



11-13 May 2026 - Milan, Italy

A Cognitive and AI-Based Training Framework for Electric Arc Furnace Workforce Development

Emilio Jimenez, University of La Rioja (Spain)

iSteel-Expert European Project



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THE ITALIAN STEEL COMMUNITY





Digital Transformation in EAF Steelmaking



Increasing
automation and
digitalization



Higher complexity
of operations



Requirements:
efficiency,
sustainability, safety



The Training Challenge



Strong dependence
on human expertise

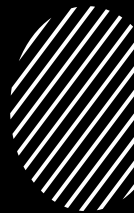
Tacit knowledge
difficult to transfer

Traditional training
not scalable

Risk of knowledge
loss



Limitations of Current Training Systems



Simulation: process-
centric

Documentation: static

Lack of cognitive
support

Limited decision-
making training



Proposed Approach



AI-enhanced
training ecosystem

Human-centric
perspective

Integration with
existing simulators



From Process- Centric to Human- Centric Training



Focus on operator
decision-making



Explicit modelling
of cognition



Support for
reasoning and
learning

Overall Training Architecture



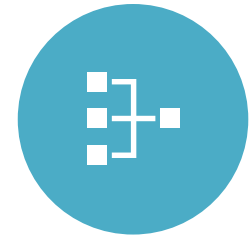
KNOWLEDGE LAYER



COGNITIVE LAYER
(CLEAR AGENTS)



INTERACTION LAYER
(CHATBOT)



INTEGRATION LAYER
(SIMULATORS)

System Components



KNOWLEDGE
ENVIRONMENT



COGNITIVE
AGENTS (CLEAR)



CONVERSATIONAL
ASSISTANT



INTEGRATION
WITH SIMULATORS

Cognitive Agents (CLEAR Architecture)



Emulation of
expert reasoning



Explainable
decision support



Adaptive
behaviour

Cognitive Architectures for Advanced Simulation in iSteel

1. Introduction: What Are Cognitive Architectures?

Cognitive architectures are computational frameworks designed to model human-like reasoning, decision-making, and learning processes. Unlike conventional algorithmic systems, which typically follow predefined rules or optimization procedures, cognitive architectures aim to reproduce the internal mechanisms underlying intelligent behavior.

At their core, cognitive architectures integrate:

- **Perception** (interpretation of the environment),
- **Memory systems** (short-term and long-term knowledge),
- **Decision-making mechanisms** (rule-based or probabilistic),
- **Learning capabilities** (adaptation from experience).

Their purpose is not only to solve problems but to **simulate how intelligent agents behave under dynamic, uncertain, and context-dependent conditions.**

From a traditional engineering standpoint, we could say that they are the natural evolution of control systems: we've moved from "controlling processes" to modeling decision-makers. In other words, we don't just simulate the plant... we simulate the operator..

Integration with Industrial Platforms

Cognitive architectures are theoretical and computational frameworks that seek to model the human mind to create intelligent artificial agents capable of reasoning, learning, and acting.

- **SOAR (State, Operator, And Result)** is one of the oldest and most established architectures, focused on problem-solving through rules, while
- **CLEAR (Concise, Logical, Explicit, Adaptive, Reflective)** is a more recent approach focused on integrating language models, knowledge graphs, and supervision.

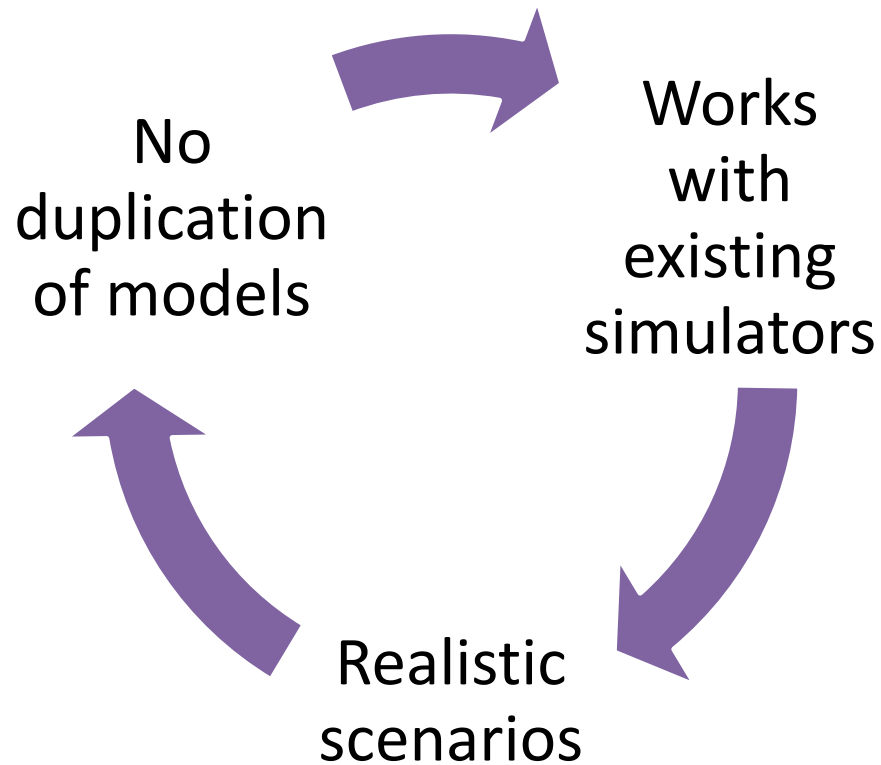
Training Methodology

Progressive learning approach

Knowledge → Guided → Scenario →
Autonomous

Gradual reduction of support

Integration with Industrial Platforms



Integration with Industrial Platforms



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Integration Platform

WP4 Education & Training

Home

Process-Centered Simulator

Operator-Centered Simulator

Knowledge

Results

User session

Mercedes

mercedes (user)

Logout

UNIFIED ACCESS

iSteel Integration Platform

Training, simulation and AI-assisted knowledge support for iSteel-Expert

A single entry point for simulation, knowledge, training and AI-assisted decision support.

Three complementary modules developed by **SIM4Future**, **UNICL** and **UNIRIO**.

Integrated access to the Process-Centered Simulator, the Operator-Centered Simulator, and the knowledge and training module.

[Open Simulation Hub](#)

[Open Knowledge Hub](#)

Process-Centered Simulator (SIM4Future)

3D process simulation environment developed by **Sim4Future (SIM4)**. This module represents the process-centred simulation layer of the iSteel platform.

Operator-Centered Simulator (UNICL)

Operator dashboard and plant-effects simulation developed by **Université Catholique de Lille (UNICL)**.



Co-funded by the European Union – RFCS Programme

Knowledge, Education & Training (UNIRIO)

Knowledge base, training resources, cognitive architecture material (SOAR / CLEAR), interactive tests and AI-assisted support tools developed by **University of La Rioja (UNIRIO)**.



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Integration Platform

WP4 Education & Training

Home

Process-Centered Simulator

Operator-Centered Simulator

Knowledge

Results

User session

Mercedes

mercedes (user)

Logout

SIM4 MODULE

Process-Centered Simulator

SIM4Future Process Simulation Module

This section provides access to the process-centred simulation environment developed by **Sim4Future (SIM4)**, together with its supporting documentation and media resources.

Simulator access

Launch the Process-Centered Simulator from the current SIM4 environment. At this stage, the simulator is treated as an external module connected through the iSteel portal.

[Open Process-Centered Simulator](#)

Note: the final access mode may be a controlled link, embedded view, or API-based integration, depending on the deployment agreed with the partner.

User manual (PDF)

Access the current PDF manual of the Process-Centered Simulator.

[Open PDF manual](#)

Interactive manual

This area will provide a more interactive and user-friendly version of the simulator manual, including structured navigation, visual support and guided access to the main functions.

[Interactive manual \(under construction\)](#)

Videos

Access video demonstrations and guided usage material for the Process-Centered Simulator.

[Open videos page](#)

iSteel Platform

Technical integration note

The SIM4 process-centered simulator is currently deployed as a local Java backend provided by the SIM4Future partner.

In the current integration prototype, the iSteel portal provides a controlled launcher that starts the simulator and opens its local web interface.

In the final platform architecture, this module will be connected through a controlled external URL, embedded interface, or API-based integration depending on the deployment model agreed with the partner infrastructure.



Integration with Industrial Platforms



iSteel EAF Learning System



Session Info

Learning Time: 0:44

Testing Time: 00:00

Points: 0

3D Views : Automatic Sequence View

The image shows a 3D simulation of an Electric Arc Furnace (EAF) interior. A yellow crane is positioned on the left. A semi-transparent control menu is centered over the scene, and a control panel is on the right. The menu includes options for scenario selection and manual/demo modes. The control panel lists various EAF components and their operational states.

Choose Scenario

- Natural Deslagging
- Tapping
- Free View
- Automatic Sequence
- Manual Deslagging
- Demo Mode

Control Panel:

- Connecting Car: In, Out
- Slag Door: Up, Down
- Hopper: Deploy, Retract
- Consteel Cover: Open, Close
- Electrodes: -, +, Down, Tapp., Up
- Crane: Crane L, R; Trolley In, Out; Hoist Up, Dwn
- EBT Flap: Open, Close
- Slag Door Cleaner: Clean, Idle
- Yaw: Up, Dwn; Ext., Retr.

50%

Next

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Integration Platform

WP4 Education & Training

Home

Process-Centered Simulator

Operator-Centered Simulator

Knowledge

Results

User session

Mercedes

mercedes (user)

Logout

UNICL MODULE

Operator-Centered Simulator

Operator Simulation Module

This module corresponds to the operator-centred simulation environment developed by **Université Catholique de Lille (UNICL)**.

Purpose

Simulation of operator decisions, dashboard monitoring and plant effects.

Integration

The simulator is launched locally through the iSteel portal using a controlled launcher that starts Pitch pRTI and then opens the exported EAF Factory Model runtime.

Status

Current version: simulator running correctly through the local portal integration.

Resources

Access the operator-centered simulator and its supporting documentation.

Simulator running

Open Operator Gateway

Documentation

Interactive documentation

Status: pRTI and simulator are running. Use the Operator Gateway button to access the integration page.

Note: the current AnyLogic exported frontend is locally executable, but remote rendering may be restricted by the AnyLogic runtime/export configuration. The gateway provides a controlled access point and documents this technical limitation.

Integration with Industrial Platforms

Operator-Centered Simulator

The Operator-Centered Simulator is running locally through an AnyLogic exported runtime.

The current AnyLogic frontend is available locally at:

<http://127.0.0.1:23952>

When accessed remotely through the iSteel platform, the current AnyLogic export may block or fail to render the frontend. This is a restriction of the AnyLogic exported frontend, not of the iSteel integration platform.

For the project demonstration, the simulator can be shown locally, while the remote access limitation is kept visible as a documented technical restriction to be addressed with the simulator provider/export configuration.



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Integration Platform
WP4 Education & Training

Home

Process-Centered

Operator-Centered

Knowledge

Results

User session
Mercedes
mercedes (user)

Logout



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ion.

The gateway





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Integration Platform
WP4 Education & Training

Home

Process-Centered

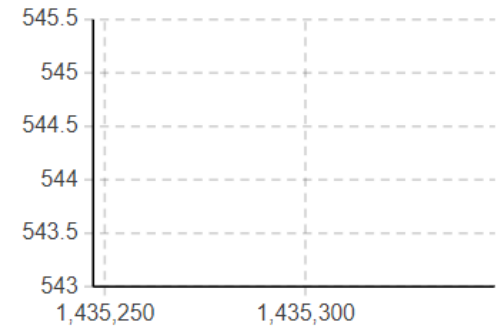
Operator-Centered

Knowledge

Results

User session
Mercedes
mercedes (user)

Logout



● furnace time

Clean Slag Door

Manual Deslag

FOMPath
.\FOM.xml

⚡ sendUpdate
0.529

f handleUserInput

simulationFederate
eaf_factory_model.SimulationHLAFederate@564c56a7

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ion.

The gateway



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iSteel-Expert
Integration Platform
WP4 Education & Training

Home

Process-Centered Simulator

Operator-Centered Simulator

Knowledge

Results

User session
Mercedes
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Logout

UNIRIO MODULE

Knowledge, Education & Training

University of La Rioja (UNIRIO) – Cognitive Training and Knowledge Module

Documents, procedures, training material and structured knowledge supporting the education and training activities of the iSteel platform.

NotebookLM workspace

[NotebookLM Tutorial](#)

[Open NotebookLM](#)

The platform integrates an AI-assisted knowledge system based on NotebookLM, which allows operators to query project documentation interactively.

Documents

- [Tests and training notes](#)
- [SOAR and CLEAR explainers](#)
- [Milestone and deliverable support material](#)

Chatbot

[Chatbot manual](#)

[Open Chatbot](#)

Interactive tests

Access the interactive training tests developed within the iSteel education module.

[Open the interactive tests](#)

[Open Formation tests](#)

Integration with Industrial Platforms



Sources

+ Add sources

Search the web for new sources



Web

Fast Research



Select all

 Attachment_0-1.pdf

 Attachment_0-10.pdf

 Attachment_0-11.pdf

 Attachment_0-12.pdf

 Attachment_0-13.pdf

 Attachment_0-14.pdf

 Attachment_0-15.pdf

 Attachment_0-16.pdf

Chat



Customize

iSteel-Expert Project Management Plan

35 sources · Jan 29, 2026

These documents outline the administrative and operational framework for **iSteel-Expert**, a project funded by the **Research Fund for Coal and Steel** to improve steelmaking through virtual expert systems. The first source establishes **ethical and legal guidelines**, covering essential topics such as **research integrity**, compliance with the **Artificial Intelligence Act**, and the protection of **personal data**. The second source serves as a **Data Management Plan**, detailing how information collected from sensors and simulations will be stored and processed. It emphasizes the use of **Zenodo** and **TENOVA cloud** to ensure that research outputs remain **findable, accessible, interoperable, and reusable**. Together, these materials provide a roadmap for managing **intellectual property**,

Start typing...

35 sources



Studio

 Audio Overview

 **BETA** Slide Deck

 Video Overview

 Mind Map

 Reports

 Flashcards

 Quiz

 **BETA** Infographic

 Data Table

 iSteel-Expert Quiz
35 sources · 13h ago

 Primo operatore EAF tra dati e...
Deep Dive · 35 sources · 18d ago

 Guida Dati
Brief · 35 sources

Add note

Integration with Industrial Platforms

iSteel Assistant

Ask about modules, documents, or training resources.

Chatbot

Type a message...

Integration with Industrial Platforms



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Integration Platform

WP4 Education & Training

Home

Process-Centered Simulator

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TRAINING TEST

Sample Knowledge Test

This sample test demonstrates user-based result storage in the iSteel platform.

1. Which module corresponds to the process-centred simulator?

- UNIRIO
- SIM4Future
- UNICL

2. Which module corresponds to the operator-centred simulator?

- UNICL
- SIM4Future
- NotebookLM

3. What does the knowledge module include?

- Only videos
- Documents, training materials and support tools
- Only the EAF simulator

4. The platform identifies the current user and can store training results.

- True
- False

5. Which middleware is required for the operator-centred simulator?

- Apache
- Pitch pRTI
- PostgreSQL

Submit test

Reset



iSteel Platform

Integration with Incidents



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Integration Platform
WP4 Education & Training

Home

Process-Centered Simulator

Operator-Centered Simulator

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mercedes (user)

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TRAINING TEST

Sample Knowledge

This sample test demonstrates user-based result storage

1. Which module corresponds to the process-cente

- UNIRIO
- SIM4Future
- UNICL

2. Which module corresponds to the operator-c

- UNICL
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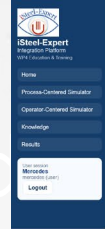
- True
- False

5. Which middleware is required for the iSteel Platform

- Apache
- Pitch pRTI
- PostgreSQL

Submit test

Reset



Formation Tests

The advanced version of the training test supports section filtering, random question selection, automatic correction, final score calculation and a full review of incorrect answers.

Test configuration

Section: **All areas** | Number of questions: **15** | [Generate test](#)

You can generate a prior random test for daily training or use the full set for complete formation assessment.

1. 2nd/3rd EAF Operator
What risk does most 2nd/3rd EAF Operators manage during scrap charging?

- A) Slag surface on the ladle
- B) Excessive cooling of the arc
- C) Disturbances or misalignments in scrap descent
- D) Breaches in slag door closure

2. 1st EAF Operator
What best describes the "Safety Responsibility" for the role of 1st EAF Operator?

- A) High coordination (shutdown, secures furnace, handles emergencies)
- B) Medium: follows instructions, reports issues, performs tasks
- C) Medium: secures areas, stops systems, collaborates in emergencies
- D) None of the above

3. 1st EAF Operator
Which PPE is essential for 2nd/3rd EAF Operators working near the slag zone?

- A) Face shield, heat-resistant gloves, and armoured clothing
- B) Only ear protection and boots
- C) Long-sleeved and safety glasses
- D) Reflective vest and anti-slip shoes only

4. 2nd/3rd EAF Operator
What is the primary role of the Consteel Operator during melting operations?

- A) To supervise the melt-charger
- B) To ensure continuous, safe, and efficient scrap feeding into the furnace
- C) To coordinate and adjust with the 1st EAF Operator
- D) To inspect slag removal

5. 1st EAF Operator
Why is the 1st EAF Operator key in emergency decision-making?

- A) Because they are closest to the slag pot
- B) Because they supervise all furnace operations and safety alerts
- C) Because they fit the furnace roof during emergencies
- D) Because they clean the crucible

6. 1st EAF Operator
How does the 1st EAF Operator manage scrap charging?

- A) By setting the Consteel test speed
- B) By coordinating gradual movement and energy distribution from the EAF control desk
- C) By feeding scrap manually into the furnace
- D) By opening the EBT channel before the top

7. 1st EAF Operator
What best describes the "Safety Responsibility" for the role of 2nd/3rd EAF Operators?

- A) High: coordinates shutdown, secures furnace, handles emergencies
- B) Medium: secures areas, stops systems, collaborates in emergencies
- C) Medium: follows instructions, reports issues, performs tasks
- D) None of the above

8. Consteel Operator
What best describes the interaction between slag management and furnace performance?

- A) They are unrelated
- B) Good slag control contributes to energy efficiency and process safety
- C) Only affects final inspection timing
- D) Good slag is secondary to energy

9. Consteel Operator
Which of the following combinations best reflects safe operation practices?

- A) Communication and speed
- B) Control and heat
- C) PPE and real-time system monitoring
- D) Autonomy and troubleshooting

10. Consteel Operator
Which PPE is essential for the Consteel Operator during conveyor inspection?

- A) Safety glasses, helmet, and anti-slip shoes
- B) Only safety shoes and a vest
- C) Dust mask and apron
- D) None, as inspections are fully remote

11. Consteel Operator
Which of the following situations requires immediate electrode inspection?

- A) Irregular sound from the arc or high voltage alerts
- B) Temperature fluctuations in the slag pot
- C) Signal fluctuation in system pressure
- D) Increase in scrap temperature

12. 1st EAF Operator
Why is electrode condition important for the 1st EAF Operator to monitor?

- A) It determines the quality of alloying additions
- B) It affects safety and furnace being charged during melting
- C) It is an indicator of the electrode's health
- D) It is related to slag handling, typical for 2nd/3rd EAF Operators

13. Consteel Operator
How should EAF and Consteel operators approach communication with supervisors during shift changes?

- A) Leave the job without notice
- B) Only report if asked
- C) Ensure clear handover and pass on any relevant issues
- D) Wait for the supervisor to initiate an interaction

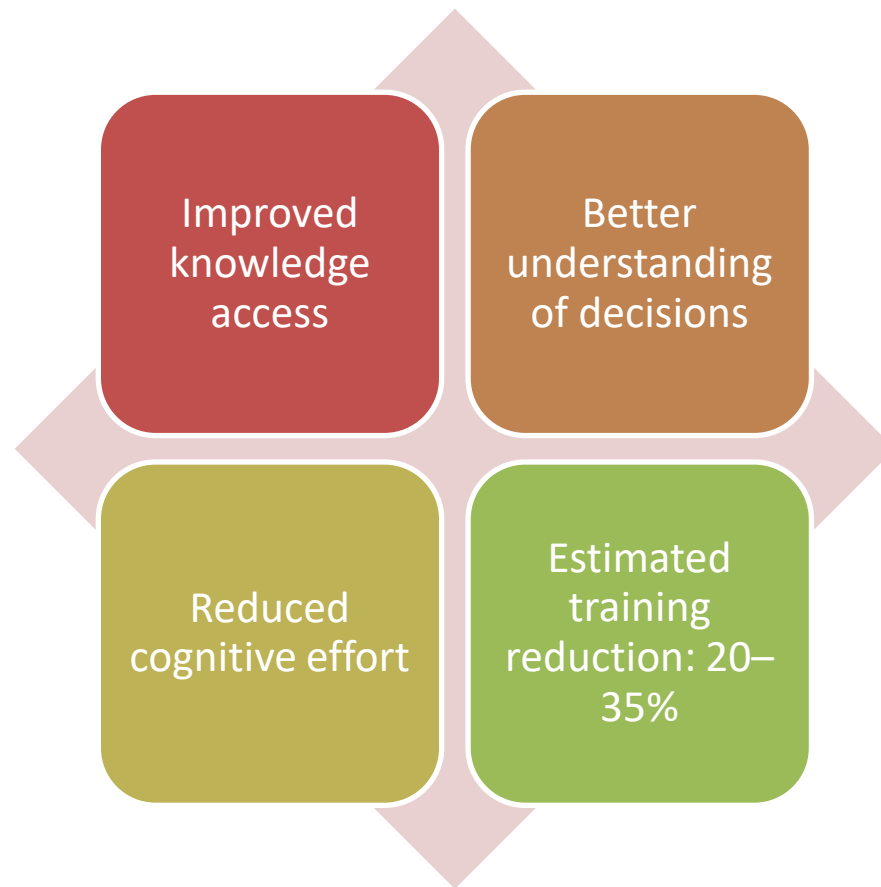
14. 1st EAF Operator
What is the 1st EAF Operator's role regarding slag control?

- A) Calculating slag levels during tapping
- B) Manually controlling the slag flow from the pot
- C) Monitoring slag levels and confirming operations are within safety margins
- D) Disposing of crucibles at end of shift

[Advanced Test](#) | [Generate new random test](#)



Preliminary Results



Expected Benefits

Faster
onboarding

Reduced
errors

Improved
safety

Knowledge
transfer

Conclusions

Human-centric
training
approach

Integration of
AI and
cognition

Complement
to simulation
systems

Thank You

- Questions



Thank You

- Questions?





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Emilio Jimenez, University of La Rioja (Spain)



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