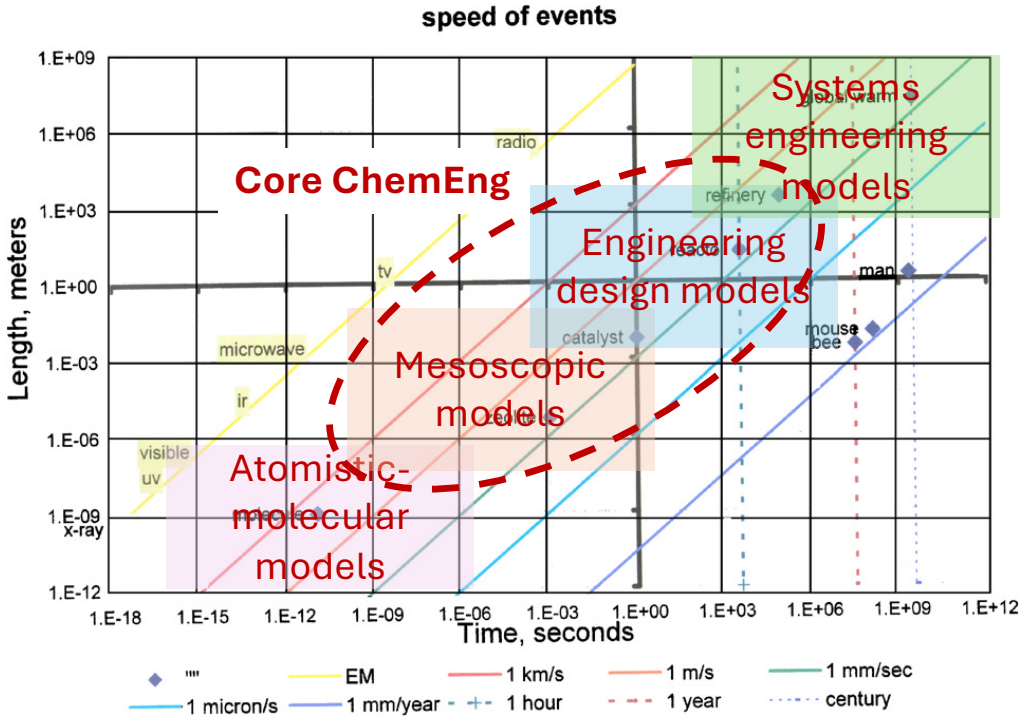
Because chemical engineers deal with both **molecules** and the **enormous industrial plants** that produce them, their work encompasses a **large range of length and time scales**, from the nanometer scales of chemical bonds and reactions to the kilometer scales of crude oil (petroleum) refineries, and from nanosecond chemical reactions to batch processes that take hours. Few fields of science or technology deal with changes of **more than a dozen orders of magnitude in both length and time scales**. The core curriculum of chemical engineering has lasted more than a century because it focuses on the analysis of linked processes regardless of scale.

Chemical Engineering across multiple scales

How to «orchestrate» Chemical Engineering skills in multi-scale contexts

elaborated from:

James Wei
Coordination of multi-scales in chemical engineering.
Chemical Engineering Science
62 (2007) 3326–3334



The Chemical Engineer: specialist or generalist?

- Chemical engineering education has historically combined competence of **molecular scale applied chemistry** with **equipment scale process engineering**, a very successful concept that is still here today. That is why chemical engineering curricula entail more required disciplines than any other engineering curriculum.
- **Chemical Engineers are inherently interdisciplinary even at the core level**, nevertheless they are most frequently perceived as «specialists», due to their ability to target the many facets of their culture on very specific accomplishments.
- The widespread perception of Chemical Engineers as specialists, in comparison with other professionals, may hamper full appreciation of the breadth of our culture and of the potential impact of our community on society, especially at the «systems engineering» level, where «decisions are made».

Chemical Engineering education:
The «depth» vs «breadth» dilemma

- For Chemical Engineering education to meet societal needs and expectations it must not generate «one-man-bands», but rather open minded professionals able to build up their own identity, to interact with other chemical engineers and with other professionals, sharing goals, abilities and methodologies.
- The Chemical Engineering community as a whole must take over the responsibility to develop and «orchestrate» the portfolio of competencies needed to meet societal demands.
- Grafting of other disciplines (and scales) onto core Chemical Engineering education on an individual basis is the key to the richness, breadth and «biodiversity» of the community, while preserving its identity.
- The starting point is a robust core education rooted in the fundamentals, with enough «docking sites» for grafting of elective components.

Coming to Sustainability…

Sustainability has always been present in Chemical Engineering education, mainly in relation to the prevention/mitigation/remediation of environmental impact of process industries and judicious utilization of resources.

BUT

«Why is so much of engineering devoted to finding more efficient ways to do things that should not be done? …The engineering professions, who have been one of the main enablers of industrialisation, now need to step up and take on their responsibility for correcting the potentially disastrous consequences of industrialisation. … This is an ethical imperative that goes beyond the imperative to practice our art responsibly.» (Roland Clift, George E. Davis Lecture, 6 July 2017, IChemE)

Sustainability and Chemical Engineering

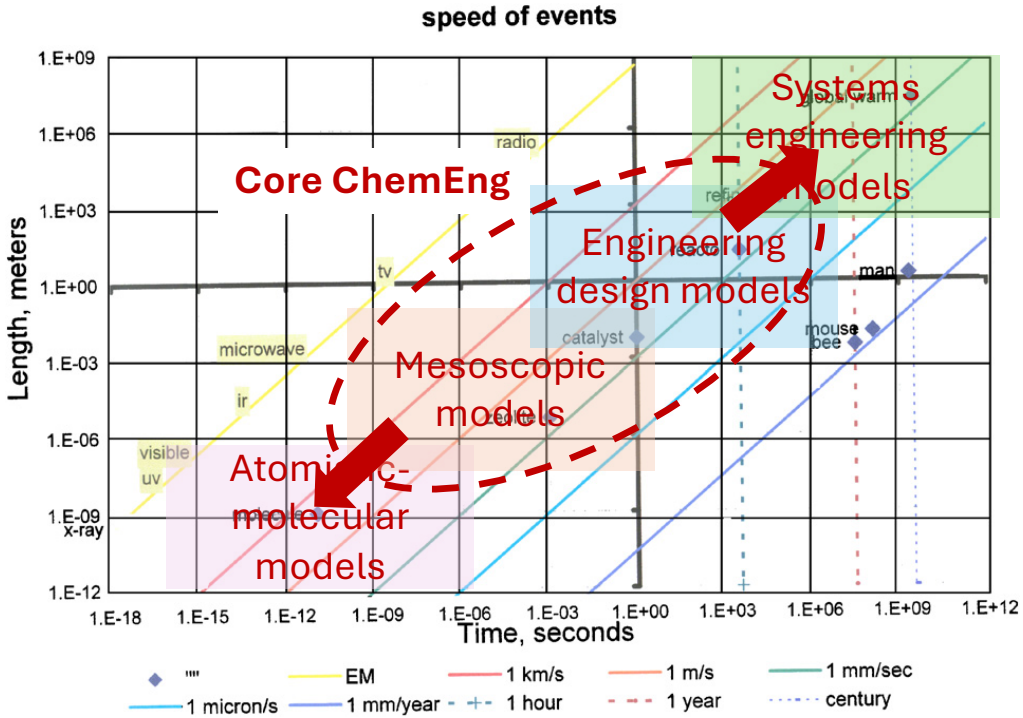
- Italian Chemical Engineering education has always kept the pace with emerging sustainability issues. Many established and ongoing innovations in educational pathways.
- Study programmes can be easily tailored to the careers of students with an interest in sustainability.
- Sustainability is the focus of dedicated curricula or single electives that can be grafted onto the core Chemical Engineering curriculum, most typically at the MSc (Laurea Magistrale) level.

Sustainability and Chemical Engineering

Sustainability-oriented education often falls within the domain of core Chemical Engineering.

Some remarkable attempts have been made to broaden the scope of education beyond the limits of traditional Chemical Engineering:

- Systems engineering abilities of Chemical Engineers have been empowered by increasing engagement in Industrial Ecology and its tools: Life Cycle Assessment, Material Flow Accounting.
- The «Sustainable-by-design» paradigm has been sustained through deeper engagement of Chemical Engineers in molecular, biological and formulation sciences.



Sustainability and Chemical Engineering: dedicated programs/curricula

- Chemical Engineering - *Sustainable Chemical Engineering* (Napoli Federico II)
- Chemical and sustainable process engineering (Torino Politecnico)
- Chemical and Process Engineering - *Sustainable Technologies and Biotechnologies for Energy and Materials* (Bologna)
- Chemical engineering - *Sustainable process engineering* (Palermo)
- Chemical Engineering - *Energy and Environment* (Salerno)
- Chemical Engineering - *Environmental chemical engineering* (L'Aquila)
- Chemical Engineering for Industrial Sustainability (Catania)
- Chemical Engineering for Sustainable Development (Roma Campus Biomedico);
- Materials and chemical engineering for nano, bio, and sustainable technologies (Trieste)

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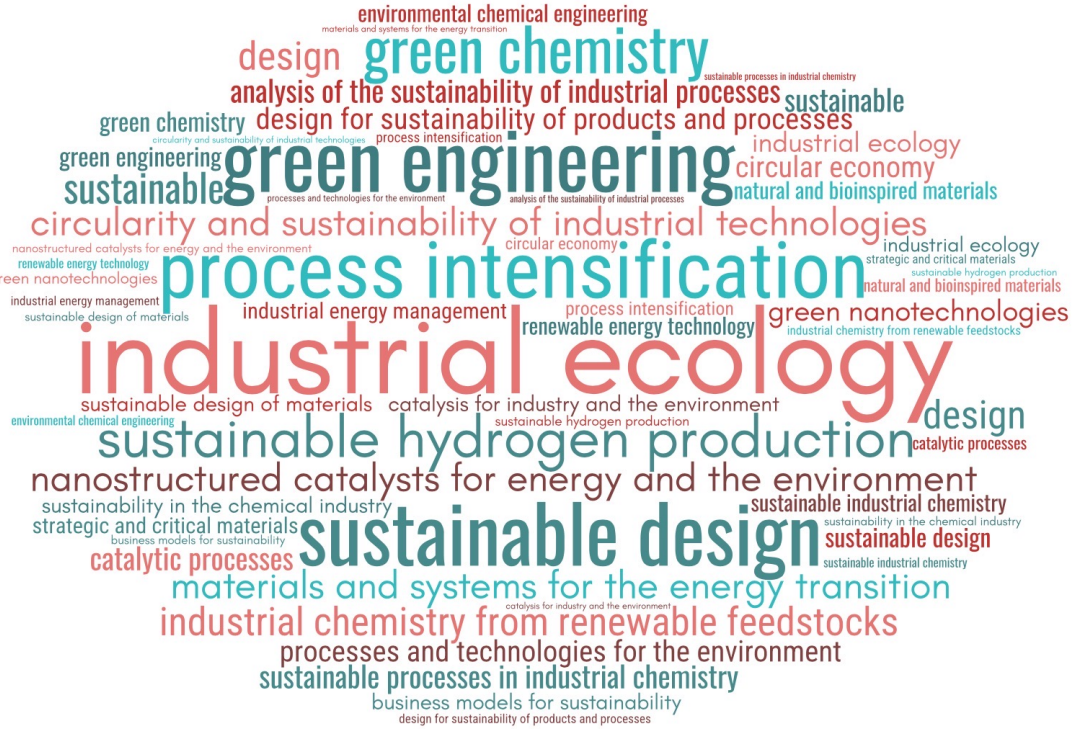
Sustainability and Chemical Engineering:

a broad and diversified choice of electives



A pilot initiative: the «Minor» in Green Technologies

Why Develop professionals with a systemic approach, interdisciplinary vision, digital abilities, attentive to innovation, to face the transformations of the Ecological Transition.

How 30CFU module embodying:

a) cross-sectorial sustainability-oriented technical-scientific studies;
b) training activities for the promotion of digital skills;
c) training activities in the legal/regulatory, economic/social and managerial culture contexts.

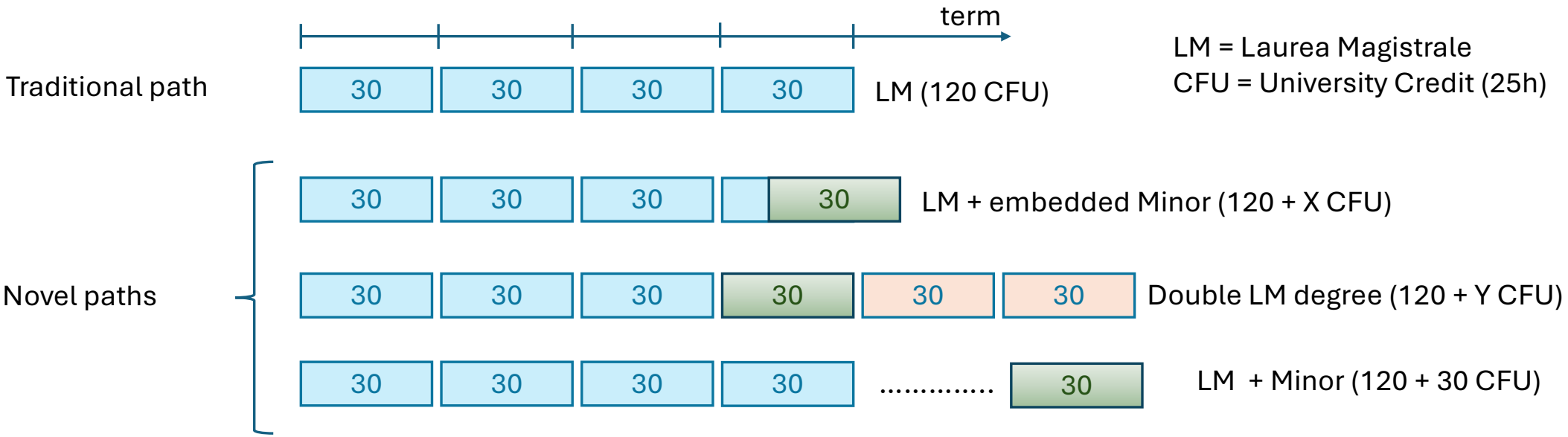
Who MSc students in: Chemical Engineering, Electrical Engineering, Energy and Nuclear Engineering, Mechanical Engineering, Environmental Engineering, Materials Science and Engineering.

A pilot initiative: the «Minor» in Green Technologies

Where The initiative was started as part of a broader project (Technologies for transitions) by a consortium of Engineering Schools: Politecnico di Bari, Politecnico di Milano, Politecnico di Torino, Università di Bologna, Università di Napoli Federico II, Università di Padova, Università di Palermo, Sapienza Università di Roma.

When Embedded in the final term of MSc programs, bridging multiple MSc programs to get a double degree, or as a standalone module for continuing education programmes. Recognition of microcredentials.

The Minor as a building block of educational paths



Thank you

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