INL/MIS-22-67486-Revision-0

NRIC Digital Engineering Ecosystem

June 2022

Changing the World's Energy Future

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Idaho National Laboratory

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Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

NRIC Digital Engineering Ecosystem

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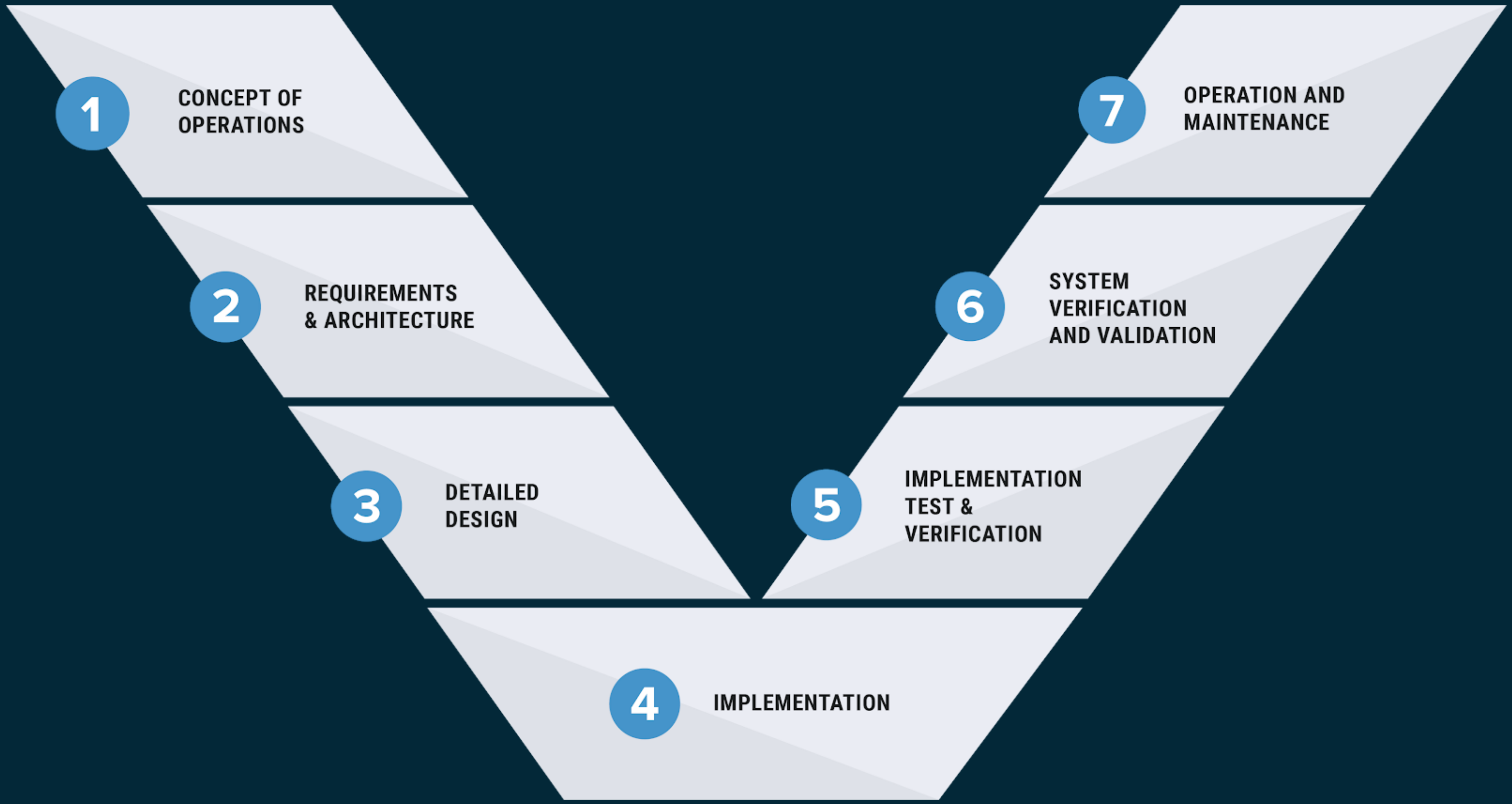
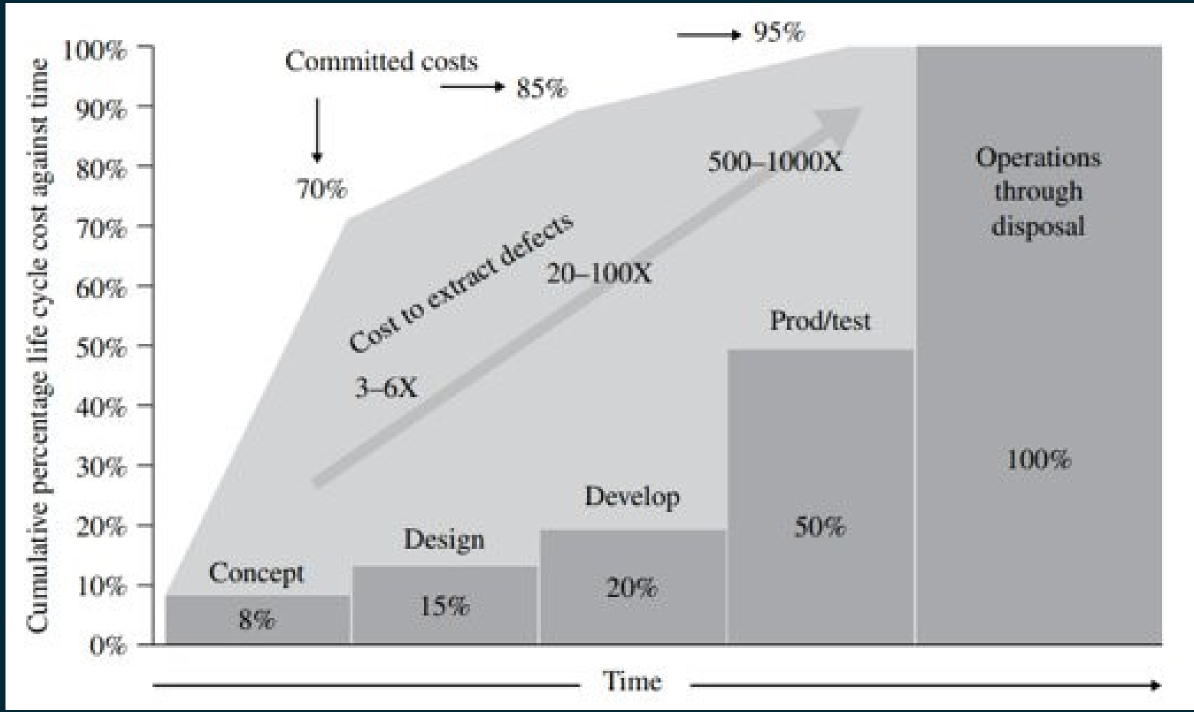
Systems Engineering (SE)

- Application of systems thinking to complex engineering projects
- Holistic, encompassing approach to analyzing a problem and how the constituent parts of entities interrelate
- Systems engineering is distinctly different than system engineering
- Interdisciplinary, structured process and means to enable the realization of successful systems or capabilities
- Concentration on the whole rather than the parts

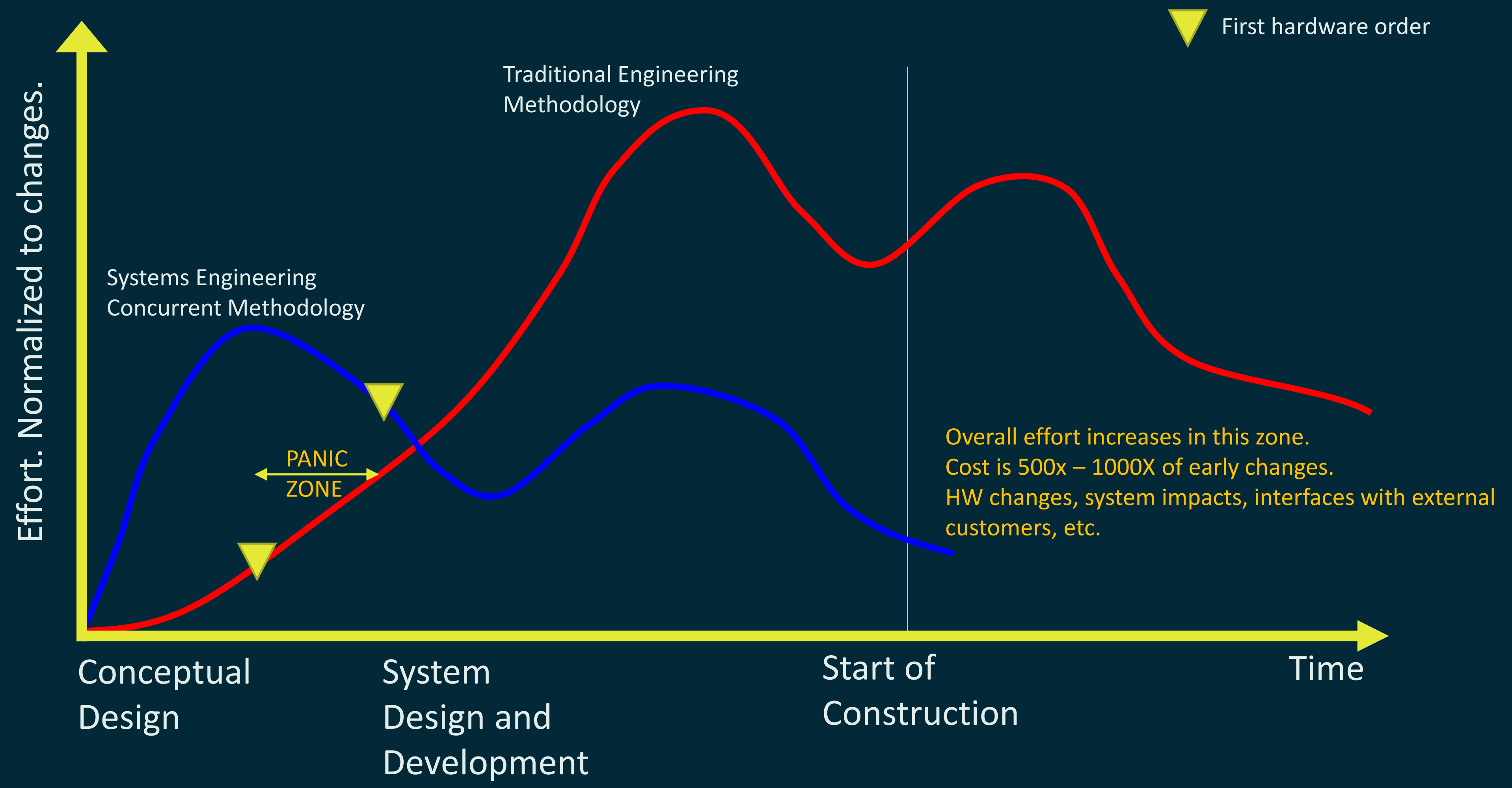
Systems Engineering “V” Diagram



Why Systems Engineering?



Systems Engineering vs. Traditional Engineering



Note: The area under the curve for SE is smaller over the full project if executed wholly. Milestones like HW ordering may lag traditional expectations, causing project anxiety and concern. End to end SE in a concurrent, collaborative Digital Engineering space brings significant savings to projects of all sizes and industries.

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What Are the Problems of Current SE Practices?

- Microsoft Word, PDFs, Spreadsheets, Paper Documents, Visio Diagrams, Legacy Systems, etc. dominate the design process
- Software tools are disparate and siloed
- Changes are manually intensive, difficult to assess impacts
- None of this is “wrong”, but it is tedious, costly, and induces significant delay

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Model-Based Systems Engineering (MBSE)

Systems Engineering → With Digital Engineering → Model-Based Systems Engineering (MBSE)

- MBSE: the shift from document-based, static approaches to the use of LML/SysML models and databases as the means of information exchange
- Model: A simplified version of a concept or structure; graphical representation of a process; abstraction of information to facilitate understanding and eliminate superfluous detail
- Models and data form an integral part of the technical baseline, not just visual depictions

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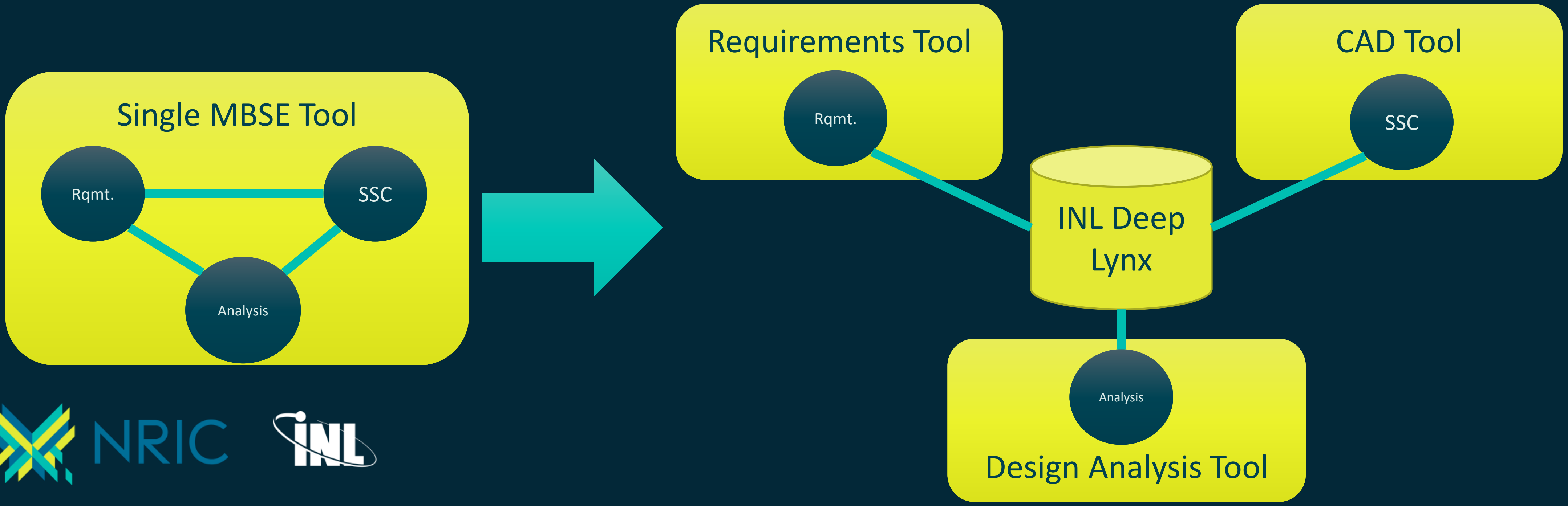
What are the Shortcomings of MBSE?

- New tools / unfamiliar processes
- Insufficient configuration management of models
- Tools typically not configured for nuclear energy applications
- Legacy programs still expect documentation
- Manual user linking

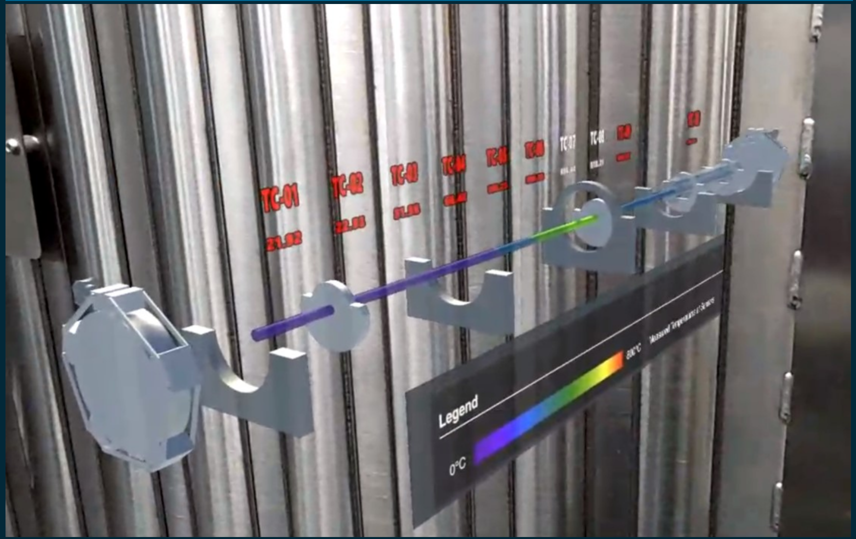
Data-Driven Systems Engineering

- Basic Premise: Use purpose-built, data-driven tools to generate the right design data with the least interference with legacy practices
- Automate data connection on the backend using custom software adapters and database APIs to accomplish the function of model-based systems engineering
- Store data in single repository under a common ontology



Future Benefits of Data-Driven SE

Artificial Intelligence / Machine Learning



Overlaying predicted temperature values from a machine learning algorithm on a digital representation of a real asset using mixed reality

Operational Digital Twins

Displaying real temperature values recorded by physical instruments on a 3D model using mixed reality

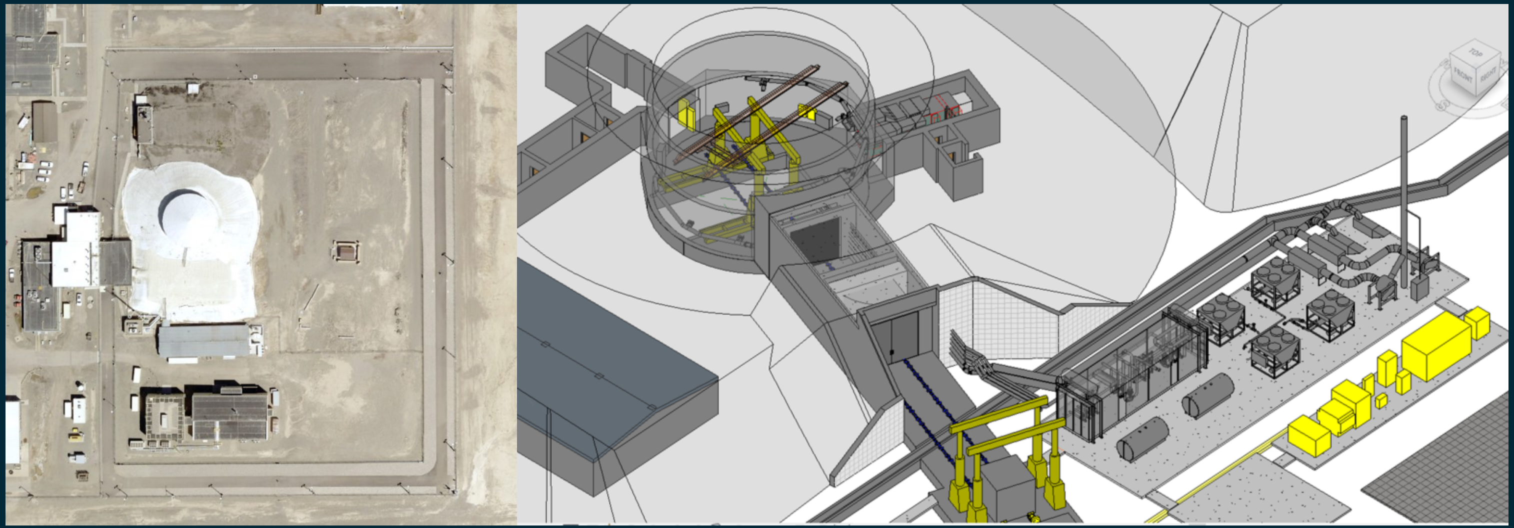
Application of Digital Engineering at NRIC

Why NRIC needs Digital Engineering

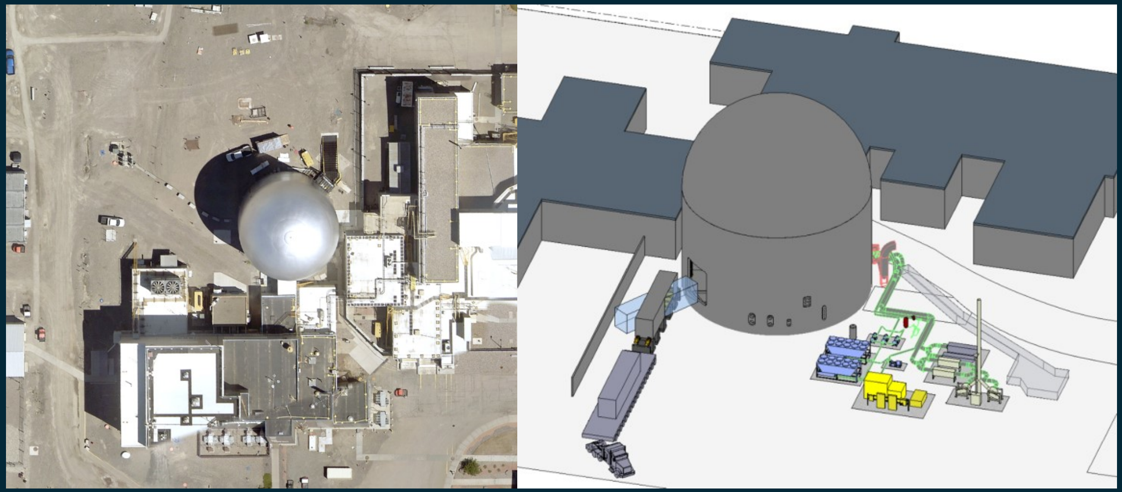
- Digital engineering provides for the most secure, highest quality, most accessible, fastest execution of large scale and complex projects.
- NRIC is charged with making nuclear development and commercialization better, faster, and cheaper as a way to support the industry and enhance public acceptance.
- NRIC expects to "Do it right." every time and provide the most advanced look at reactor and testbed integration and designs.

NRIC Test Beds

LOTUS – refurbished ZPPR
< 500kw thermal



DOME – refurbished EBR-II
< 20 MW thermal



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INNOSLATE

MBSE

IBM DOORS

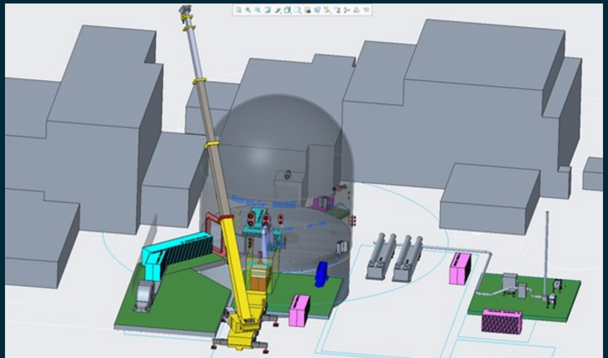
Requirements Engineering

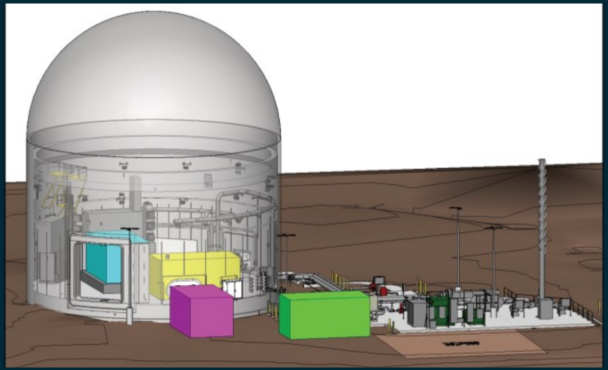
windchill

Product Lifecycle Management

creo

3D CAD Digital Twin

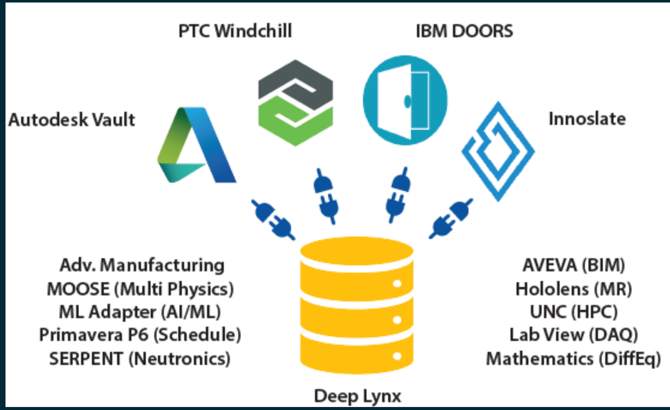




AUTODESK REVIT

3D BIM Digital Twin

- Full documentation of system requirements
- System architecture and analysis
- 3D modeling for design, simulation, and analysis.
- Democratized access to all data in real time.
- Concurrent, collaborative engineering processes



Deep Lynx

PROCORE

Construction execution

Asset Suite

Enterprise Asset Management O&M

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NRIC Digital Tools

- Innoslate – Database driven, architecture and Model Based Systems Engineering (MBSE) tool, used to perform functional analysis
- Dynamic Object Oriented Requirements System (DOORS) – An enterprise level, database driven, requirements, verification, and traceability tool.
- CREO, Inventor, AutoCAD, Revit – Digital Twin CAD software
- Windchill, Vault – Enterprise level PLM/PDM, model and document configuration management and change control tools.

Conclusions

The NRIC Digital Engineering Ecosystem allows us to employ a data-driven approach to engineering while conforming to existing INL practices / processes / procedures and connecting this rich data set behind the scenes

Systems Engineering (SE) helps us build the right thing the first time while saving time/money on rework and modifications

Questions?