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Increasing Systems Engineering Efficiency for NASA's Earth to Orbit Group and Sandia National Laboratory's Recompression Closed Brayton Cycle Initiative with the Process Management Tool Vdot™

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Author Companies

Affiliated Organizations

Agenda

- Introduction
- Process Management With Vdot™
- NASA's Earth to Orbit (ETO) Architecture Analysis
- Managing the ETO Architecture Analysis
- Sandia National Laboratory's Recompression Closed Brayton Cycle Development and Commercialization
- Managing the Supercritical Transformational Energy Power (STEP) Initiative
- Conclusions
- Acknowledgements

Introduction

- American engineer and social scientist Henry Laurence Gantt was the inventor of the Gantt chart, the most common form of showing a project plan and progress.
- The PERT (Program Evaluation and Review Technique) chart, conversely, is a pure logic representation of the project, with no time scaling, but with detailed logic relationships. Originally developed by the US Navy in the 1950s.
- However, most planning and execution software tools do not supply a real-time, critical path analysis, or the ability for the manager to quickly see a broad picture.

Introduction (Cont.)

Inputs

Manager

- What is happening right now?
- What else should be happening now?
- Are we on schedule & budget?
- Are we following the plan?
- Do we need to change the plan?
- Are we meeting technical requirements?

Do Work

Unnecessary Rework

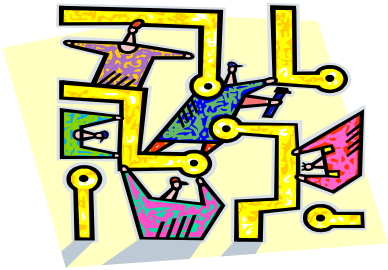
Late Deliveries

Poor Info Handoffs

Numerous Status Meetings

Overloaded Resources

Tribal Knowledge



Deliverables

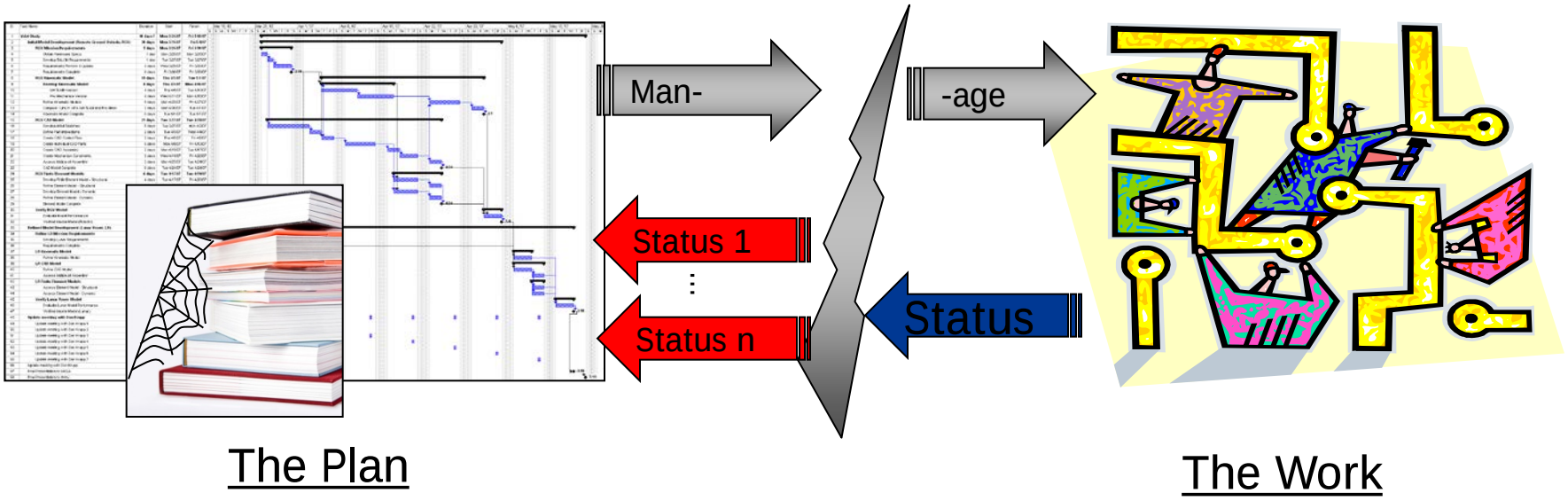
Team Members

- What should I do next?
- What is the highest priority?
- When is it needed?
- How should I do it?
- Where is the data?
- Where did the data come from?
- Who needs my deliverables?

How do you know…?

Visibility Challenges Cause Waste

Introduction (Cont.)

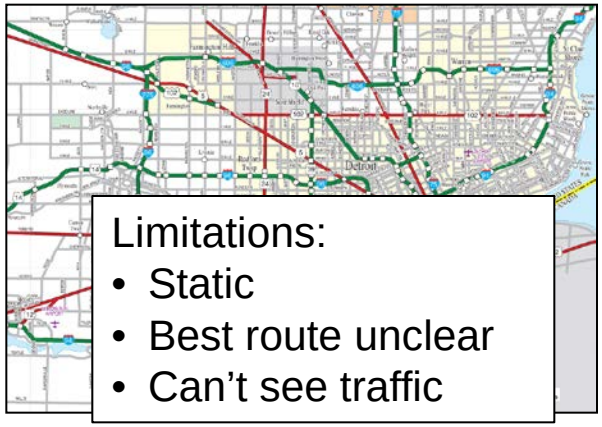


What limits visibility?

Management / Work Gap Limits Visibility

Introduction (Cont.)

Old Way – Paper Map

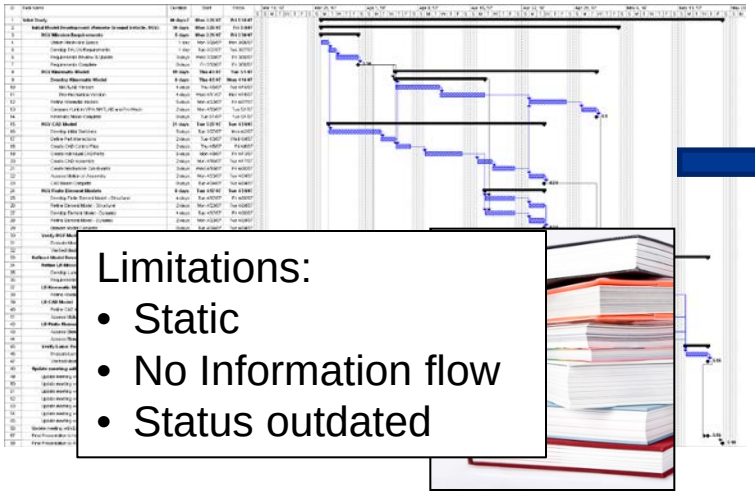


Limitations:
- Static
- Best route unclear
- Can't see traffic

Ideal – Real-time GPS

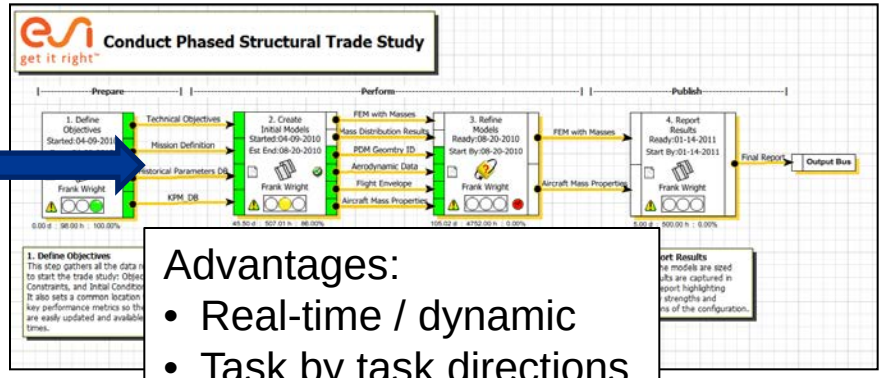
Advantages:
- Real-time / dynamic
- Turn by turn directions
- Traffic alerts

Old Way – Gantt/Procedure/Spreadsheet



Limitations:
- Static
- No Information flow
- Status outdated

Ideal – Interactive Process



Advantages:
- Real-time / dynamic
- Task by task directions
- Instant status visibility

How can we see where to go?

Vdot™ Process Management

Kit for Tools

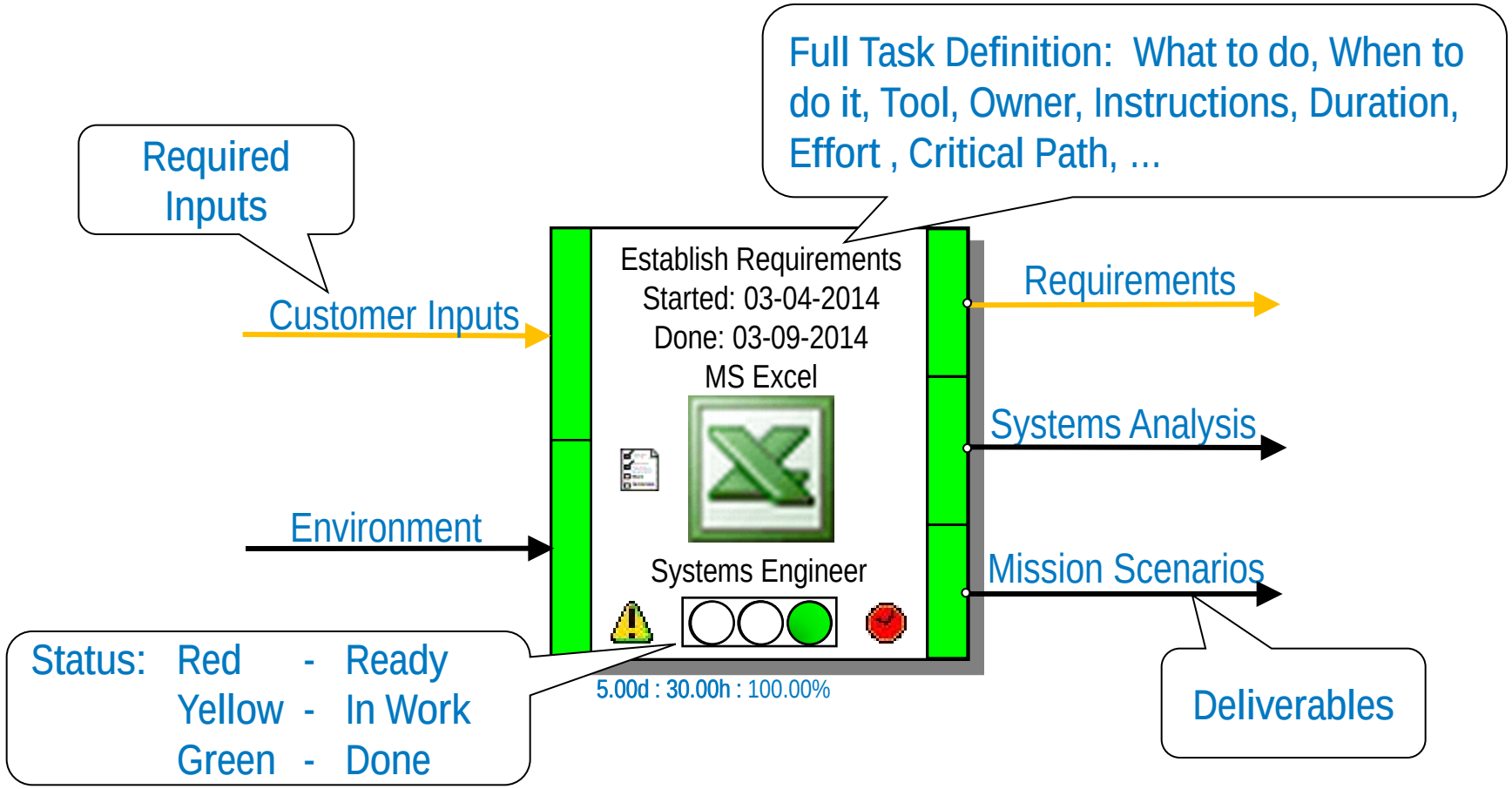
Work Instructions

Kit for Materials

How does Vdot Work?

Lean Factory "Kit" Analogy

Vdot™ Process Management (cont.)

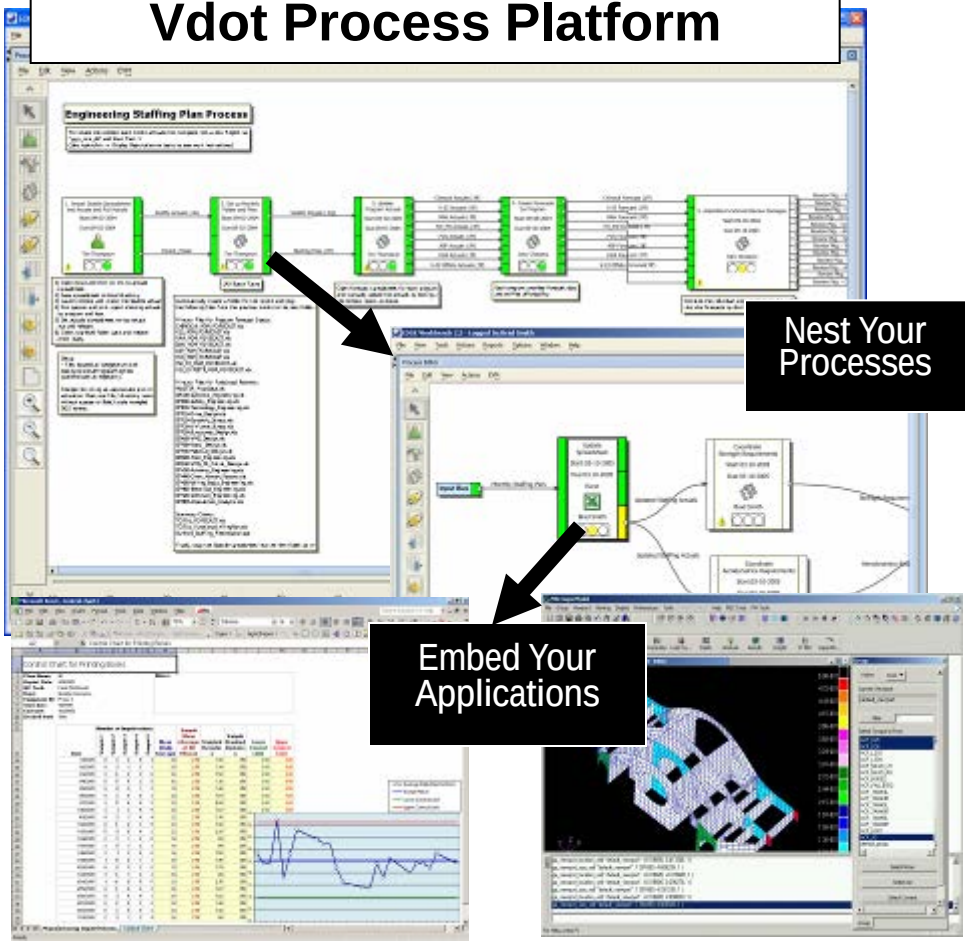


Vdot™ "Smart Task Kits" Completely Define Activities

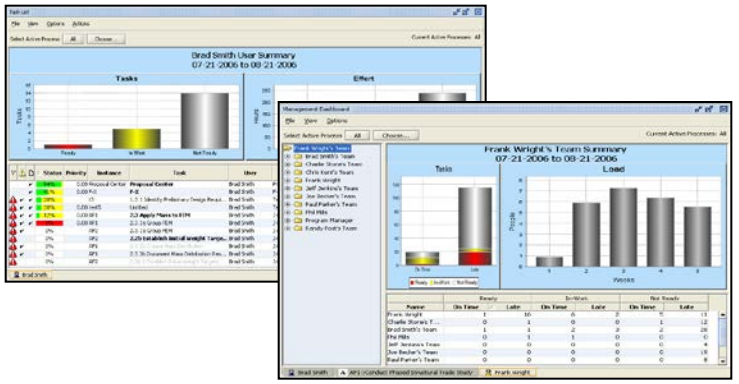
Everything Required for the Task at Hand at the Right Time

Vdot™ Process Management (cont.)

Vdot Process Platform

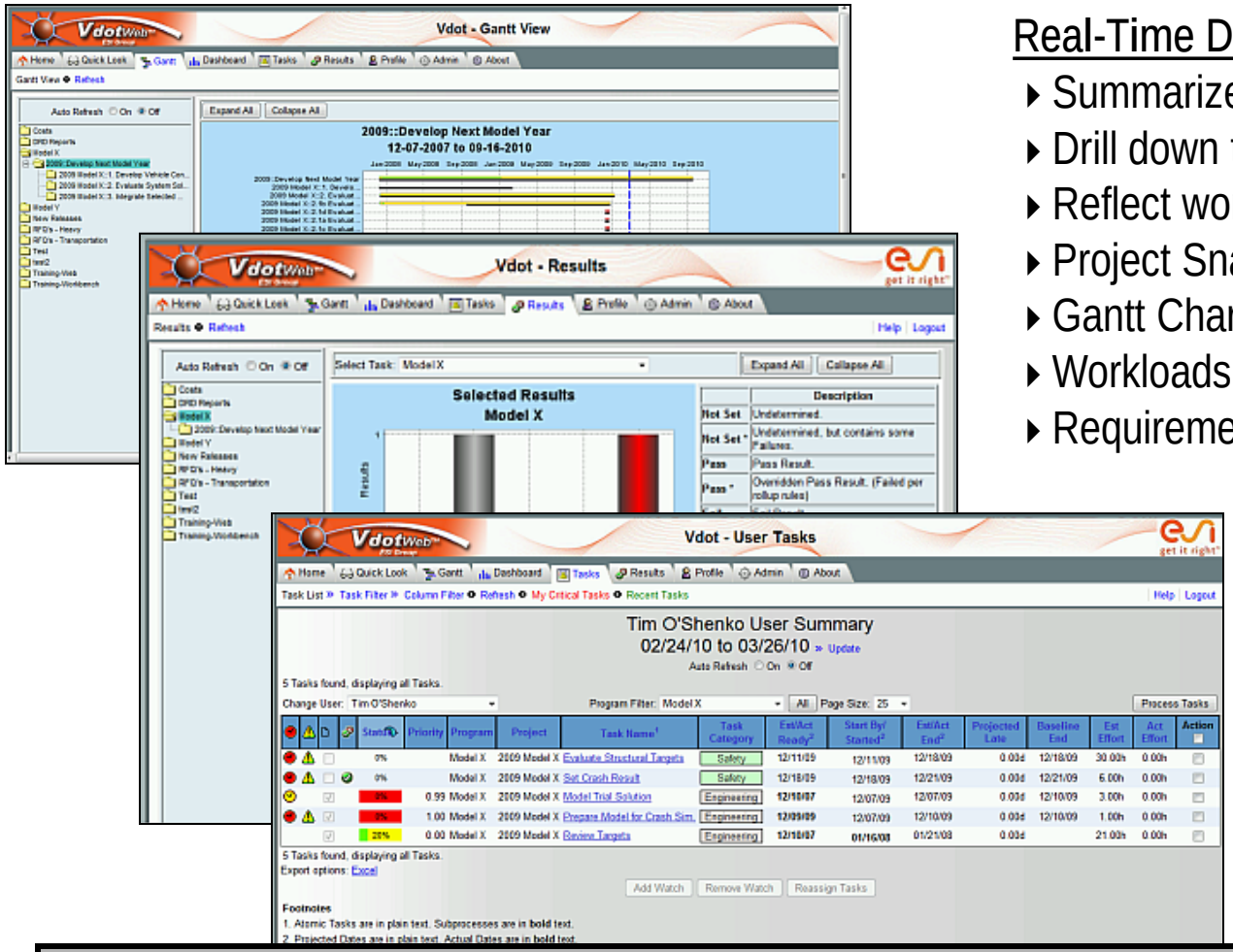


- Smart Task Flows
- Visual Process Control
- Connected to the Work
- Real-Time Dashboards



Improved Project Planning, Execution, and Efficiency

Vdot™ Process Management (cont.)



Real-Time Dashboards for Managers

- Summarize team performance
- Drill down to individual performance
- Reflect work as it is performed
- Project Snapshots
- Gantt Charts
- Workloads
- Requirements

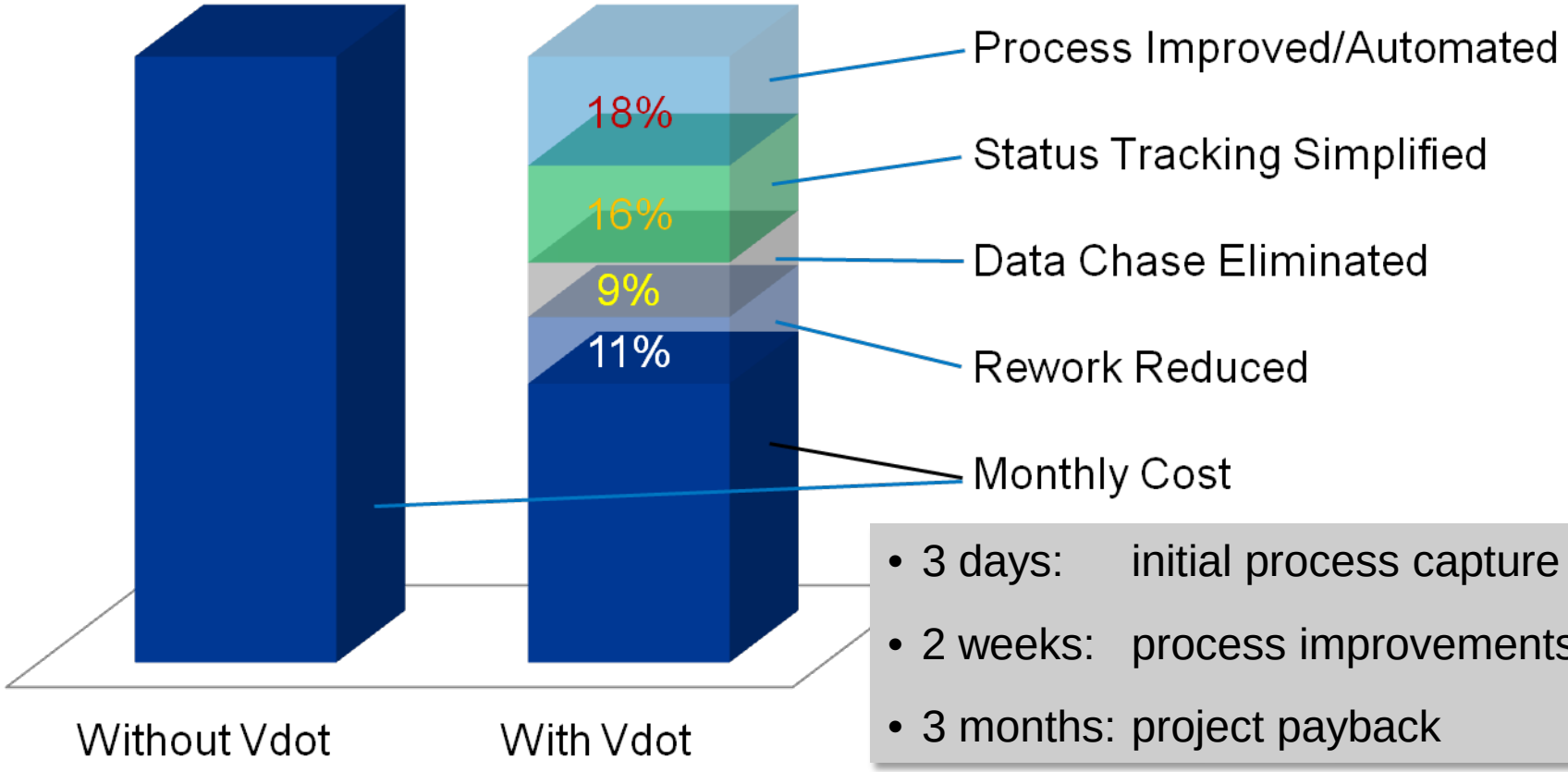
Task Lists for Team

- Gives task priority / schedule information
- Can launch tasks straight from list
- Reflects as-planned and as-changed work

Real-Time Information via the Web for All Participants

Vdot™ Process Management (cont.)

Example: 54% Cost Savings with Vdot™



- 3 days: initial process capture
- 2 weeks: process improvements
- 3 months: project payback

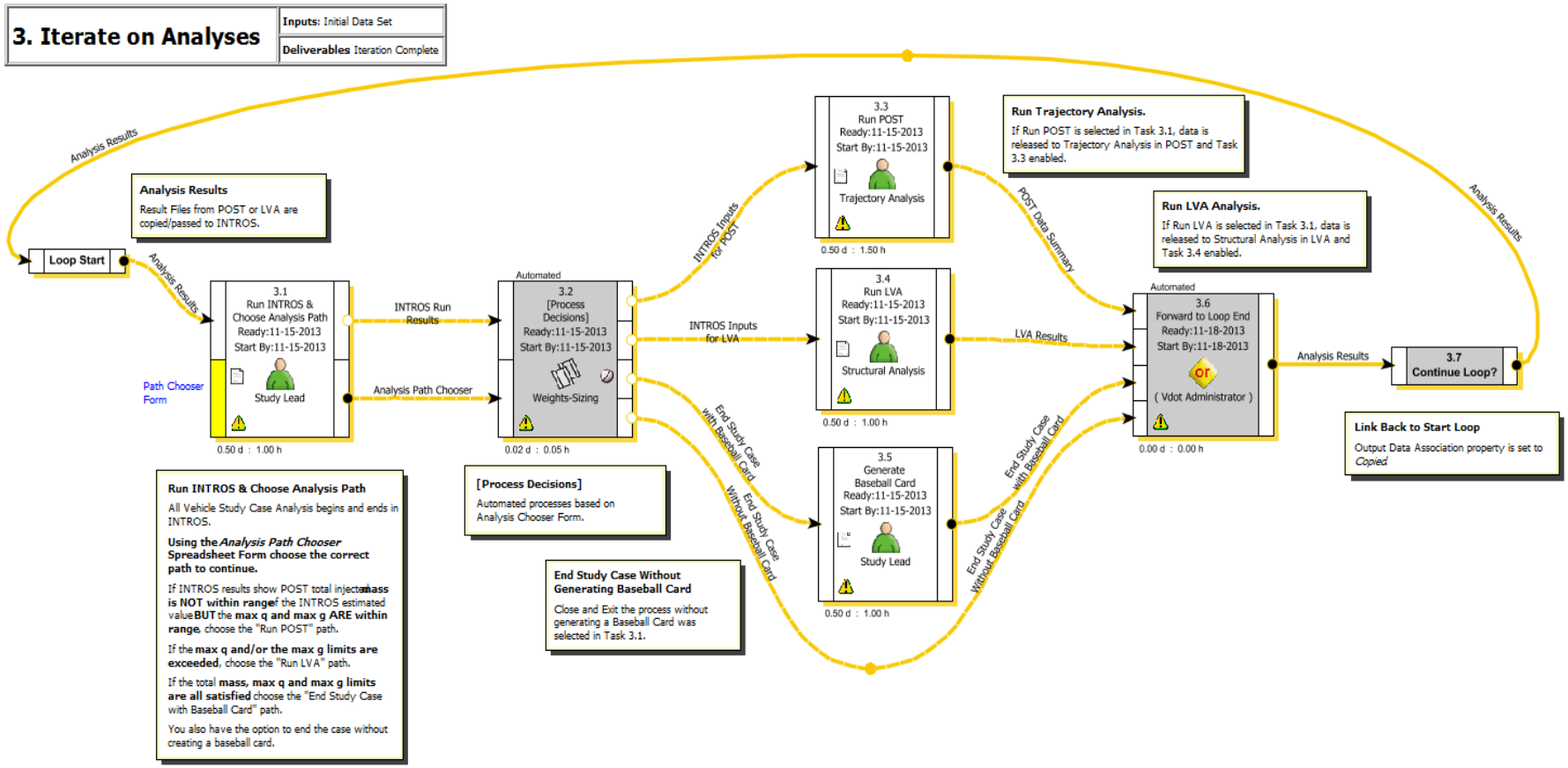
Easy, Rapid Implementation. Dramatic Savings.

NASA ETO Analysis

The ETO group is looking at various Space Launch System (SLS) heavy lift vehicle architectures, and is tasked to answer the questions: Will it work? What will it look like? What is the preliminary design?

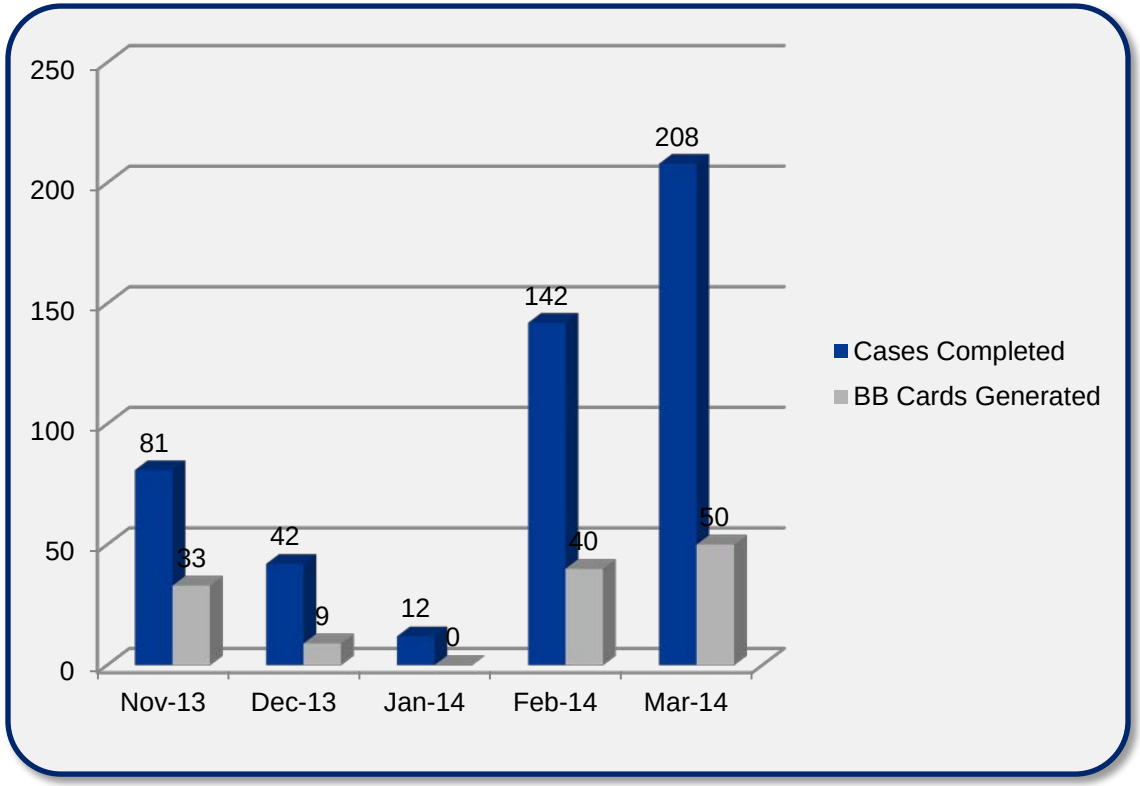
Managing the ETO Analysis

The ETO SLS Evolvability Study Execution template was put into production in Nov 2013. This process template is repeatable and reusable for all ETO SLS study cases. Once activated, multiple Vdot study cases can run simultaneously. Example of one sequence where iterations are required is shown here.



Managing the ETO Analysis (cont.)

Run times have improved from weeks to hours with Vdot. And the state of the data being analyzed is captured for each step in a database. The results of each ACO analysis are summarized in a "baseball card" showing the architecture of the mission. Productivity for these analyses has soared with the use of Vdot.



- As of 3/31/14
  - 485 Study Cases Completed
  - 132 Baseball Cards Generated
  - 19,000+ tasks executed in the system

Sandia CBC Development

Sandia took the lead in investigating the supercritical carbon dioxide (S-CO2) closed Brayton cycle (CBC) using internal research and development funds in 2007. Initial investigations focused on the stability of S-CO2 as a working fluid very near the fluid's critical point – a thermodynamic state in which fluid properties vary dramatically. STEP is funded @$27.5M for FY15, S-CO2 @$57M.

Nuclear

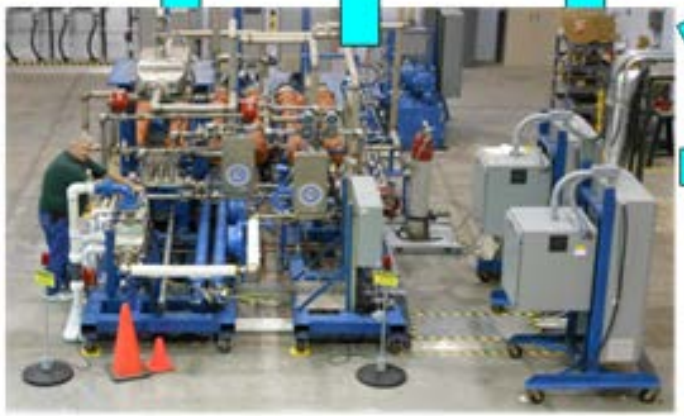
- Using Supercritical Fluids
- Higher Conversion Efficiency
- 1/10 of the Cost
- 1/100 of the Plant Volume

Fossil

Concentrated Solar

Geothermal

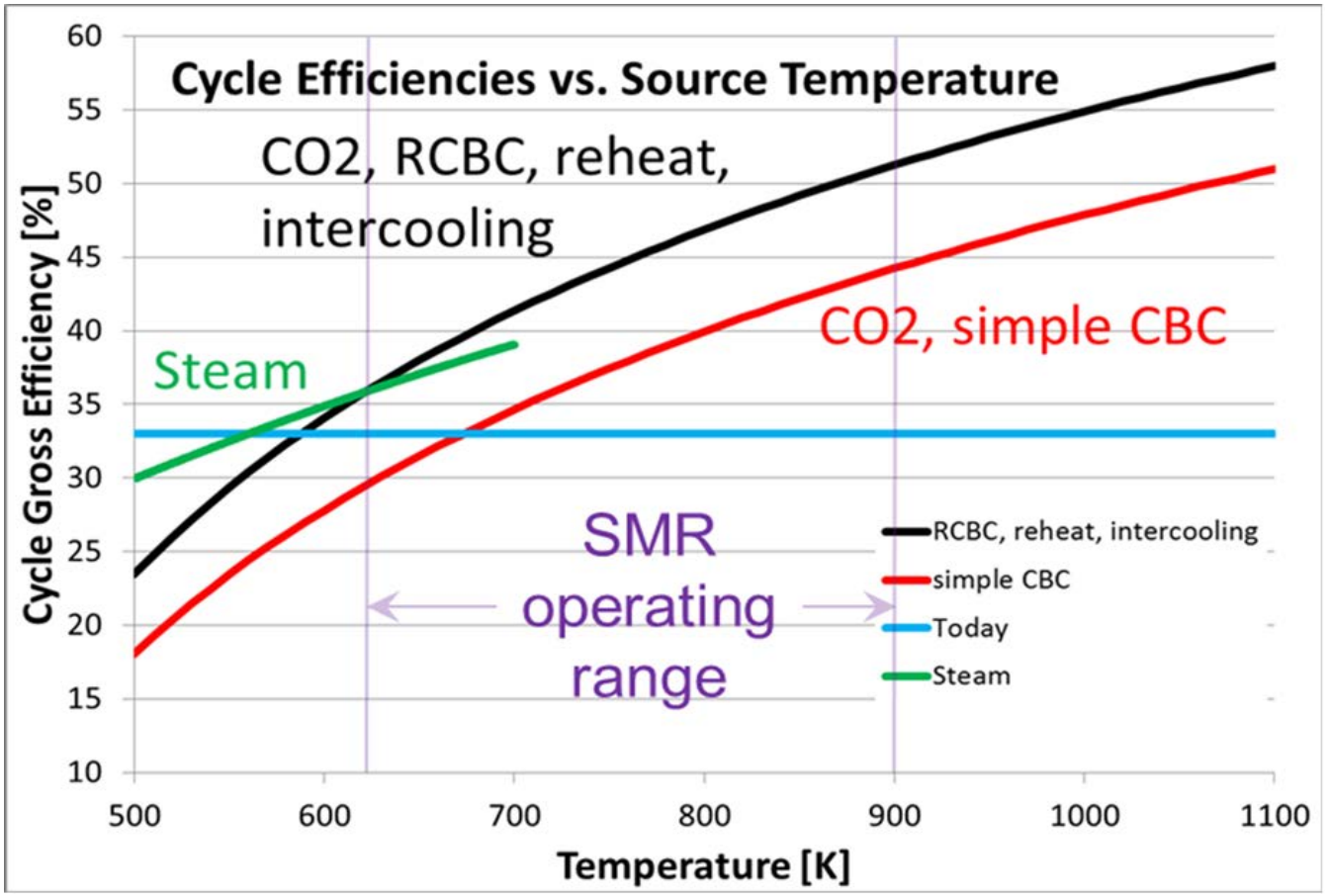
Turbomachinery



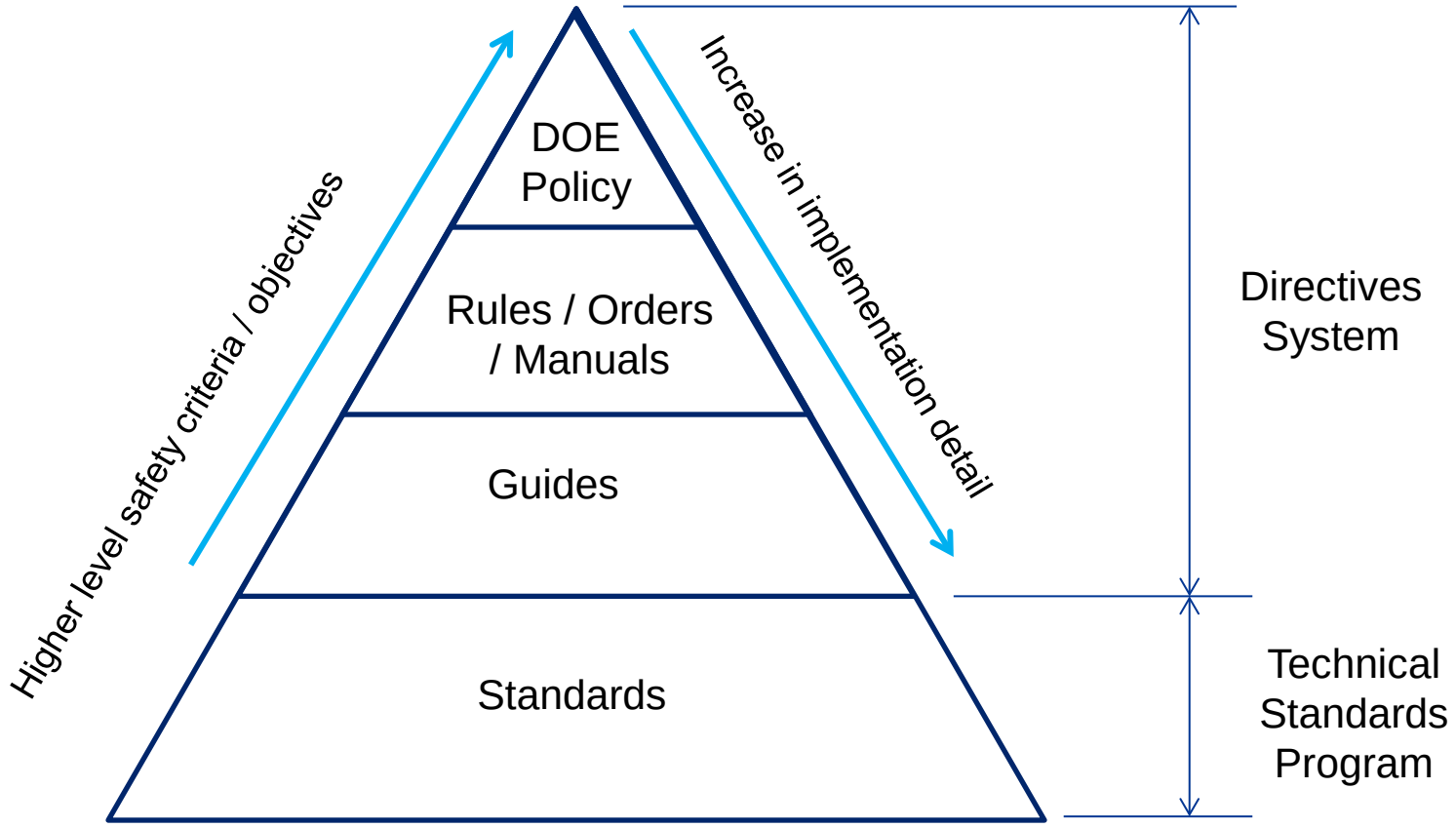
Industrial Heat

Managing the CBC R&D

The use of supercritical carbon dioxide can produce energy conversion efficiencies significantly higher than that for steam, the current standard working medium. Hence the push for commercialization efforts in parallel to the R&D.

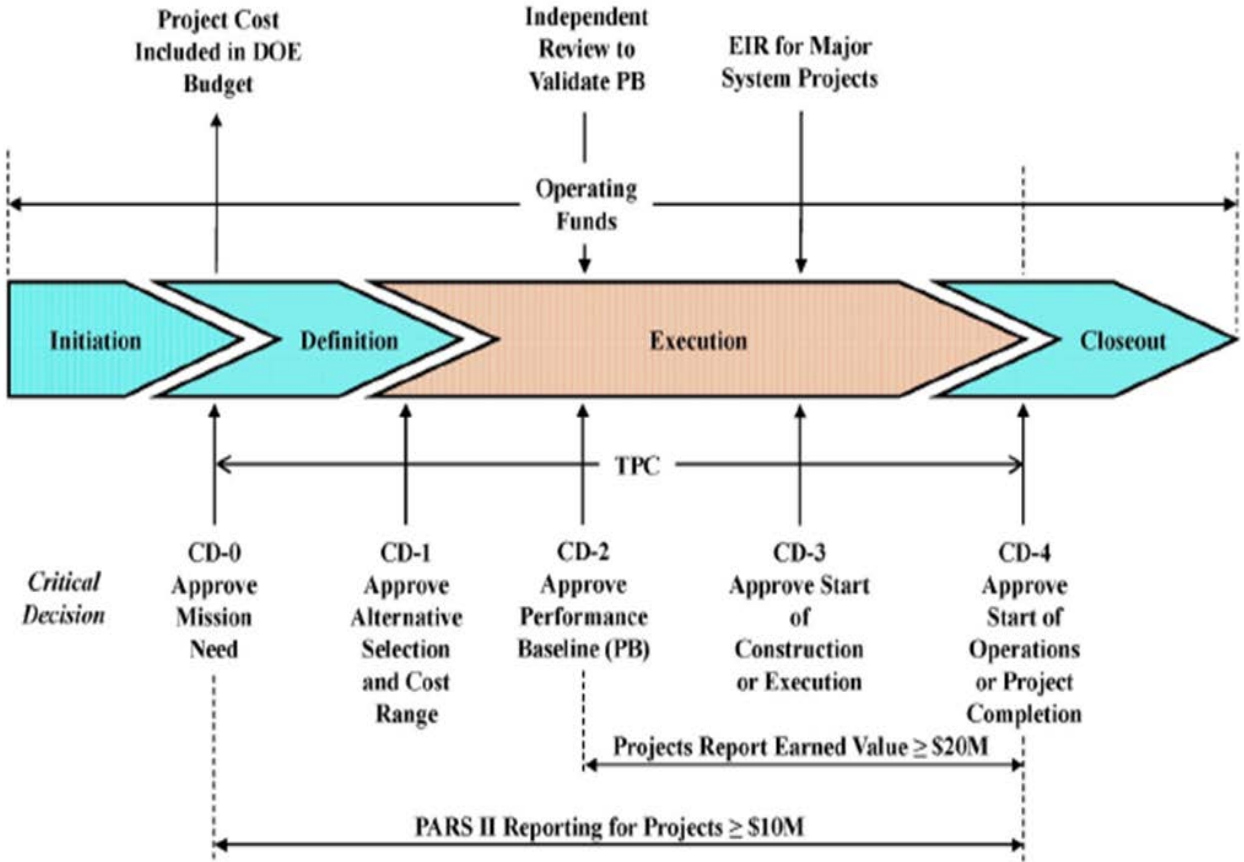


DOE Standards Hierarchy



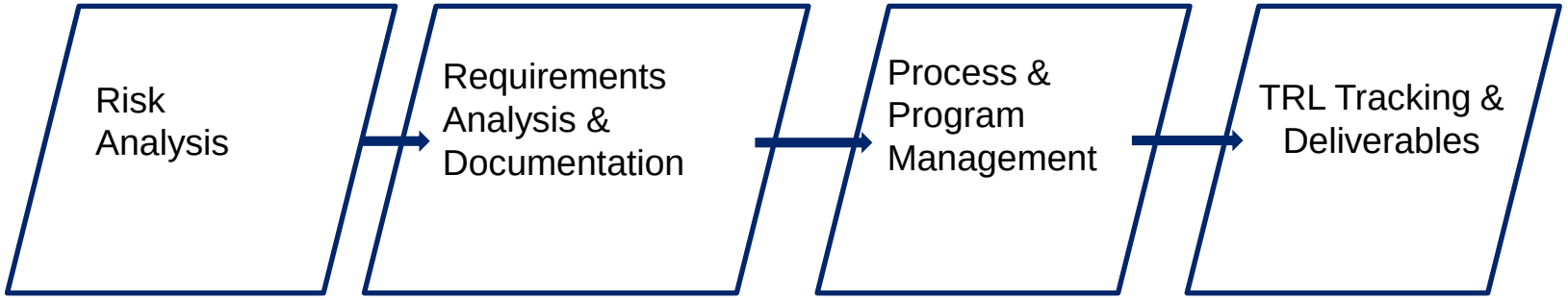
Managing STEP Initiative

As the technology R&D moves toward the full validation of these features, the DOE has a very specific set of instructions that will guide the STEP program. Available online at www.directives.doe.gov, the document “Managing Design and Construction Using Systems Engineering” will be our guide.



Managing STEP Initiative (cont.)

STEP Systems Engineering Construct



DOE-STD-1628-2013, Development of Probabilistic Risk Assessments for Nuclear Safety Applications, Commercial Tools

Cradle Requirements Tool from 3SL

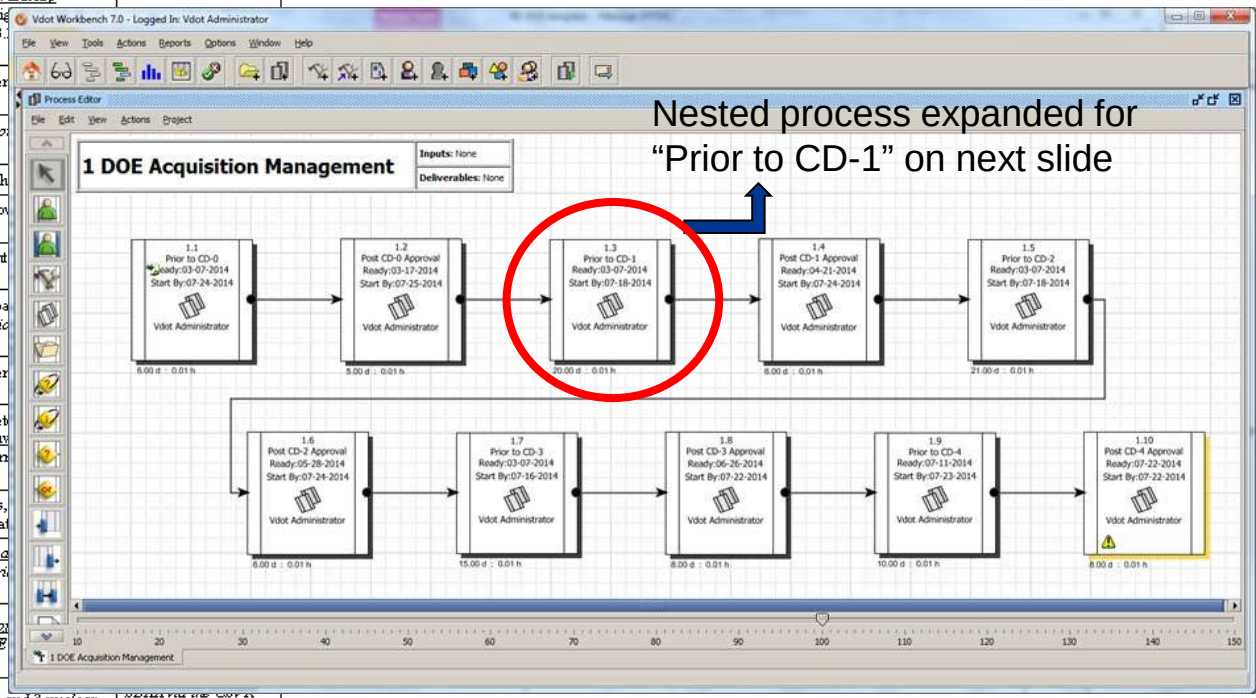
Vdot™ Process & Program Management Tool from ESI Group

Technology Program Management Model (TPMM) Sharepoint solution set from the US Space and Missile Defense Command, PARS II

Managing STEP Initiative (cont.)

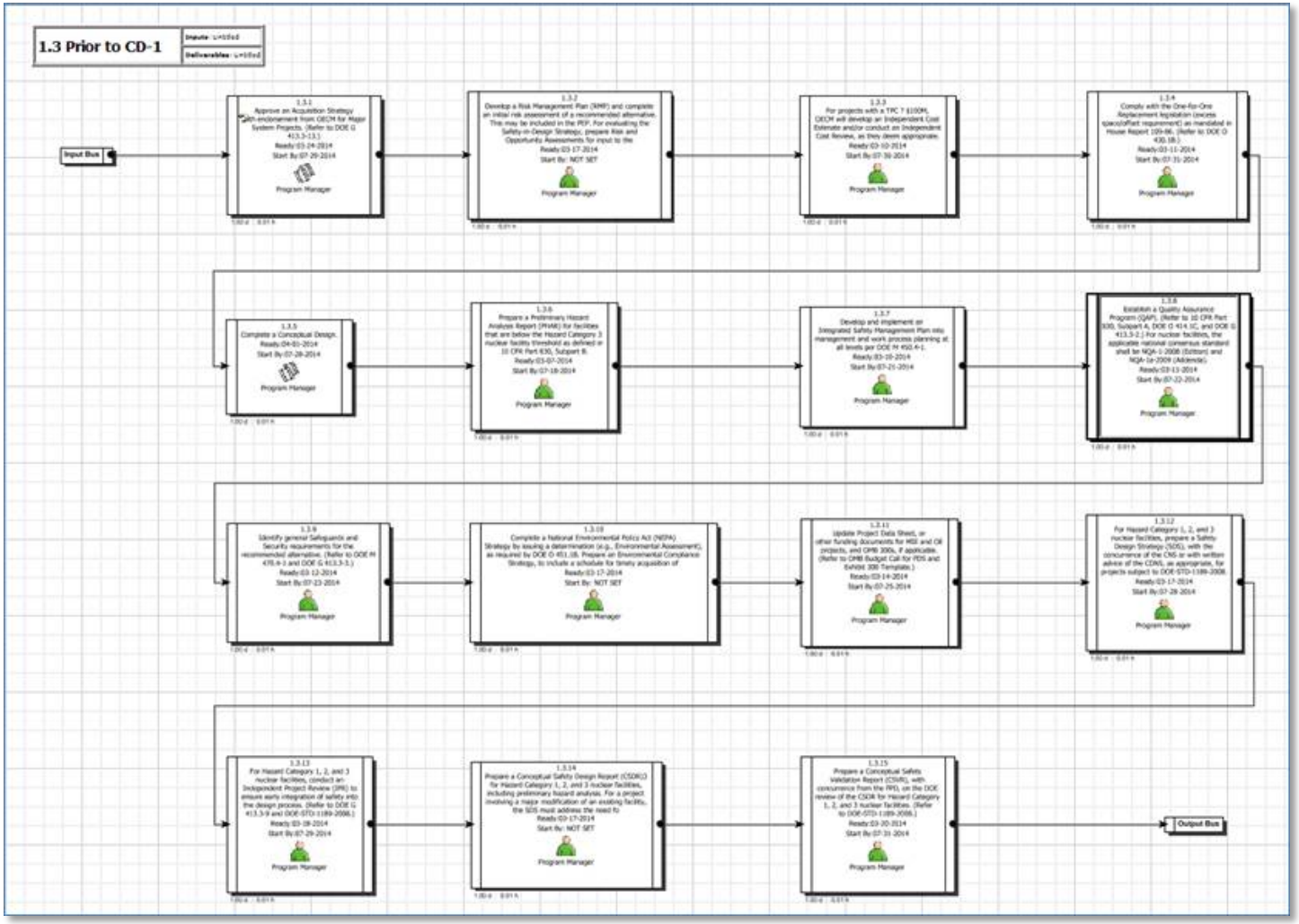
- The following representative table contains an example of the process steps required for a sample Critical Decision (CD). The process steps for each CD have been modeled in Vdot, and the overall top-level view of all the nested CDs is shown here.

Prior to CD-1	Approval Authority[2]
Complete a Conceptual Design.	
• Document High Performance and Sustainable Building provisions per EO 13423, Section 2(f), EO 13514, Section 2, and Sustainable Environmental Stewardship considerations per DOE O 450.1A, as amended, in the Conceptual Desig Acquisition Strategy, and/or PEP, as appropriate. (Refer to DOE G 413. DOE O 430.2B.)	
• Conduct a Design Review of the conceptual design with reviewers exter project.	
• *For nuclear facilities, a Code of Record shall be initiated during the co design.*	
• Complete a Conceptual Design Report. Refer to Appendix C, Paragraph	
Prepare a Preliminary Hazard Analysis Report (PHAR) for facilities that are belo Category 3 nuclear facility threshold as defined in 10 CFR Part 830, Subpart B.	
Develop and implement an Integrated Safety Management Plan into management process planning at all levels per DOE M 450.4-1.	
Establish a Quality Assurance Program (QAP). (Refer to 10 CFR Part 830, Subpa DOE O 414.1C, and DOE G 413.3-2.) *For nuclear facilities, the applicable natio standard shall be NQA-1-2008 (Edition) and NQA-1a-2009 (Addenda).*	
Identify general Safeguards and Security requirements for the recommended alter to DOE M 470.4-1 and DOE G 413.3-3.)	
Complete a National Environmental Policy Act (NEPA) Strategy by issuing a det (e.g., Environmental Assessment), as required by DOE O 451.1B. Prepare an Env Compliance Strategy, to include a schedule for timely acquisition of required per licenses.	
Update Project Data Sheet or other funding documents for MIE and OE projects, 300s, if applicable. (Refer to OMB Budget Call for PDS and Exhibit 300 Templat	
For Hazard Category 1, 2, and 3 nuclear facilities, prepare a Safety Design Stra with the concurrence of the CNS or with written advice of the CDNS, as appropri projects subject to DOE-STD-1189-2008.	
For Hazard Category 1, 2, and 3 nuclear facilities, conduct an Independent Proj (IPR) to ensure early integration of safety into the design process. (Refer to DOE DOE-STD-1189-2008.)	
Prepare a Conceptual Safety Design Report (CSDR)[4] for Hazard Category 1, 2, and 3 nuclear facilities, including preliminary hazard analysis. For a project involving a major modification of an existing facility, the SDS must address the need for a CSDR, as well as the required PDSA. (Refer to DOE-STD-1189-2008.)	
Prepare a Conceptual Safety Validation Report (CSVR), with concurrence from the FPD, on the DOE review of the CSDR for Hazard Category 1, 2, and 3 nuclear facilities. (Refer to DOE-STD-1189-2008.)	*SBAA*



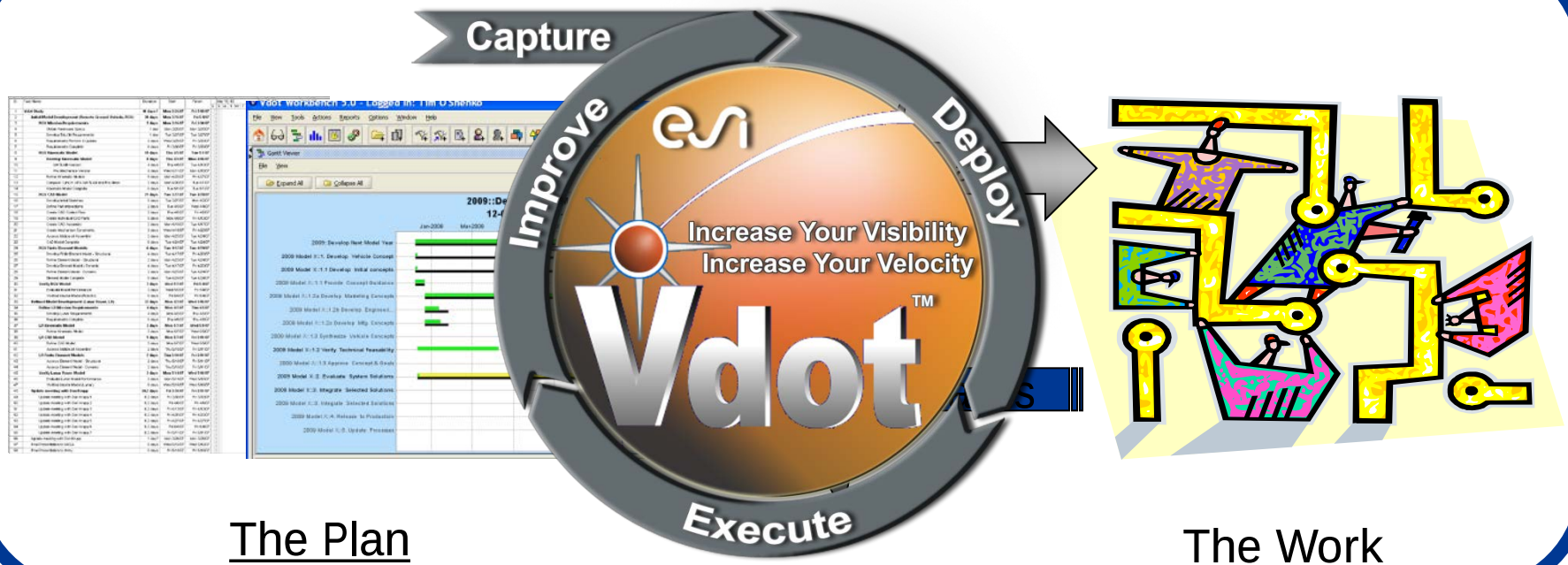
Managing STEP Initiative (cont.)

- The process steps for “Prior to CD-1” have been modeled in Vdot, as shown. This is an expansion from the nested process.



Conclusion

Vdot™ Bridges Plan/Work Gap



The Plan

The Work

Real-Time Visibility for the Entire Team in a Shared Environment

Conclusion (cont.)

- NASA's ETO Architecture Analysis benefits from Vdot by sequencing necessary tasks, deliverables, and team interactions required to produce quality products on time and within budget.
- The Sandia CBC demonstration project will see a set of macros that will work with a variety of commercially available tools to help automate, execute, and track the systems engineering process.
- Vdot™ provides an off-the-shelf platform to support automation of these and more scenarios allowing real-time, traceable collaboration between process participants.

Acknowledgements

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