JÖNKÖPING UNIVERSITY
School of Engineering

SE2:

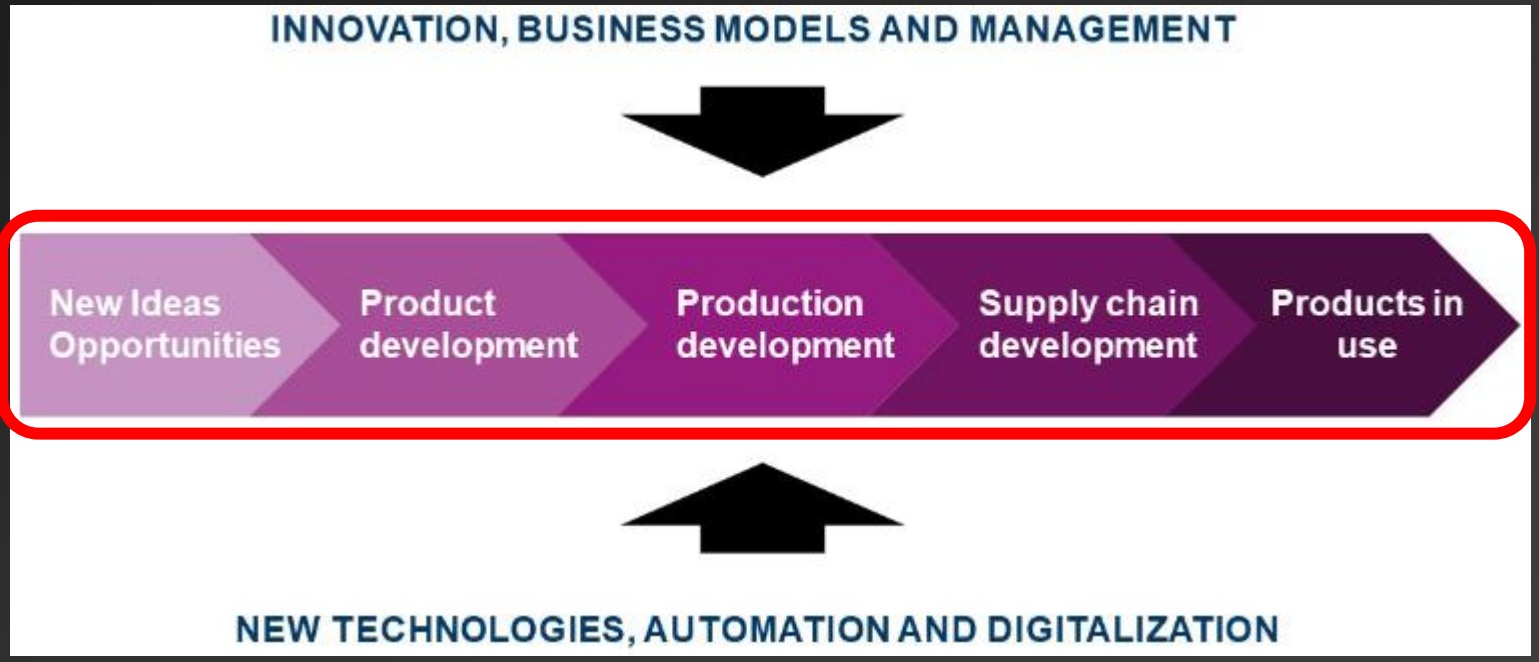
Sustainable materials, manufacturing, and cast components

Ehsan Ghassemali; Docent; SE2 leader

2023-04-20

Current status

Positioning within SPARK

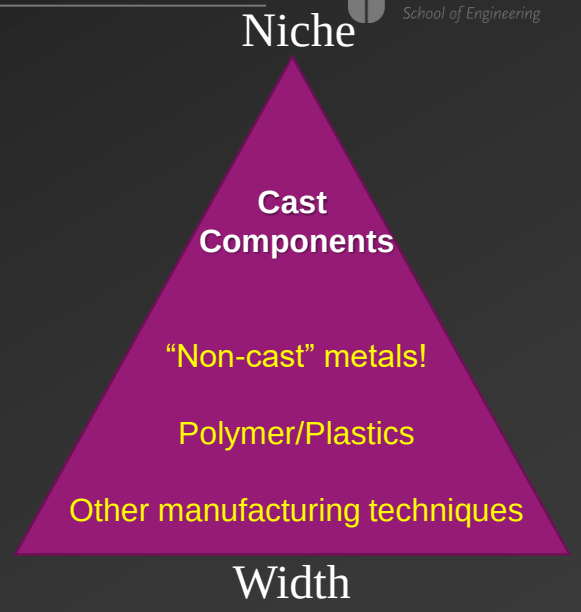


Research and education focus

Advanced materials
are **high value-added** materials that **perform better** than conventional materials, yielding **high-quality products** that, for example, are lighter, have broader service temperature ranges, are multifunctional, or have improved life-cycle performance.

Advanced manufacturing
to produce **higher quality products** in a **more resource-efficient approach** considering the use of energy and materials; or processes that are more **flexible and innovative**.

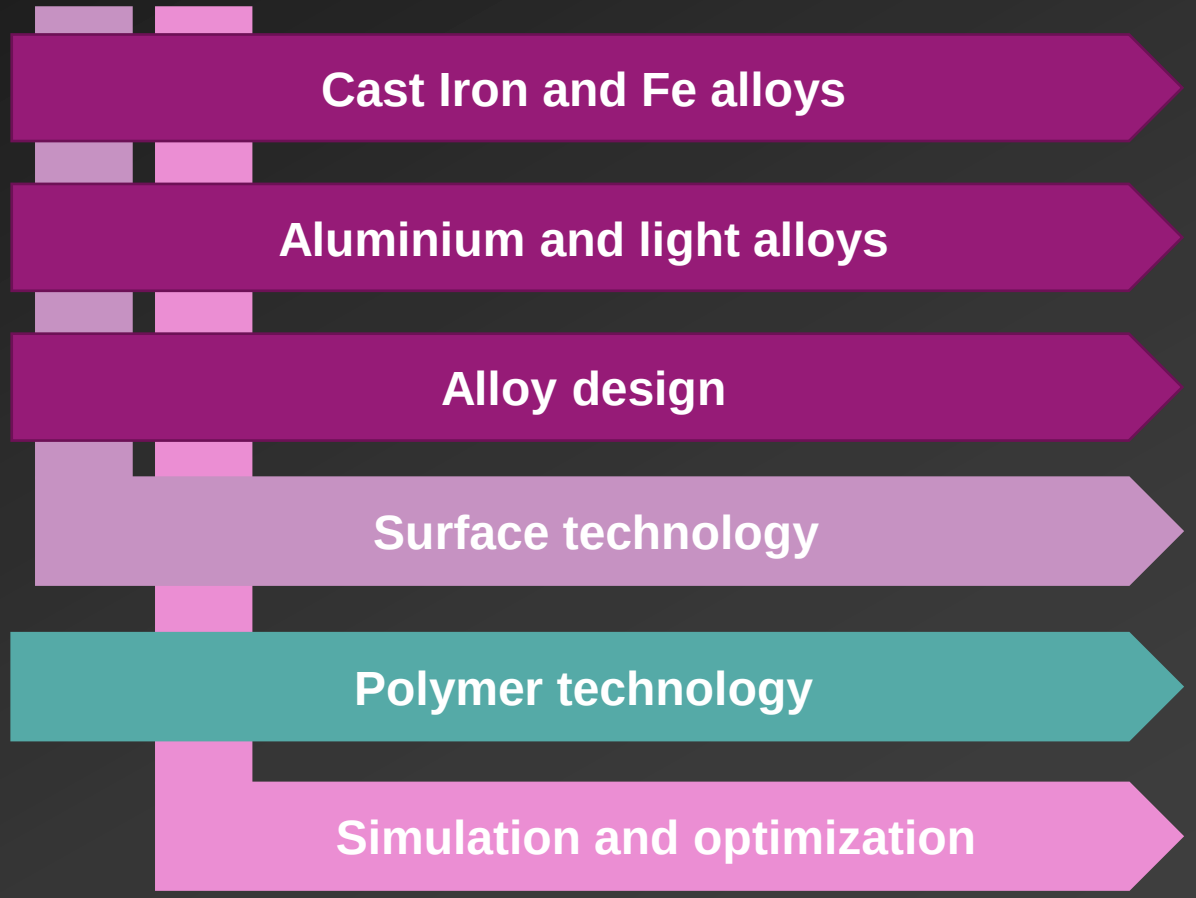
Optimization of components
are processes that **link the material to the manufacturing** to the design tools in a **continuous feedback circle**



Sustainable
Higher performance

Higher quality products & Competitive industry

Research directions



Ongoing projects and future plans (until Q3, 2022)

Submitted or future proposals

Sustainable Manuf. Center (Vinnova)
C-MEC (Competence center; Vinnova)
Surface Tech. Center (Vinnova)
…

Joint Master Programme (EU)
CRYOMETA-LH2 (EU)
GRAIL (EU)
A-SMART (VR)
…

TULC (KKs)
AllToDie (Vinnova)
E-joint2 (Vinnova)
Lifer (Vinnova)
Circular bus. model. (Wallemberg)
….

Environmental building projects

Research Profile, EU, Competence center, etc.

Elevator projects

Synergy, Expertkompetens, EU medium size, VR, etc.

Supportive projects

HÖG, Recruitment, Prospekt, Typical 1-3 yr projects incl. other SE funds

CIRCUMET
IFT:Jönköping
Cleancon II
Augmented LM
SRO-HEA
SmartIndustry PhD
Delsa
LCF-PP
Polymer Lektor
FeMMaC
ProForAl
Samuri
HEeGg
LISA
ALL4HYDRO II
KlirAl
Evident
MaReAl
Balbas
InReAl
LUMA
ALTOS
SIGMA-Mecer
ReCasting
EIAC
KOMPLÄTT
ALUSAP
ClimAl
GrönLjus
LOWEAR

KKs
Other funding agencies

Ongoing projects

Scientific international recognition (in web of science)

Component casting

24 in the world

Component casting – aluminium

Shared 9

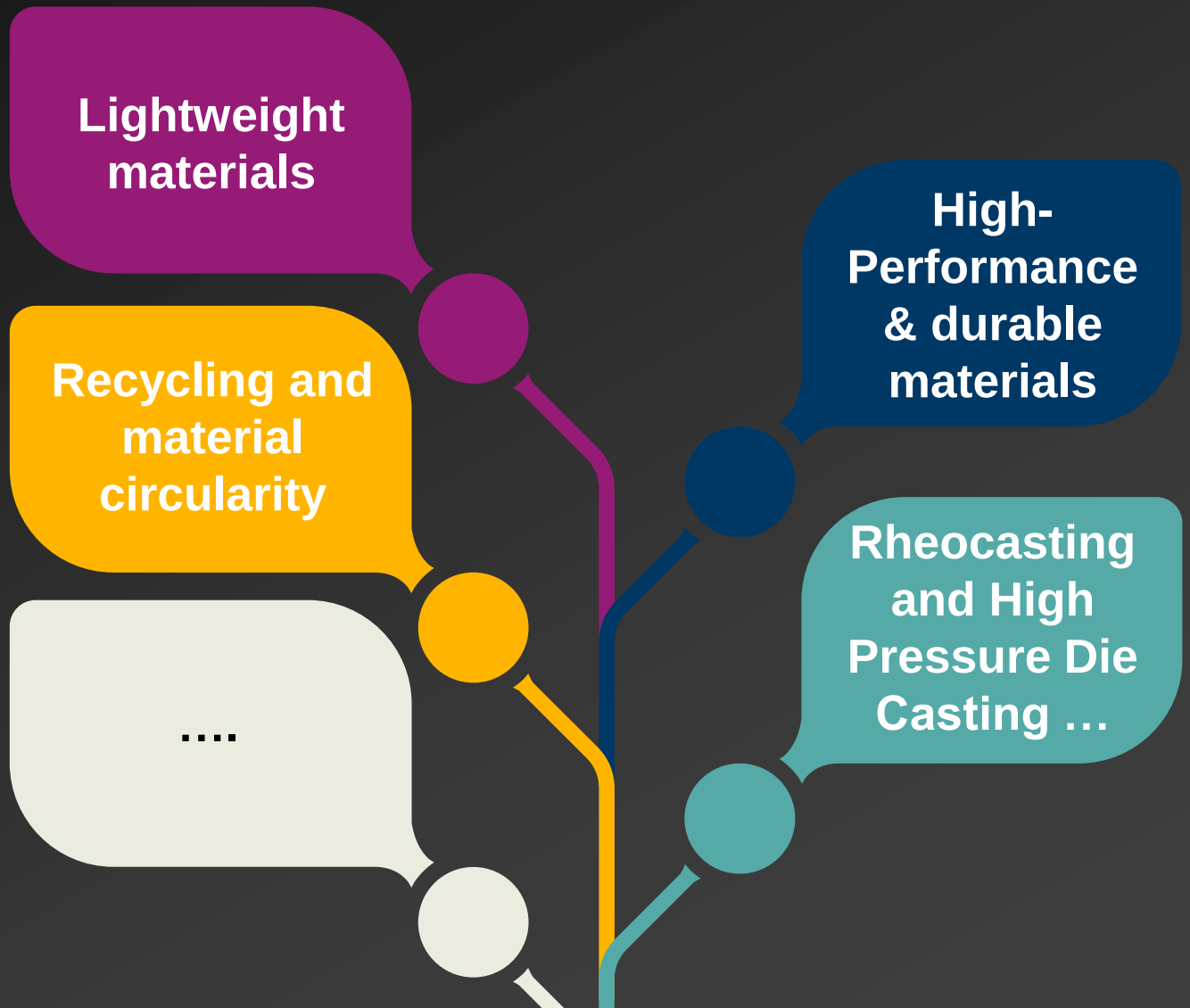
Component casting – cast iron

Number 1

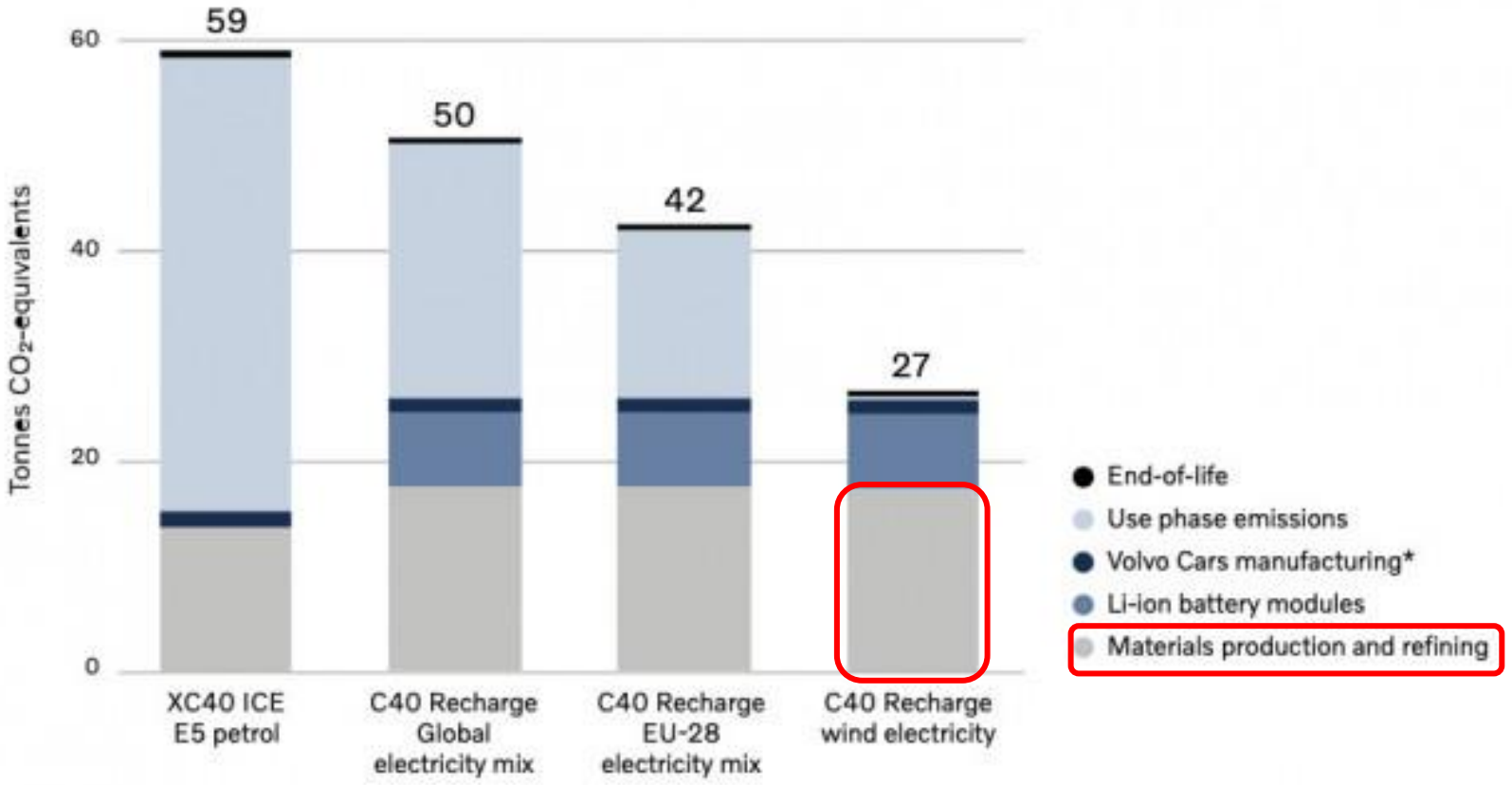
Future perspective

From last year…

Summary of the 2022 Strategic Partners' meeting
Group discussion in SE2:



Towards a carbon-neutral society …?



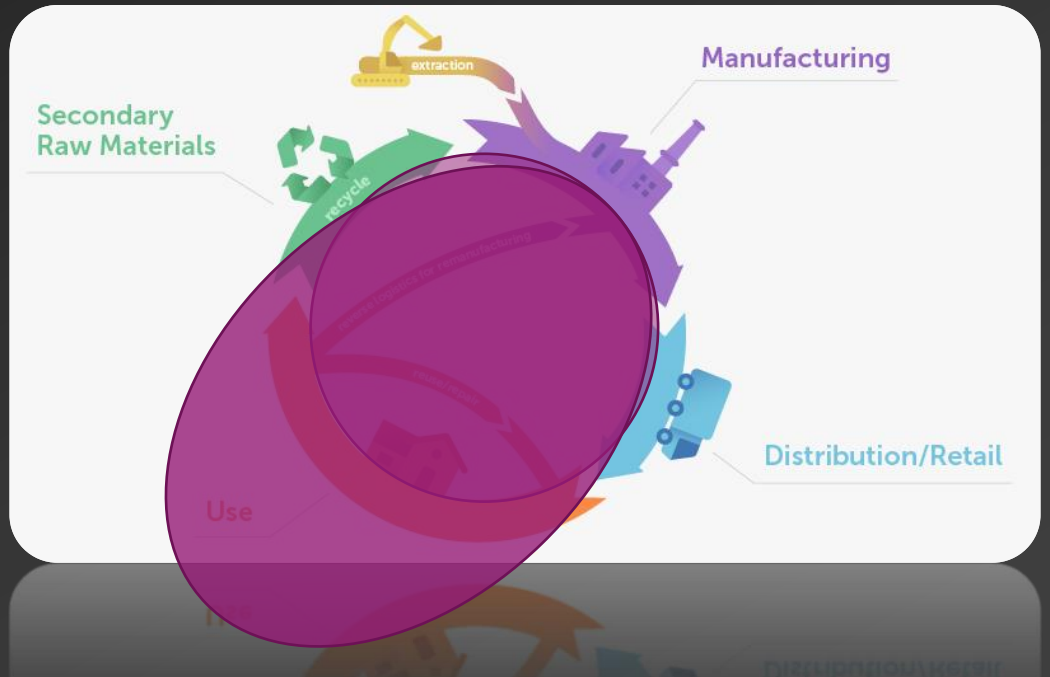
*Volvo Cars manufacturing includes both factories as well as inbound and outbound logistics.

Figure 5. Carbon footprint for C40 Recharge and XC40 ICE with different electricity mixes used for the C40 Recharge.
Results are shown in tonnes CO_2-equivalents per functional unit (200,000km total distance, rounded values).

To fight climate challenges in materials & manufacturing:

- Three themes of:
  - Circularity
  - High-performance materials and components
  - Energy and resource-efficient manufacturing technology

Cicrularity → Ovality?!



Ongoing and upcoming initiatives (taken from last year's roadmap)

By 2025	By 2030
Develop a **research school** together with strategic industrial and academic partners	Develop **tolerant cast materials** for re-use and circularity in component casting
Involve in or lead the formation of a "Casting" Strategic **Innovation Programme** (SIP) or similar	Establish **courses and educational packages** related to circularity, recycling and sustainability in materials and manufacturing
Develop larger efforts (e.g. Synergy proposal(s)) to integrate different topics for **comprehensive research to improve sustainability and material circularity** in component casting	Establish and develop a **national testbed for sustainable casting technology** together with strategic industrial and academic partners
Develop **joint PhD/Master programmes** together with European partners	Have experience in developed competence in **European project** management and consolidation
Continue expanding the research and educational activities in the field of **polymer**	…

Ongoing and upcoming initiatives

+ a number of complementing projects

Research

- IFT:Jönköping (Research profile, KKs - *ongoing*)
  - sustainable design and production of cast iron components

- Competence center application (Vinnova)
  - Circular Metals Engineering Center (CMEC; led by Chalmers – *submitted*)

Education and lifelong learning

- Advance school on circular metal components for the Swedish manufacturing industry (CIRCUMET; KKs – 30 MSEK, 6 yrs)

International effort (research education)

- European joint master programme (on lightweight mobility)
- A few EU research project applications on

Ongoing and upcoming initiatives

How your company acts for sustainability in materials and manufacturing? And

How do you see yourself in our ongoing and future (tentative) agenda?

What is missing in our roadmap that should be included?

….

Synergy initial idea

- Advancing the recycling of Al components/scrap and its effect on component integrity
  - Melting and handling
    - Quality assessment
    - Efficient melt handling
    - Alloying principles and reduced Si content
  - HPDC
    - Process optimisation with sensing
    - In-process quality asscertion
    - AI driven loop for dynamic process adjustment
  - Post processing
    - Oxides influence
      - Heat treatment
      - Coating processes
    - Trace elements
      - Heat treatment responce
      - Coating process influence

Sustainability assessment
- Energy efficiency
  - Alloying element effects
  - Effects from gating and rejects
- CO2 emissions
  - Increased amount of secondary material
- Material resource efficiency
  - Less in-house circulation
  - Reduced additives / agents
  - Reduced needs of alloying additins

Synergy initial idea

- Three action areas and one umbrella distinct areas
  - Alloy development for Melting and Handling
  - Light alloys and AL processing
  - Surface technology for Post processing
  - All providing data for durability and a sustainability analysis to initiate a deeper dive to incorporate sustainability into our research areas

A PhD student (+ a postdoc?); integrating these areas within the project
10 MSEK for 4 yrs
Application submission: May 2024
Project start: Spring 2025

Synergy initial idea – your input

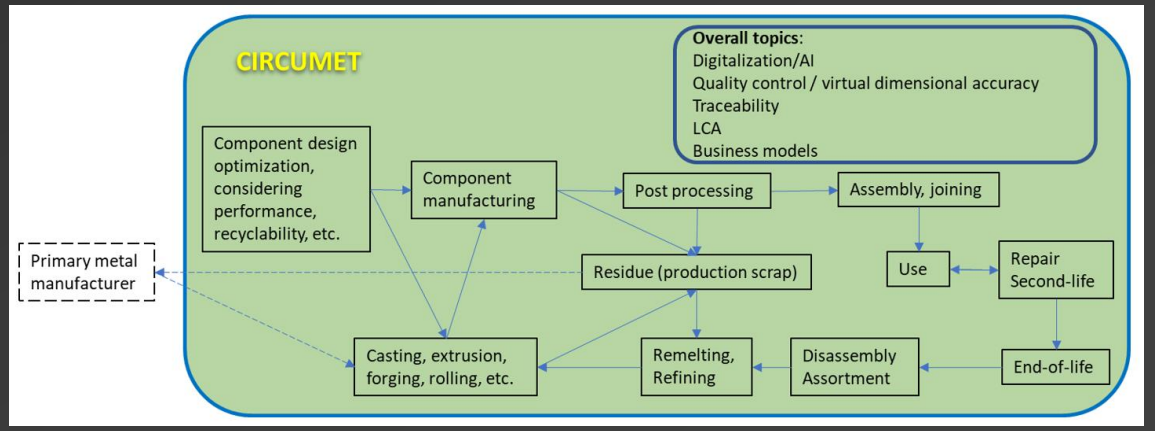
- What industrial needs do you see for future secondary light alloys?
- What knowledge/technical gap do you recognize in this field?
- Any specific application/area you would target as a focus in such constellation?
- …

Objectives and areas of focus

- Objectives

  - Create a joint effort for developing 80-90 credits courses in advanced level on the topic of climate action in the metal component manufacturing industry
  - Develop flexible pedagogical methods, and innovative admission/validation routines for effective competence supply for the professional in industry
  - Pilot-run the developed courses and accordingly fine-tune the methodologies and contents if needed
  - Plan and develop the industrial research school proposal on the climate action for the metal industry

- Fighting climate challenge in three themes:
  - Circularity
  - High-performance materials/components
  - Energy/resource-efficient manufacturing tech.



Partners and their roles

Node partners

Metal industry related associations

- GJUTERI FÖRENINGEN Swedish Foundry Association
- Jernkontoret
- Svenskt Aluminium
- Tunga fordon
- FKG

➢ Marketing & outreach to other stakeholders

Companies

Large companies and SMEs covering the entire value chain of metal component manufacturing, incl.:

- End-users ranging from automotive and aerospace, to household and gardening sectors
- Metal component manufacturing sector
- Material supplier and recycling sector

FAGERHULT, VOLVO, OVAKO, GKN AEROSPACE, STENA, Husqvarna, SCANIA, SANDVIK Coromant, COMPtech castings and moulding innovation, AGES

➢ Content setting, Guest lectures, Professionals taking the courses, Marketing & outreach

Universities and RI

Key Swedish players in the field;

A wide range of competence, incl.:

- Manufacturing : Casting, Additive Manuf., Forming, Welding, etc.
- Advanced characterization
- LCA, Data analysis, etc.

SPARK, JÖNKÖPING UNIVERSITY School of Engineering, AVANCEZ 1829, CHALMERS UNIVERSITY OF TECHNOLOGY, PRIMUS, UNIVERSITY WEST, RI.SE Research Institutes of Sweden

➢ Coordinators, Content creation and lectures, Recruitment, Admission, Examination, Execution, etc.

Courses within the three themes

Theme	Main topic	Modules (sub-topics) in each course	New courses or renewal of existing courses	Credits	Course coordinator	Guest lecturers, industrial contribution
Circularity	Introduction to Sustainability and Circularity	- Climate Action, Circularity, Decoupling & 4Rs - Ethical codes, responsible R&I; Gender balance and inclusion in circularity - MUD, Scrap, Closed loop and value retention	New	7.5	Chalmers	RISE, Volvo, Scania, Husqvarna
	Material development for circularity and future trends	- Designing tolerant alloys - Material processing window - Sustainability and commercialisation aspects in material design	Substantial renewal & update	7.5	Chalmers	JTH, Volvo, Scania, Stena, Ovako
	Component design for disassembly and recyclability	- Joining for disassembly - Sustainable welding design - Cast component design for recyclability	New	7.5	Chalmers	HV, JTH, RISE, GKN, Sandvik, Husqvarna
	Science of remelting	- Melting and melt handling of non-ferrous alloys - Melting and melt handling of ferrous alloys	New	5	JTH	RISE, AGES, Comptech, Ovako
	Applied Life Cycle Analysis (LCA)	- LCA methodologies - Application of LCA in metal component manufacturing	New	5	Scania (JTH)	JTH, Chalmers, Sandvik

Theme	Main topic	Modules (sub-topics) in each course	New courses or renewal of existing courses	Credits	Course coordinator	Guest lecturers, industrial contribution
High-Performance materials and components	Metallurgy of cast alloys	- Physical metallurgy and alloying elements - Impact of melt cleanliness - Impact of recycling and material value retention	Substantial renewal & update	7.5	JTH	Chalmers, Volvo, Comptech, Stena, Ovako
	Assessment and analysis of recycled materials and components	- Mechanical and Chemical characterizations - Melt quality assessment - Failure Analysis	Substantial renewal & update	7.5	JTH	Chalmers, RISE, Stena, Scania
	Modelling and simulation for circular metal component manufacturing	- Component Casting - Sheet metal components - Crash/Impact testing of components, durability evaluations	Substantial renewal & update	7.5	Chalmers	RISE, JTH, Volvo, Comptech, GKN
	Design for minimal material utilization	- Topology optimization - Quality process control, robust processing and design using CAE	Substantial renewal & update	5	JTH	Chalmers, Volvo, GKN
	Functional materials selection and product innovation	- Materials Selection/Design - Materials theory - Phase transformation/ thermodynamics	Substantial renewal & update	7.5	Chalmers	JTH, Ovako

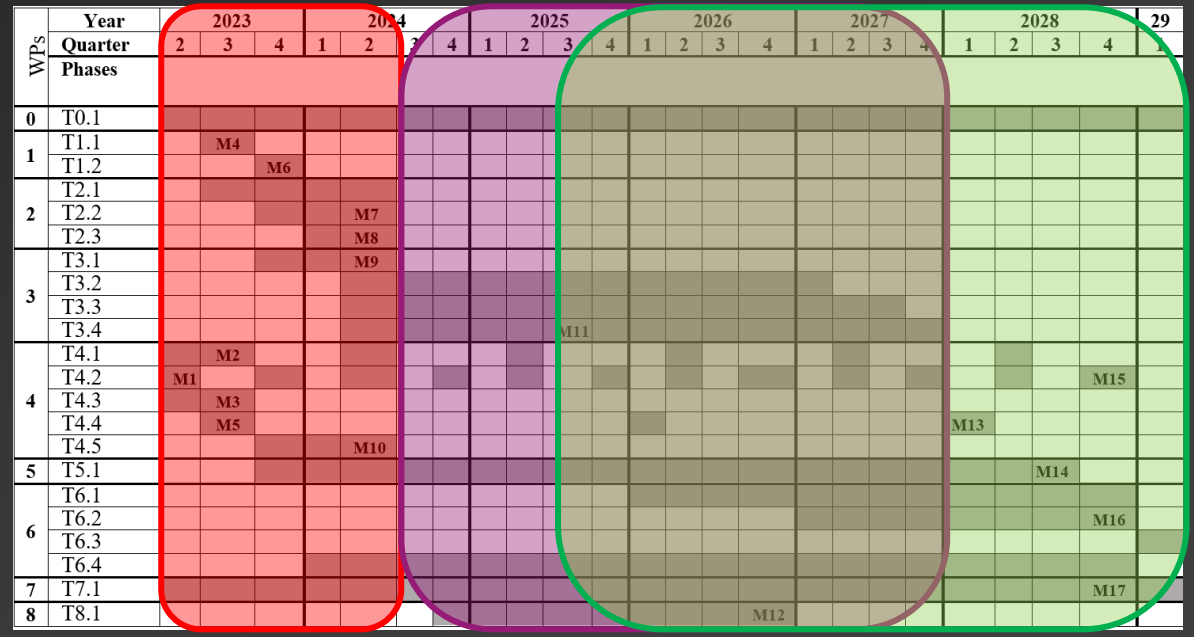
Theme	Main topic	Modules (sub-topics) in each course	New courses or renewal of existing courses	Credits	Course coordinator	Guest lecturers, industrial contribution
Energy and resource-efficient manufacturing technology	Sustainable manufacturing for metal components	- Sustainable and energy efficient Casting - Sustainable and energy efficient AM - Sustainable and energy efficient Joining	New	7.5	HV	JTH, Chalmers, RISE, GKN, Sandvik, Comptech, Scania
	Data analysis-led process optimization	- Data quality, process capability and statistical thinking for industrial problem solving - Design of Experiments - Big Data and AI/ML	New	7.5	JTH	Chalmers, RISE, GKN
	Introduction to principles of Industry 4.0 & 5.0	- Digitalization of manufacturing - Digital twins	New	5	RISE (HV)	JTH, Chalmers, Scania

- In total 87.5 credits
- Content & course list can be fine-tuned in the 1st year of the project
- Each course is designed in 2-3 modules, each being 2.5 credits

Work package and time plan

- WP0: Project management *(lead: JTH; Ehsan Ghassemali, Deputy leader: Chalmers, Johan Ahlström)*
- WP1: Survey for data gathering and fine-tuning course list *(Lead: RISE; Marie Fredriksson)*
- WP2: Methodology and pedagogical development *(lead: JTH; Madelene Zetterlind)*
- WP3: Course development and quality assurance *(lead: Chalmers; Emmy Yu Cao)*
- WP4: Marketing and communication *(lead: JTH; Linda Bergqvist)*
- WP5: Recruitment, admission, and validation *(lead: JTH; Nils-Eric Andersson)*
- WP6: Pilot run and sustaining the courses *(lead: Chalmers; Fang Liu)*
- WP7: Co-Production *(lead: Volvo Cars; Fredrik Edgren)*
- WP8: Developing affiliated industrial research school proposal *(lead: Chalmers; Lars Nyborg)*

Phase A Phase B Phase C



Kick-off meeting: May 30-31
Elite Stora Hotellet Jönköping

Your input…

How do you work with competence development in the field of sustainability today?

Any specific topic missing in our list of courses?

How would you contribute to our courses? e.g. students, case studies, interviews, etc.

Any specific input for the format of running courses?

…

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