MBSE Three Ways

A Trio of Case Studies to Satisfy Any Appetite
WHAT DO I NEED TO LEARN?
Models help us collect and organize facts so that we can gain insights from them. It's critical to have a plan for our models to ensure our efforts add value.

WHAT QUESTION AM I TRYING TO ANSWER?
Models, like design, answer questions. It's imperative to identify the question(s) we need to answer before we begin.
WHAT PROCESS DO I NEED TO IMPLEMENT?

MBSE represents a set of languages and toolsets. It is vital to have a robust development process identified to guide our deployment of MBSE.

WHO NEEDS TO RECEIVE INFORMATION CONTAINED IN MY MODEL?

As modelers, it is our responsibility to use our models to effectively communicate with our stakeholders. Our models must consider our stakeholders and their needs.
Tell the Story

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Change Management

MBSE ENABLES EFFICIENT, EFFECTIVE CHANGE MANAGEMENT
Our Problem:

AN LED IN AN IMAGING SYSTEM HAS GONE OBSOLETE. WE NEED TO FIND A SUITABLE REPLACEMENT
Describe the boundary

- Duty cycle
- “rise and fall” times dictated by subject speed
- Necessary life of LED
- Camera sensitivity
- Acceptable light levels for camera

Illuminate subject for camera

Drive voltage
Drive current

Controls

Inputs

Outputs

Enablers

Light output
- Brightness
- Beam angle
- Field angle
- Color (Wavelength)
- Color temperature
- Waste heat

Subject position
LED expected life

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Describe the behavior
Describe the existing structure.
Allocate behavior to structure

Subject

Image System

Subject Illumination Assy

Illumination LED

LED Driver

Position Sensor

Image Capture Array

Camera Assy

Image Processing Assy

Rendering SW

Proximity detector

Camera

Image sensor

Allocate

Imaging

Allocate

Allocate

Allocate

Allocate

Allocate

Allocate

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Allocate

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Allocate

Allocate

Allocate

Allocate

Allocate
Describe the existing interfaces
Ensure requirements are captured

```
«block»
Illumination LED

constraints
{light_intensity <= 100.0}
area : Illuminated Area
radius : Illuminated Radius
light_output : Lux Calculation

values
beam : Beam Angle{unit = Degrees}
luminous output : luminous flux[lumen]{unit = lumen}
light_intensity : Light Intensity{unit = Lux}
rise_time : time[second]{unit = second}
```

```
«extendedRequirement»
Max Illumination
Id = "1"
Text = "The LED shall emit not greater than 100 lux when peak drive voltage and drive current are applied."

«requirement»
LED Rise Time
Id = "2"
Text = "The LED shall have a maximum rise time of not more than 100 microseconds."
```
Identify Key Performance Parameters

**STUDIO SE**

- INSPIRE
- INFLUENCE
- IMPACT

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**Illumination LED**

- **constraints**
  - $(\text{light\_intensity} \leq 100.3)$

- **values**
  - beam : Beam Angle (unit = Degrees)
  - luminous output : luminous flux (lumen) (unit = lumen)
  - light\_intensity : Light intensity (unit = Lux)
  - rise\_time : time (unit = second)

---

**Illuminated Area**

- **constraints**
  - $(\text{Area} = \pi r^2 
  \times 3.14)$

- **parameters**
  - Area : Real
  - $r$ : Real

---

**Lux Calculation**

- **constraints**
  - $(\text{lux} = \text{lumens} / \text{Area})$

- **parameters**
  - Area : Real
  - lumens : Real
  - lux : Real

---

**Illuminated Radius**

- **constraints**
  - $(r = h \times \tan(a))$

- **parameters**
  - $a$ : Real
  - $r$ : Real
  - $h$ : Real

---

**Illumination distance**

- **distance (metre)**

---

**light\_output : Lux Calculation**

- $(\text{lux} = \text{lumens} / \text{Area})$

---

**Illumination LED**

- **luminous output : luminous flux (lumen)**

---

**light\_intensity : Light Intensity**

---

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Identify and analyze possible alternatives

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<td>1</td>
<td>subject Illumination Assy - LED 1</td>
<td>0.1 m</td>
<td>60</td>
<td>31.8471</td>
<td>3</td>
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<tr>
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<td>50</td>
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MBSE and Process Design:

DEVELOP A COMPLIANT USABILITY DESIGN PROCESS
Usability

- design
- functionality
- engaging
- simplicity
Our Challenge:

DEVELOP A COMPLIANT USABILITY ENGINEERING PROCESS FOR MEDICAL DEVICES
What is the lifecycle of a medical device?
What is a use error?

User

Use Error

Likelihood

values: Probability [unit = Percent]

Harm

Severity Classification

Mild
Moderate
Severe
Catastrophic

Cause

Perception Error
Action Error
Cognition Error
Use errors expose hazards
Describe the boundary

- User Types
- User Characteristics
- Use Environments
- Environmental Characteristics
- Task List
- Interface Design/Prototype

Evaluate Usability

- Regulations
- Regional/cultural nuances
- Experience of Expert reviewers/users
- Maturity of design/prototype

- Evaluation Results
- Evaluated design changes (improved interface)
- Usability Risks and mitigations
- Usability Report
- Validation Evidence
- Finalized UI design

- Usability evaluation tools/methods
- Human Factors Standards
- Expert Users
- Usability Engineering Process

STUDIO SE
INSPIRE・INFLUENCE・IMPACT

STUDIO SE
INSPIRE・INFLUENCE・IMPACT

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Identify the process steps

1. Describe mission of system
   - Collect known use errors
   - Identify users
   - Describe user characteristics
   - Identify environments of use
   - Describe environmental characteristics

2. Analyze user interactions
   - Perform formative studies
   - Refine UI design
   - Perform summative validation
   - Finalize HFE report

[Yes] UI Design Complete?
Identify information flow
Identify interfaces to other processes
Identify necessary documents

- **Formative Report**
  - User_Environmental Analysis
    - User limitations
    - User Expectations
    - User Preferences
    - Environmental Effects on Users
    - Environmental Constraints
    - External Systems in Use Environment
    - Cultural Considerations
  - Environmental Characteristics Data
  - User Characteristics Data

- **UX Portfolio**

- **HFE Report**
  - parts
    - HF Validation Summary
    - HF Validation Results
    - summary of use errors
    - use related risk summary
    - critical Tasks
  - references
    - aFMEA
    - HF Analysis Tool
    - uEA Report

- **aFMEA**
  - parts
    - clinical consequence
    - task Analysis
    - UI Requirement
    - severity
    - pCA Analysis
    - critical Tasks

- **HF Plan**
  - parts
    - Study Objective
    - Summative Study Strategy
    - Critical Task Analysis Plan
    - Strategy to ID known use errors

- **HF Analysis Tool**

- **HF Validation Protocol**
MBSE and Social Systems:

CHARACTERIZING HOMELESSNESS TO IMPROVE SUPPORT SERVICE EFFECTIVENESS
Seeking Human Kindness
Our Challenge:

IMPROVE THE ABILITY OF SUPPORT ORGANIZATIONS TO PROVIDE ASSISTANCE TO INDIVIDUALS EXPERIENCING HOMELESSNESS
Let's first examine System Resiliency
Next, we can apply it to the human experience.
What is Human Capital?
What determines the value of Human Capital?

- Political Institutions
- Job Availability
- Housing Availability
- Healthcare systems
- Environment
- Education
- Transportation Availability
- Wealth

Community Characteristics

Perception of Human Capital Value

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What is "Home?"
Experiencing Homelessness is a possible state of "being"
How does this help?

We can use our understanding of the states of being housed and our analyses of home and human capital to help support organizations tailor the services to maximize their impact.
Support services can be classified using our model.

Some services target transitions - either encouraging positive outcomes or preventing negative outcomes.

Other services provide sustainment support for individuals. These services don't directly impact positive transitions.
The analysis guides how services are delivered.

Service providers benefit from understanding human resilience.

Determining the category of service focuses implementation.

Focused implementation leads to more effective assistance.
MBSE is most useful when coupled with a robust process.

Focus on behavior first.

Consider stakeholders when communicating your work.

MBSE gives us a set of tools.
Questions?

CASEY.MEDINA@STUDIOSE.DESIGN

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Tutorial: March 13, 2021

Solving Problems with MBSE

Using SysML to Choose Our Path Forward