Artificial Intelligence for Steelmaking: optimizing processes, augmenting workers, blurring accountability

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Data and de-centralised AI for a competitive and green European Metallurgy Industry

- **EU Horizon 2020 funded interdisciplinary project (2022-2025): ALCHIMIA**
  - Partners – technology development partners, two (three) steel industry corporations, two universities Alchimia Project | (alchimia-project.eu)
- **Optimization of EAF scrap-mix by means of MACHINE LEARNING:**
  - AI – Federated Learning & Continual Learning
  - Narrow AI: i.e. Machine Learning and application of statistical methods to perform tasks and make predictions from large data-sets without explicit programming (Kelly 2022); ALCHIMIA = Black box background decision support
- **(Industry 5.0) Principles: Human-centered design** (ISO 9241-210: 2019 Ergonomics of human system interaction), **Trustworthy AI (ALTAI), compliance with HLEG AI seven guidelines = Human Centred Manufacturing** (see Briken et al 2023)
- **ALCHIMIA will be developed for and deployed at 3 Electric Arc Furnace plants and within one automotive brake disc manufacturer and a further forgery (recently added – aluminum die-casts)**
- **Scalability and replicability of ALCHIMIA for more efficient and environmentally friendly metallurgy industry**
- **Technological innovation and transition = workforce implications… i.e. Human Factors**

Steel Industry Context

- **Steelmaking – two main methods:**
  - Primary: Integrated Blast Furnace / Basic Oxygen Furnace: iron ore to steel
  - **Secondary: Electric Arc Furnace (EAF): recycled steel scrap to new steel**
- **High Carbon Emissions:**
  - Largest single energy related CO_2 emissions globally by industry (Ritchie and Roser, 2016)
  - 3 billion tonnes of CO_2 per year = 8% of global emissions
- **Decarbonisation:**
  - Carbon Direct Avoidance: Hydrogen; Green Electricity
    - Transition to EAF
  - Smart Carbon Usage: Carbon Capture and Storage; Carbon Capture and Use
  - Efficiency innovations e.g. **ALCHIMIA**

Themes:

Industry 4.0 and Industry 5.0:

- From **Industry 4.0** and digitalisation of manufacturing (cyberphysical systems, big data, internet of things, **Artificial Intellgence**, etc.) (Schwab, 2016; Pfeiffer 2017) to **Industry 5.0** (human centred, sustainable and resilient) [see Leng et al, 2022]… **[HCD and ALTAI]**

- **Digital Technology:**
  - Highly rewarding for some (Brynjolfsson and McAfee, 2014), technology induced unemployment for others (Frey and Osborne, 2017 *cf*. Autor 2015), end of work (Spencer, 2018)
  - Wacjman (2018: 168] challenges the 'widespread assumption that digital technologies… [are making us]… mere hostages to the accelerating drive of machines'
  - Edwards and Ramirez (2016) understanding technology 'effects' offers an opportunity to negotiate technology insertion… understanding discontinuities…

‘Human Factor’ Research: ‘Imaginaries’

- Four (Five) Research Sites:
  - Italy (Automotive parts) [+ Italy and Die Cast Aluminium]
  - France, Poland, Spain (secondary steel production)
- Ex-ante surveys (37) and interviews (46) at 4 sites (Italy, Poland, France, Spain)
  - operators, Maintenance, ICT Management, HR Management, Production Management
  - current roles, patterns of work and perspectives/awareness (imaginaries) of AI and ALCHIMIA
- **Ex-post surveys and interviews – September 2025**
  - post-insertion perspectives and evaluation of ALCHIMIA
- Deliverables:
  - Guidelines for trust, safety and human use of AI tools in heavy industrial environments, including recommendations for human-centred technology development and insertion
  - Skills development strategy, training, education plan and products

‘Human Factor’ Research: ‘Imaginaries’

- Three aspects of analysis of algorithmic imaginaries…

1. Optimisation
2. Augemtation
3. (Blurring) Accountability

The Ex-Ante Data: Optimisation of Production Processes and Changes to Work Processes

- **Some divergence of opinion as to the potential to optimize some production processes through changes to work processes, e.g. in scrap sorting**
- **Diverse imaginaries/expectations:**
  - **intensification** of work processes
    - For example, sensor maintenance, data labour, accuracy of readings, AI training data)
  - **de-intensification** of work processes
    - For example, fewer checks, fewer points of intervention)
- **Overall: No or little change to:**
  - work processes [But… Function Creep?] (Edwards and Ramirez 2016)
  - job security

*'No, **I don't think workers can be replaced by the system**. Certainly not at the production level; at the follow-up level a series of "OK, you can lighten a series of checks, however less frequent", but still you have to do them. So, I'm having a hard time seeing where it can physically be reduced the number of people as checks still need to be done… they will not get rid of hourly check hourly control because it's mandatory and obligatory'* (AutoCo.IT1).

ALCHIMIA

The Ex-Ante Data: AI and the Augmentation (or not) of Steel Workers' Capacities

- **Range of perspectives on augmenting steelworkers' capacities**:
  - NEGATIVE IMAGINARIES = cognitive complacency, de-skilling and overall diminution of workers' capacities,
  - POSITIVE IMAGINARIES = upskilling, enhance knowledge, widen skills and occupational profiles

*'Now we are focusing attention basically on knowledge about artificial intelligence, data management, data engineers and data scientists. So, we think that in the near future we will need more of this…[AI PLATFORM], I think it will make the people increase. I don't think they will lose their job. I mean with [AI PLATFORM], it's more a question, that they will have to deal with new tools, and we have to train them to know these new tools…**my view is that we will require less people in production** but in the other hand, **we will require more people in maintenance**, so this is something that we see quite clear that maybe they will move people from production to maintenance because this new computers needs to maintain, need people who takes care of them'* (SteelCo.ES7).

ALCHIMIA

Blurring Accountability for Decision-Making

- The AI technology, ALCHIMIA, will be a *partially autonomous system* (Rafsanjani and Nabizadeh 2023)… with distributed agency for decision making between workers and the AI' (Rammert, 2008)
- ALCHIMIA is being designed to holistically optimize processes and be capable of making decisions affecting tasks and whole processes that are currently taken by operators…. [the function creep?]
- Outcome?
  - Will likely reduce agency in the furnace control
  - de-skilling around critical thinking and decision-making
  - Blurring accountability for decision-making

Blurring Accountability for Decision-Making

'If [AI PLATFORM] ***were to automate decisions, the short-term risk is that work becomes duller as operators just need to oversee an automated process. In the long run, there is a considerable risk of de-skilling****. So, you are offering to me a system [AI PLATFORM] that provides us with continuous forecasts, and we try to follow along with that. On one side, it diminishes firm's know-how and depletes employees who are supposed to grow [in terms of knowledge acquisition]. When you use this system, you are given pre-digested information. So, you don't have to make any sort of effort to understand it…to understand how you got there'*. (AutoCo.IT1).

'They don't see it [AI PLATFORM] as a threat to them because it's basically a support because at the end of the day, they're in charge of making decisions about it*. So just another tool to factor in while taking decisions'* (AutoCo.IT3, interpreter summary).

'[AI PLATFORM] will be something that supports the worker and doesn't replace them because ***it's still a suggestion instead of a command****. So, it can give you an alert, do this or watch out or there might be a problem, but it's still the worker who makes the final decision on it. It can definitely open further avenues for implementing further AI into their daily routine. However,* ***that might even spark some concerns about is the human still allowed to make decisions, or are we just, should we just follow along what AI says. But [AI PLATFORM] definitely like lies within this safe perimeter of leaving the final decision to the worker****'* (AutoCo.IT6, interpreter summary).

Initial Conclusions + Thoughts

- Positive and negative (or conflicting) imaginaries of a future with the AI platform
  - Positive: upskilling, augmenting workers capacities, helping with tasks and decision-making
  - Negative: de-skilling, blurring accountability for decision-making

- Project aims to adopt the principles of ALTAI for ethical AI, HCD, and aspires to the goal of I5.0 – but questions are raised…
  - Tensions between stakeholder and user preferences in HCD?
  - Tensions between user preferences in HCD?
  - Need for collective voice for 'humanising' worker experiences of the digital workplace – unions as stakeholders?
  - Does supposed alignment with ALTAI merely create means for stakeholders to persuade users that AI can be trusted?
  - Does the I5.0 language of worker 'well-being' and 'narratives and discourses of 'agility, flexibility and competitiveness', as well as 'synergies, collaboration, empathy, trust and respect' merely foreshadow other initiatives that seemingly claim to enable workers – High Performance Work Systems – which blur accountability and create greater work intensification?
  - Does nominal alignment with the frameworks obscure structural imbalances to disadvantage segments of the workforce?

THANK YOU!

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