D-E-J-I Model for Product Development

Adedeji Badiru
Traditional definition:
“A system is a collection of interrelated elements, whose collective output is higher than the sum of the individual outputs of the elements.”
Flexibility is the ability to adapt to changing requirements and an unknown future. The application of design flexibility to military use is derived from the desire to deliver additional capability to the warfighter, while achieving the desired effects within the constraints of cost and schedule. Design flexibility is a key enabler of the National Security Strategy and facilitates the defense acquisition requirements for affordable system operational effectiveness. Extensive research and literature has been dedicated to defining flexibility, capability and modularity, but little work has been done to attempt to quantify the capability attained through design flexibility so that military commanders can make educated acquisition decisions in the tradeoff between capability integration and cost. At its heart, the acquisition process is about decision making and making the necessary tradeoffs between cost, schedule and performance. Using a case study of the Joint Direct Attack Munition (JDAM), a decision making process was developed and paired with utility theory to develop a methodology to quantify capability gained through the use of design flexibility increments. This focus on the problem-solving process allows decision makers to incorporate flexibility early in the acquisition cycle by comparing alternative capabilities and quantitatively analyzing their contributions to the mission objectives.”
The biggest challenge of product development is coordinating and integrating the multiple facets that affect the final product . . . . from a systems view.
Product Development Changes

Sources of Variability

People  Process  Technology
Product Life Cycle

- Initial Phase
- Develop Phase
- Implement Phase
- Closeout Phase

Resources vs. Time
Internal Factors

Schedule Constraints

Cost Constraints

Quality Requirements

Value Boundary

Output

External Factors

Product Boundaries
D-E-J-I Cycle
(Design-Evaluate-Justify-Integrate)
D-E-J-I Cycle
(Design-Evaluate-Justify-Integrate)
Design
Integrate
Justify
Evaluate
**D-E-J-I Cycle for Product Development**

See Reference [1]

- **Design**
  - Blueprint templates
  - Standards
  - Life cycle planning
  - Process mapping

- **Evaluate**
  - FMEA
  - DFM
  - Pareto Analysis
  - Benefits-cost analysis

- **Justify**
  - Business alignment
  - Benefit/Cost
  - Cpk
  - Operational feasibility

- **Integrate**
  - Human Factors
  - Processes
  - Work tools
  - Ergonomics

FMEA = Failure Mode & Effects Analysis
DFM = Design For Manufacture
Cpk = Process Capability

Prof. Adedeji Badiru
Design
- Blueprint templates
- Standards
- Life cycle planning
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Evaluate
- Failure Mode & Effects Analysis (FMEA)
- Design For Manufacture (DFM)
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- Human Factors
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- Work tools
- Ergonomics
Tools: Triple C Model

Communication

Cooperation

Coordination
Tools: Product Value Vector

$$DV = f \ A_1, A_2, \ldots, A_p$$

$$= f \left\{ \left[ \sum_{i=1}^{m_1} f_i \left( \sum_{j=1}^{n} z_j \ v_j \right) \right]_1, \left[ \sum_{i=1}^{m_2} f_i \left( \sum_{j=1}^{n} z_j \ v_j \right) \right]_2, \ldots, \left[ \sum_{i=1}^{m_k} f_i \left( \sum_{j=1}^{n} z_j \ v_j \right) \right]_p \right\}$$

Note:

$$f_i \longrightarrow f_{(k)i}, \ k=1, 2, \ldots p$$

- Value is a function of Attributes
- Attribute is a function of Factors
- Factor is a function Indicators
Tools: Product Overlap for Integration

\[ C = \iiint_{C_y C_x} z(x, y) \, dy \, dx \]
Tools: Half-life of Product learning curves

\[ C(x) = C_1 x^{-b} \]

\[ x_{1/2}^{-b} = \frac{1}{2} x_0^{-b} \]
# Tools: State-Space Product Transformation

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Conclusions

• Think systems across product development
• Design, Evaluate, Justify, and Integrate each product

Questions?
Discussions


