[Top 10 Approaches to User-Specific Design Prototype Process Capability Constraints Advance Readiness]

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All of the technology advancements in the world don't really mean much to the warfighter unless DoD can design, make and support the product. DoD must meet availability/reliability targets when the troops need it on time to execute field-level efforts critical to mission success. Advances in how DoD designs and produces weapons system impacts bottom line of achieving quality, quantity & cost/benefit objectives.

Weapons System equipment availability/reliability parameters must be explained and guide Design trade-off studies of mission capability and operational support, defining baseline against which the new system will be measured.

So performance factors need to be matched up with Job Site user-specific requirements into clearly defined system parameters and allocate/ integrate parameters to relevant disciplines needed to realise design success.

Systems engineering design attempts to optimise effectiveness and affordability as the capability is created. The systems approach makes sure the question What are the user needs and constraints? is answered before designing the answer.

The top-level design programme plan for achieving required available/reliable is executed in manner to ensure requirements are achievable. Through understanding user needs and constraints, new capabilities begin to be defined.

Must establish the case for a materiel approach to resolve gaps in capability. The primary focus is to acquire quality products balancing process of satisfying user needs while improving mission capability and operational support, also adhering to Design/Build Scheduling constraints and justifiable acquisition costs.

During capability assessments, time and resources need to be set aside to measure and characterise current operational experience, organise metrics and supply line performance to reach conclusions about the causes of shortfalls.

It is also imperative to understand subsystem design complexity and influence on availability/reliability. Capabilities-based approach leverages the expertise of all service directorate activities defining new capabilities.
Primary focus is to ensure that joint force is properly equipped and supported to perform across disciplines to identify improvements to existing capabilities and crate new warfighting capabilities.

Process defines needed capabilities through characterisation of doctrine, organisation, training, materiel, leadership, and Labour at Job Sites. Availability/reliability levels are defined within this framework, principally in the category of materiel.

So Goal is to inform and share information among decision makers tasked with design, buy, use, and system support. Information to be shared includes user requirements, and how system will be used or potentially miss targets.

Agents with control and self-initiative characteristics can be used to represent type of entities in a market-based design system. utiliing traditional user behavioural interactions such as phone conversations, meetings, back-of-envelope sketches, prototype models, etc.

While not necessarily standard, the Pentagon is more and more often relying on prototypes for proof of concept – replacing at least some of the paper exercise associated with a traditional procurement with the ability to kick the tires.

The Pentagon notes three areas where prototyping is primarily used in acquisition. First is proof of principle – that is, demonstrating the feasibility of an integrated capability or the ability to overcome specific technical risks, and to develop detailed cost estimates. Second is fieldability – or the ability to demonstrate performance in operational scenarios . And third is pre-engineering and manufacturing development – to demonstrate such things as military utility, fabrication processes and performance, and to define form, fit and function.

Prototyping is not done well in defense now. It’s just a different way of thinking. Clearly in commercial aerospace many quality requirements must be followed, just like in defense. But these requirements must be balanced with speed and low-cost design and manufacturing approaches.

In many cases, prototypes are actually manufactured on the production equipment that ends up being used which turns out to be more efficient. When the production stage is reached, it is already clear what machine product will be made on since the tooling is done.

The current implementation application represents only Components and Markets as agents. A Component is a segment in larger pattered space that represents the structure of the product. In general, a designer or design team is assigned to each component.

Depending on the design approach that is used, the space patterns may or may not be defined in advance, but it is still important to distinguish between the component agent, which represents a specific functional slot in the design, and a specific candidate to fill that slot. For example, the transmission agent in the design of a power system might consider several different physical transmissions.

Another approach is for each physical component to function as an agent, competing for a role in the design. While this approach may be useful for catalog-based design, the more fundamental view of the product segment as the component agent supports a broader set of problems, including those in which the specific physical component has not yet been defined.

Characteristics are definable attribute or parameter of a component, such as its weight, power consumption, RPM, torque, or size. Characteristics are defined per component. The weight of the motor is a different characteristic than the weight of the transmission, though both are of the same characteristic type.

Constraints are relation between two or more characteristics. Constraints typically arise either physics e.g., power consumption equals voltage times current flow or design decisions e.g., the output RPM from the motor equals the input RPM to the transmission; a given RPM and torque characterise the same shaft.

Initially, we expect most constraints to exist in agent-based designer behaviour, but decision makers must building role for them into proposed architecture to permit them to be captured and automated in later versions.

Markets represent process that maps potential buyers and potential sellers of a good to one another and optionally to a price at which a sale can take place. The goods traded in such a market are characteristics or options for characteristics. Each distinct good requires a separate market, and markets for different goods may have different protocols.

We visualise each market as existing in connected design space. In practice, many markets might exist in one space intersection, but this implementation detail makes no difference to the actual operation of the system.

Key to any assessments is description of use/support location, constraints on what support is available for system, what information will be available to decision makers, and how that information will be verified.

Weapons systems production planning effort is an important element of the overall programme to design and construct an advanced product. Successful efforts have been made by the production planning team to standardise methods and products. Lessons learned by the production planning effort can be transferred to future programs.

To facilitate production planning efforts, one fact is clear: the customer must create the forums and policies necessary to achieve a design that can be produced. No future acquisition program can afford to ignore advancements in system product technology in order to travel the path of least resistance.

It is important to define the level of detail at which a design product transitions from generic to Job Site specific. The level of detail of design where the information becomes build team specific is actually at a point of considerable detail. Substantial planning can and must be achieved as part of the design and this effort will not limit competition too much.

Production planning efforts must be carried forth into future programs. Several specific accomplishments in application creation features, e.g Transfer effort, Sectional Construction Drawing, Planning/Sequence documents, have been well documented in programme procedures and stand as non-proprietary references for future weapons system programmes.

The greatest payback for a weapons system acquisition production planning effort is during the period prior to construction. The price of making a change, even a very worthwhile one, is often too expensive in cost and schedule once the system is in the construction phase. Product design programme must make production planning a major goal of the design from the outset.

There is strong justification for Sectional Construction drawings to follow a trade structure, not a purely product structure. The drawings must be usable by any qualified weapons system builder. To force a trade-oriented Job Site to re-plan a totally product-oriented construction drawing would compromise competitive position.

Conversely, the drawing as a unit represents a high-level product approach and supports product-oriented work force to a large extent and most workable system considering the programme desire not to dictate changes to system build process.

Capability of a Zone Logistics/Sectional Construction Drawing based plan must be progressed from the standpoint not only of cost but of overall schedule with far greater confidence that a conventional system structure component standup system drawing approach.

The direct relationship between the Sectional Construction Drawing, Planning and Sequence documents, and the Master Construction Schedule provides Job Site workforce with new tools to improve the logistics of a very complex process.

Zone logistics techniques are the focus for providing all the necessary requirements for constructing an interim product. Design products are brought into the conversation since the timely delivery of design products, that is, drawings, is particularly significant.

The assessment that a profitable production planning Review can only be done before the design product is released is correct. As drawings are utilised in construction, the Review process will transition from an in-process review of drawings to a review of process improvements that does not require expensive changes to the design.

Weapons Systems specifications define the purpose of a sectional construction drawing, but it was left to the Production engineers to structure this new type of drawing. The goals in creating the sectional construction drawing were: 1) Support zone oriented construction, 2) Create work packages based on sound Logistics, 3) Ensure the drawing could stand alone in the workplace, 4) Minimise additional planning by the build provider.

Supporting the construction scheme through the application was accomplished by designing each specification to create an interim product, whether the product be an item or a large module. The application identifies a list of material engineering parts list and goes through the necessary sequential steps that build the product.

In the case of an item, the engineering parts list starts with raw material, consumes it in the manufacturing process and prepares the item for joining with other products. A module would start with previously assembled interim products, such as items, packages, and sub-modules and then work through the requirements sequence to put the module together.

Zone-oriented construction is a variant of group technology developed for weapons system builds. Zone-oriented construction divides the system into modules that are defined on an arrangement basis or zone of the product structure rather than a system basis.

Job Sites have integrated zone construction into their weapons systems construction programs. The investment in bringing this new technology into the build and expanding it have been significant.

Build Sites have been built to assemble the large modules that are fabricated in shops. Previous weapons systems designs created a system-oriented application. For a Job Site to utilise a zone construction method, the system design must be translated to define the module arrangement.

Although the translation was a significant effort, the benefits of utilising zone construction by better organising the flow of work and also reducing the amount of work required within the fully assembled weapons system structure component made it worthwhile.

Since Weapons Systems have been conceived from the outset with the requirement that its design fully support zone construction, the goal of maximum outfitting of modules prior to end-loading into component sections will be achieved.

DoD has concentrated more on examining production compared to product design. This is true in part because it is easier to assess performance in production compared to in product design. Probably also true because production is an inherently repetitive process and therefore more likely to produce learning than a non-repetitive process, like product design.

Design processes are much less repetitive than in production and have higher variability. Design involves inherently expandable tasks. This has important implications for how process control systems should be structured.

Here we concentrate on specific practicable methods, rather than general principles, that have helped organisations achieve significant reductions in new product cycle time. Strategy is outlined below:

1. Establish Economic Objectives

To balance multiple design objectives, they must be expressed in some common denominator. For example, quantifying the cost of delay helps to determine the cost of queues in the design process and emphasises the importance of attention paid to information processing to improve decision making.

2. Highlight Utility of Risk Assessments

Design must be changed to add value, and this change creates risk. For example, in repetitive manufacturing all variability is waste; in design, eliminating all variability eliminates all value added. In manufacturing, all rework is waste; in design, certain rework is required for efficient learning.

3. Create Capacity Utilisation Action Teams

Many designers still view excess capacity as waste. In reality, design processes need excess capacity to function optimally in the presence of necessary uncertainty or risk. New principles suggest using queuing techniques can provide strong insights on how to quantify the true cost of queues and provide fiscal justification for extra capacity at bottlenecks.

4. Reduce Batch Size

In manufacturing, batch size reduction is the single most important factor leading to remarkable reductions in cycle time. In contrast, batch size reduction is dramatically under utilised in design. New principles suggest that delivering requirements in smaller batches improves speed, cost, and quality.

5. Use Cadence and Coordinating Schedules

Most design processes move work products when deliverables are complete, driving variability into the schedule. Another approach is to move design work on a regular cadence which reduces variance, and linking schedules reduces queues. For example, using daily stand-up meetings and frequent “drawing-board” reviews have achieved large cycle time reductions.

6. Accelerate Feedback

Slow feedback loops cause enormous waste in design cycle time. Well-structured feedback loops actually create opportunities to smooth flow, reduce variability, and improve quality. For example, issuing design iterations on a frequent, regular cadence, even though there are unresolved technical issues, accelerates feedback and accelerates closure to an optimal design solution.

7. Decentralise Flow Control:

Because design projects have different costs-of-delay, designers need well designed priority systems to reduce the total cost of queues. This requires flow controls different from detailed planning and scheduling and a change in mindset to achieve decentralised control.

8. Decomposition-based approach

Proposes systems are designed first, and then main components are designed to enclose the cumulative system volume and area as mapped through functional allocation- “inside-out” design. This approach provides a means to conduct functional /physical system design to identify functions requiring complete process presents physical design parameters to meet these needs, and maps the interrelationship between the two. Decomposing into subsystems creates a logistics structure with bounded subsystems that can be more easily assessed & designed.

9. Job Site Value Stream Mapping

Reviews of new construction commercial design, materials, and manufacturing processes, along with creation of supporting recommendations for future state improvements, demonstrate the value of Value Stream Mapping as an assessment tool to document complex pre-construction and construction processes. The Value Stream Mapping assessments are key tool in identifying opportunities to re-engineer processes, reduce Non-Value Added time phases, and improve quality.

10. Implementation

Successful implementation of Smart Product Design processes starts with initiating small group pilot projects, taking their results and scaling them up to larger projects. Such was the purpose of the Systems Design Capability Readiness pilot project on the Initial Systems Open Architecture Sub- Process of Preliminary Design.