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Modeling in requirements derivation
Lessons from FCS-MGV Program

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The work presented here was conducted while the author was at SAIC and part of the FCS LSI team

Overview

- FCS program involved complex and continuous requirements derivations through a variety of methods.
- Derivation methods varied from very systematic, analysis based, decomposition and allocation to decision by fiat and BOGSAT.
- While defined as a Soldier Centric System of Systems the program did not have a Soldier Centric KPP or other Soldier Centric governing requirement.

BLUF

- HSI effectiveness in SE was dependent on our ability to deliver credible quantitative data
- Gaps in modeling tools and lack of computability between those tools was a major challenge
- UML imposes a challenge, at times a problem (no user, timeless, flawless)
- HSI modeling was a key to success

User Centered Design

The challenge: to introduce MANPRINT/HSI as early as possible.

- Design drivers competition
- Utilizing user focused requirements analysis
- Designing for future population
- Expanding beyond 5th to 95th to central 90 percent and assure that modeling accounts for Soldiers' dress and equipment likely to be available at fielding time

User Centered Design Goals

- Set realistic system requirements
- Identify future manpower & personnel constraints
- Evaluate operator & crew workload
- Test alternate system-crew function allocations
- Assess required maintenance manhours
- Assess performance during extreme conditions
- Examine performance as a function of personnel

MANPRINT in FCS-MGV SDD

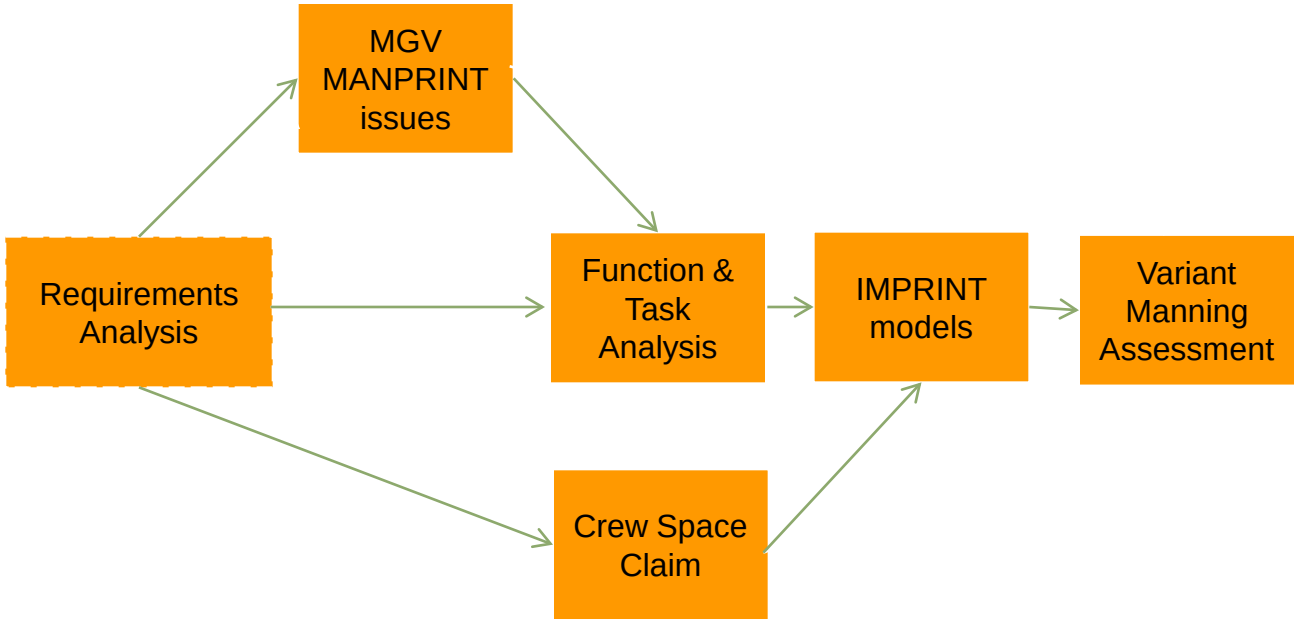
- Manning Assessment process
- Advocacy by MANPRINT engineers, Soldiers, Crew Systems IPT engineers and external support from G1 MANPRINT office, ARL-HRED, TARDEC
- Driving and ownership of Risks and Trades

Developing Unique HSI Requirement Management Process

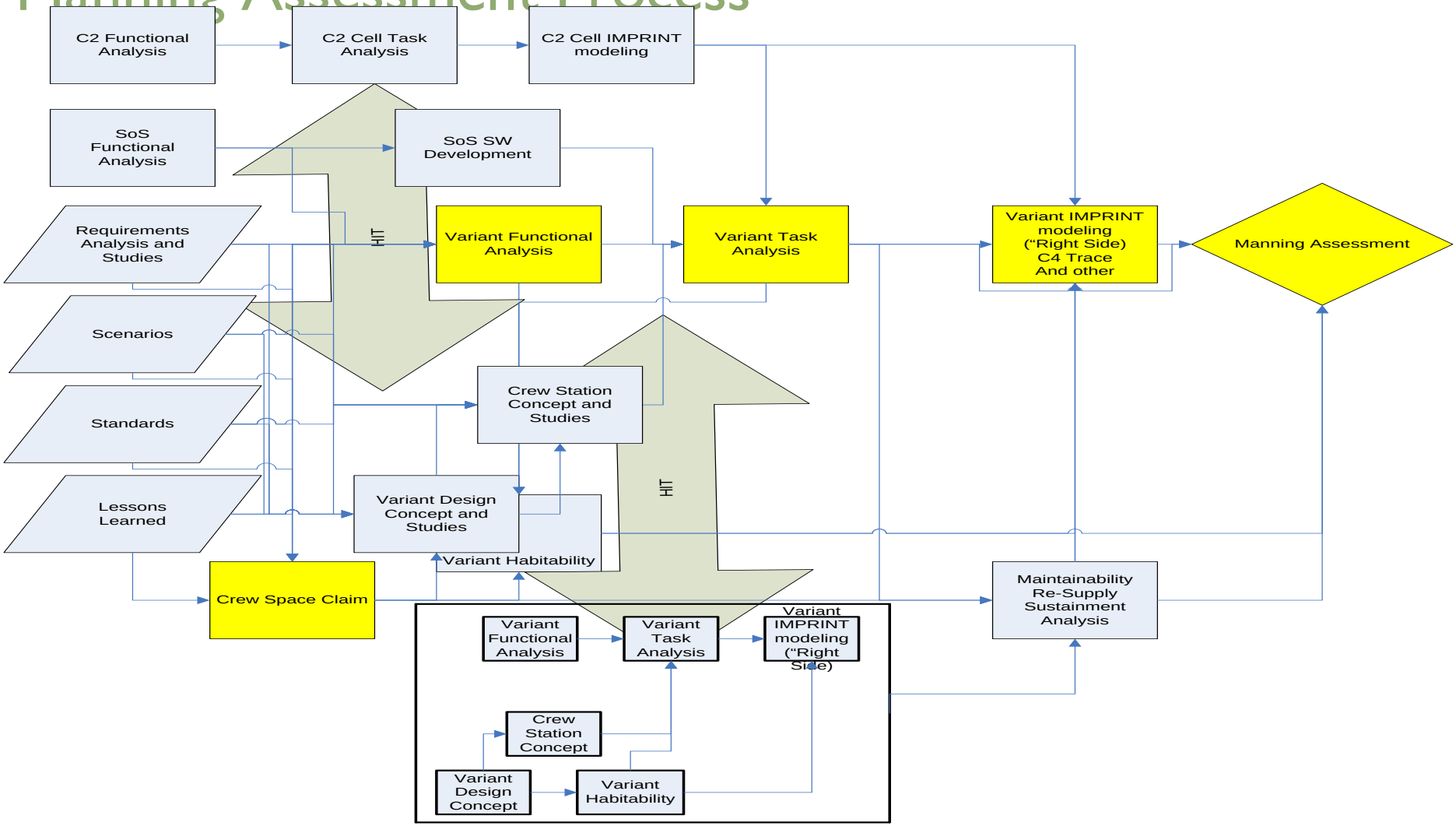
Following a growing body of literature advocating a modeling based process

- Manning Assessment:
  - Assist in formulating human centered design requirements
  - Keep the focus on the critical elements
  - Serves as a basis of coordination between IPTs
- Two Vectors of analysis
  - Physical constraints addressed through ergonomic analysis and modeling – Jack
  - Information-cognitive constraints addressed through cognitive analysis and modeling - IMPRINT

Core Elements of Manning Assessment



Manning Assessment Process



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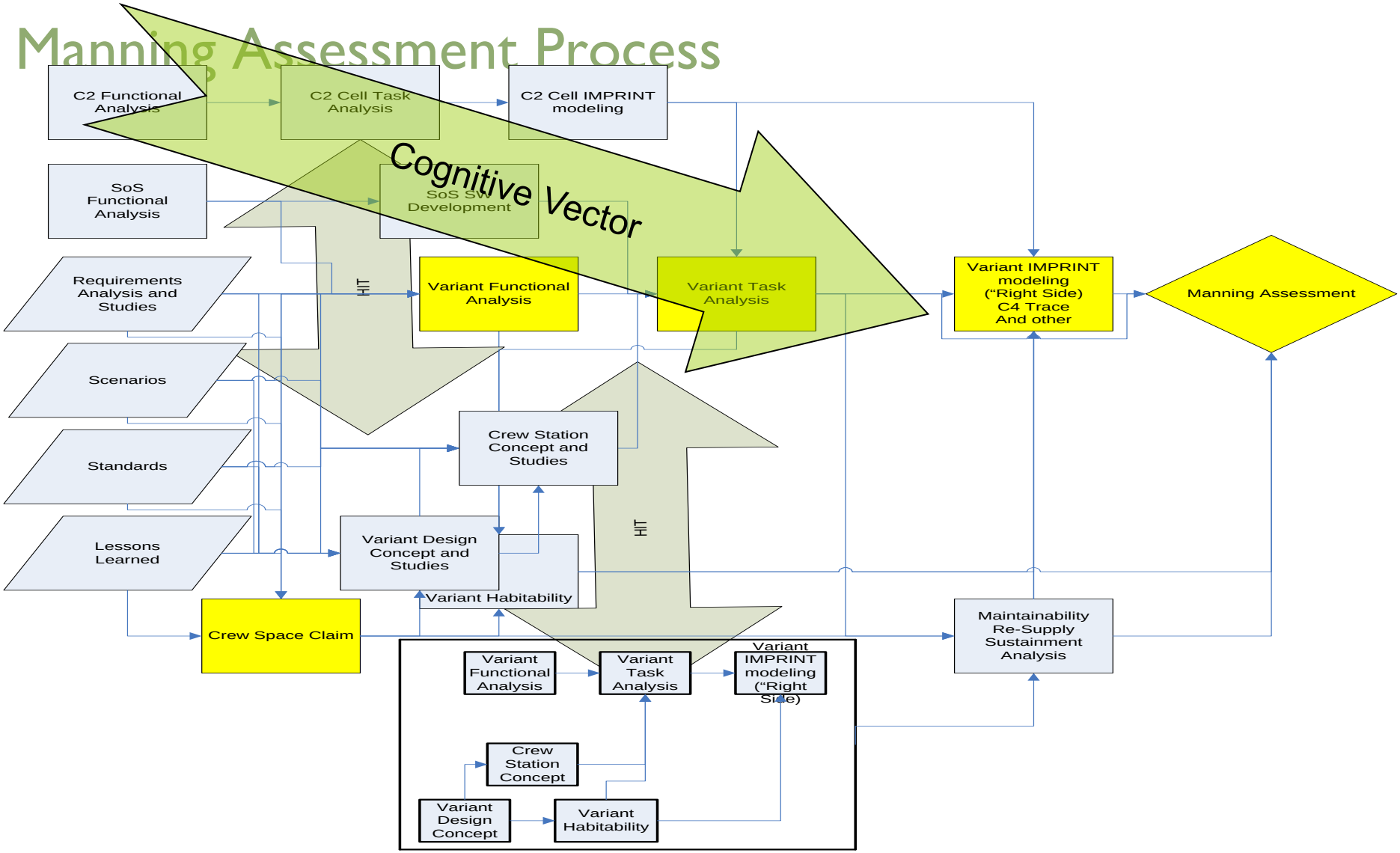
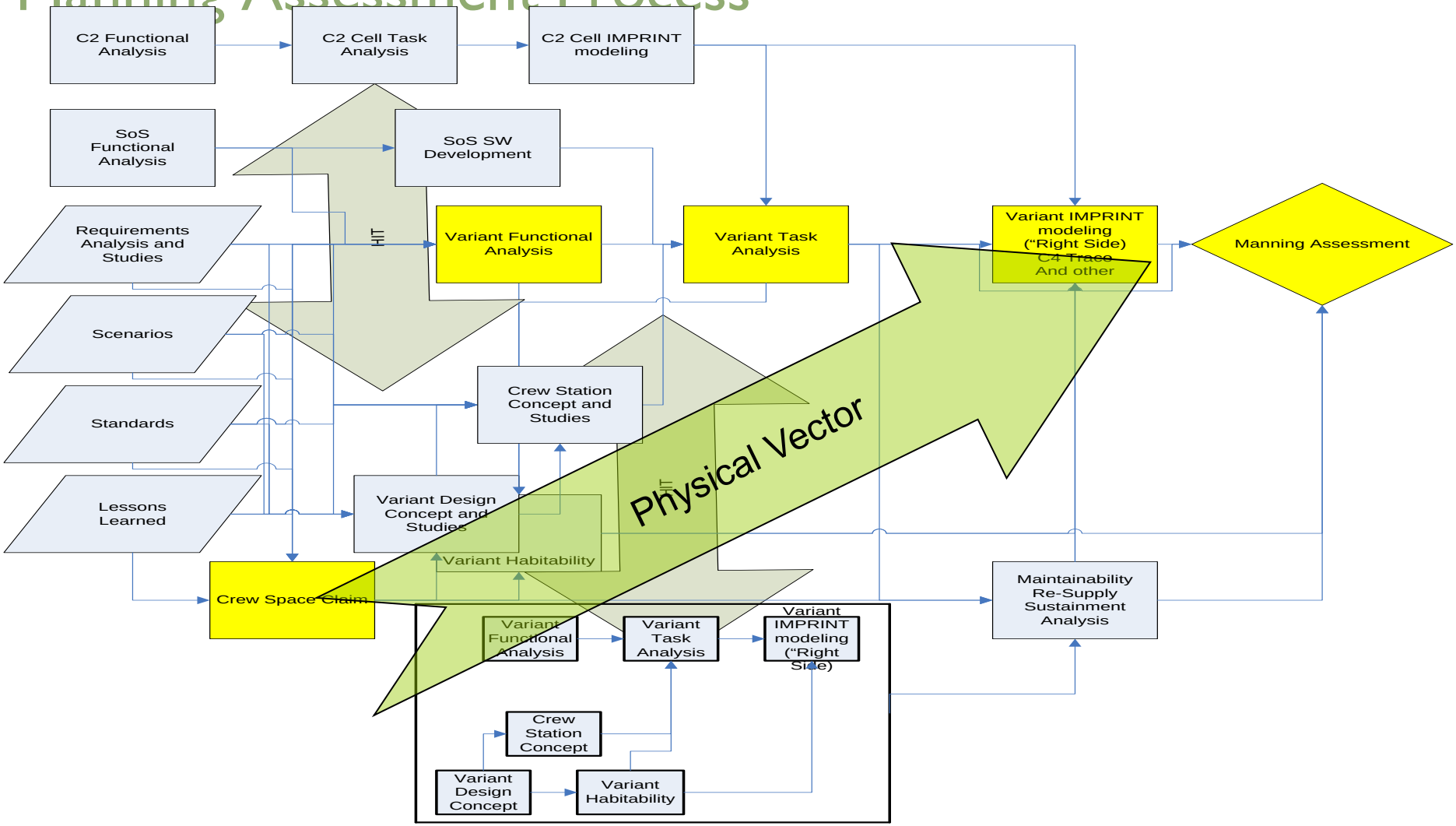


Manning Assessment Process



Case 1 – IMPRINT in crew size trades (the good)

- Example: Crew size of MCS
- Models developed by ARL-HRED prior to FCS SDD phase
- Used successfully to change crew size from 2 to 3
- Lesson – Task Network modeling, IMPRINT, is an effective quantitative method

Case 2 – IMPRINT in crew size trades (the bad)

- Example: Crew size of C2V
- While some modeling of the C2 functionality in IMPRINT and C3TRACE addressed some aspects of the mission, the overall C2 mission was never analyzed
- Vehicle crew size was determined by physical constraints only
- Lesson(s) – IMPRINT alone cannot model all elements required to assess complex distributed large team functionality

Case 3 – IMPRINT in crew size trades (the ugly)

- Example: Crew size of ICV
- Even though very similar to MCS in some combat functions, an IMPRINT model for ICS was developed only after PDR
- Vehicle crew size was an issue at PDR and became a major program risk
- Lesson – Without modeling we failed to address a major issue

Case 4 – transition gap between modeling tools

- Example: seat configuration in mission area of RSV
- Changes in physical configurations were addressed efficiently by JACK (and embedded analysis in Pro-E).
- Effects of change were not assessed for effects on Soldier interaction and communication.
- Lesson – The use of compatible connected tools will help in tying different analysis and trades together (see Alion's Crew Station Design tool)

Case 5 – non modeled impact

- Example: Soldier Machine Interface design in MCS
- As design progressed, MCS IMPRINT model was not updated with design decisions but roles assessment indicated a potential problem
- MCS IPT started extensive Soldier in the Loop testing to assess impact and planned an even larger effort before program was canceled
- Lesson – DOORS was not effective without a tie to prototyping and/or modeling tools

Case 6 – GUI decisions not captured in modeling

- Example: Soldier Machine Interface design in MCS gunner station
- As design progressed, MCS IMPRINT model was not updated with design decisions in the development of the SMI
- Major program risk of Area Security could not assess the role of the MCS gunner in local SA/SU
- Lesson – GUI design tool that is tied to the modeling would have provided a seamless update (see Alion's GRBIL)

Case 7 – Impact of not modeling

- Example: Weight Reduction Initiatives – Removal of display from common crew station
- Common Crew Station SMI and the C4ISR SMI used on it were not modeled. When decision to remove a display was made there was no data to prove key Soldier performance or vehicle performance requirements impact
- Lesson – modeling need to encompass, at least at some detail level, all key user functionality

Case 8 – Impact of modeling

- Example: Area Security
- Local SA/SU as related to the protection of vehicle and the force in its close proximity from small arms, mines, IEDs etc. was assessed as an issue but was not proven
- Use of modified existing IMPRINT models demonstrated high workload associated with those tasks and resulted in allocation of resources to address
- Top program risk established and executed
- Issue flowed to GCV RFP (withdrawn)
- Lesson – modeling can serve as a stepping stone

Following observations

- The examples presented here are just a small sample!
- SEs can not become HSI engineers just because they have access to modeling tools
- SEs expect HSI to deliver compatible meaningful analysis, reviews, models that identify issues, problems, risks, trades
- In many cases, HSI delivers qualitative assessments that can not be used in regular SE process as they can not be traded.
- Modeling (IMPRINT, C3TRACE, Jack) proved to be the second best data source after human in the loop testing.

One last thought

- MANPRINT / HSI / HFE has a major role to play in the new emphasis on affordability. The honorable Mr. Carter's initiative calls for affordability to be a system requirement and addressed in any milestone, gate review, trade and risk. MPT is a key cost element and for most systems, the highest cost element as measured throughout the life cycle of the system. Comprehensive modeling processes can address the analysis need established by the affordability requirements.

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