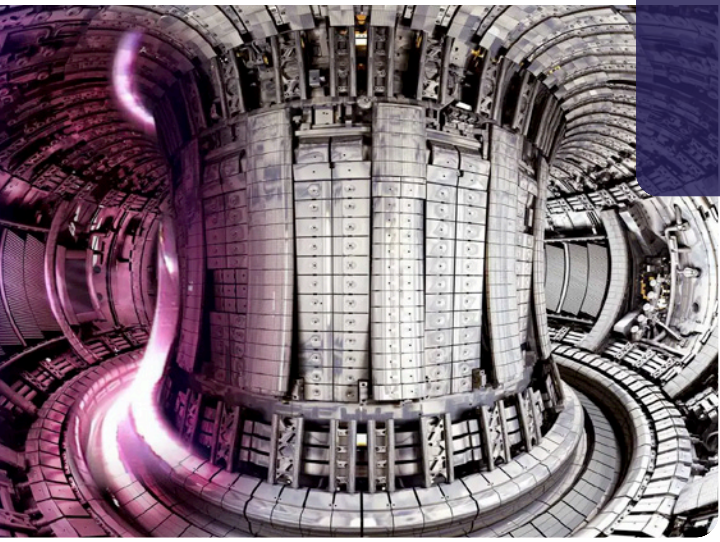
ENERGY

Conceptual Design of the STEP Fusion Power Plant



"Throughout this journey, adopting Capella with its user-friendly interfaces has allowed us to better engage with the programme in the MBSE approach and embed better SE practices. - Yitong Chen

Context

STEP (Spherical Tokamak for Energy Production) is a £220M (€264M) project aiming to deliver a UK fusion energy plant prototype, targeting 2040, and set a path to commercial viability of fusion.

The current step is to develop a conceptual design for a First of a Kind commercially viable fusion power plant by 2024.

Designing a power plant at this scale comes with immense challenges: the Systems Engineering approach is relatively new to this industry which is heavily research based and where engineering processes are not fully established.

UKAEA, the organization running the STEP project, needed a Model-Based Systems Engineering approach to manage the complexity of the system, by performing system analysis and logical architecture analysis, and generating engineering artifacts from the model.

Jason JOANNOU

Jason Joannou is Group Leader for Systems Engineering at the UK Atomic Energy Authority, responsible for enabling the effective implementation of Systems Engineering across the organization. He also leads the Model Based Systems Engineering and Information Framework workstreams in STEP.

Yitong CHEN

Yitong Chen is a Systems Engineer with UK Atomic Energy Authority. During her time at UKAEA, she has been a part of the delivery of the conceptual design of STEP and has focused on applying the Systems Engineering approach on fuel cycle systems, at the whole power plant level.

Solution

UKAEA adopted Capella to work with an agile top down approach, building the model incrementally in a series of sprints.

The architecture definition activities allow early formalization of the textual requirements, to drive detailed engineering design in the next phases.

Through NGO (Needs, Goals, Objectives) analysis, key system capabilities are realized to functional chains, which forms the basis for firstly deriving the Logical architecture, and then the Physical architecture. The differentiation between Logical and Physical architectures ensures that the team focuses on defining the problem space.

To date, a majority of time is still spent on the Logical Architecture Layer, allowing engagement with the Product Areas, but an increasing effort is gradually engaged on the Physical Architecture as design decisions are made.

Deployed with several add-ons such as PVMT, Team for Capella or M2Doc, Capella is used with people who have the domain knowledge. With the mentoring and guidance from Capella experts, the model is becoming an authoritative source of truth.

Result

The approach and the usage of Capella provide benefits on several aspects:

- **Better communication:** by helping to onboard new starters, and bringing development partners/suppliers up to speed quickly.
- **Interface management**: capturing, controlling and communicating information at interfaces, at each level of system decomposition (external stakeholders to system boundary, subsystem to subsystem) provides context for decision making.
- **Complete and consistent set of requirements**: by assisting in developing the requirements, and helping to provide traceability from stakeholder objectives through to components in physical architecture.
- **Fully documented digital twin**: by going to trace system structure (e.g. PBS) from model to PLM system.

Some challenges will need further investigation such as variant modeling, to be able to generate variant physical architecture candidates whilst maintaining traceability with high level logical architecture. Also, the need to implement a middle-out approach, which is favored for STEP, whereas Arcadia method recommends the top-down approach, while being adaptable to other life cycles.