2021 Annual INCOSE international workshop
Virtual Event
January 29 - 31, 2021
Premier Systems Engineering Workshop

Modeling Resilient Hospitals

www.incose.org/iw2021/

Outline

- Who we are, why we are here
- What we are doing; how we are doing it
- Intended products
- How we are using modeling to achieve our goals
- Some open issues

Who We Are

International Council on Systems Engineering (INCOSE)
https://www.incose.org

IEEE Communications Society (ComSoc)
https://www.comsoc.org
IEEE Engineering in Medicine & Biology Society (EMBS)
https://www.embs.org

InfraGard National Disaster Resilience Council (NDRC)
https://www.InfraGard.org

National Association of
County and City Health Officials
https://www.naccho.org

Society for Disaster Medicine and Public Health (SDMPH)
https://sdmph.org

Lightning Round

Why We Are Here

- To develop interest in our project
  - And, possibly, to interest you enough that you will want to contribute
- To let you know of some open issues and get your ideas
  - Outreach session Saturday

What: Improve Hospital Resilience

- Now: help hospitals:
  - Understand the risks associated with catastrophic power outage
  - Determine how to minimize those risks
    - That is, how to minimize the impact
- Future: help them improve resilience to other risks.

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How [1]: Reference Model

- Work with experts in a variety of fields
  - Critical infrastructure
  - Healthcare
  - Power Systems
  - Emergency response
  - Model-Based SE
- Develop a reference model of a hospital that is resilient to catastrophic power outage

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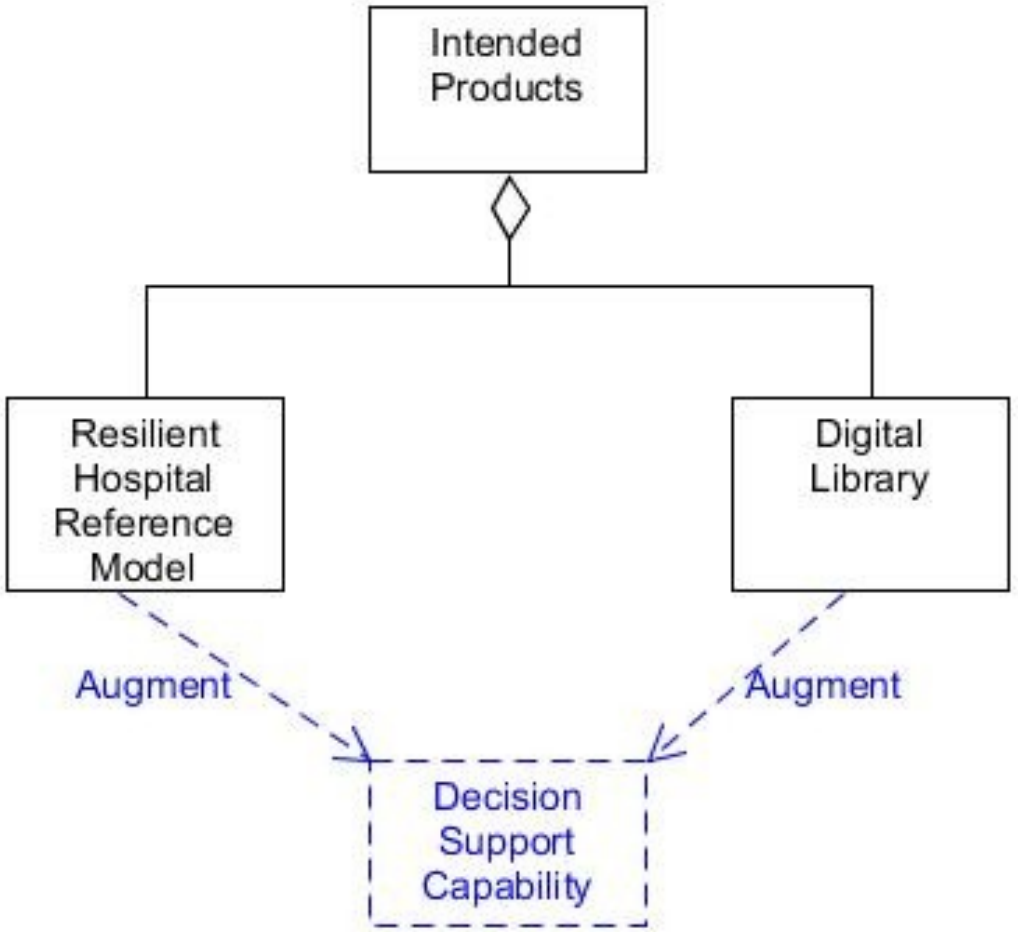
How [2]: Digital Library

- Provide a digital library of
  - Relevant regulations and requirements for hospitals
  - Other useful information
- Information not included in the model

Intended Products



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Reference Model

- Captures a Reference Architecture
  - Modeling language may be textual, graphic or both
  - Level of formality can vary
    - Highly formal: Formal, mathematical proofs are possible
    - Moderately formal: Software error checking
  - We use a moderate level of formality
    - Like many if not most MBSE projects

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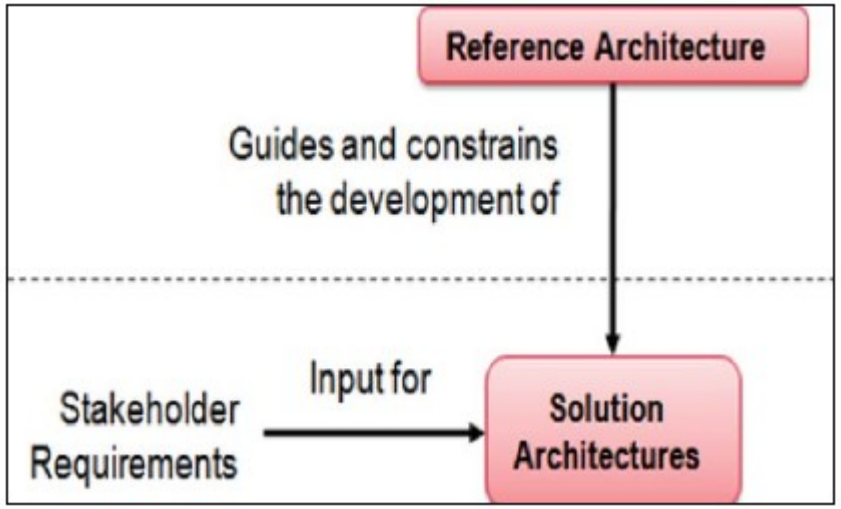
Reference Architecture

Authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions

U.S. DoD "Reference Architecture Description", June 2010



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Resilient Hospital Reference Model [1]

- Captures hospital and environment
  - Structure
    - Building, equipment, people, information, etc.
  - Behavior
    - Processes (automated and human)
    - Actual events to date, and possible future events
- Concerns relevant to resilience

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Resilient Hospital Reference Model [2]

- Helps organize (textual) digital library
  - This is a key need of our stakeholders
  - Digital library will guide model development
- Augments existing decision support
  - Is not a decision support capability by itself

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Resilience to Catastrophic Power Outage

- Resilience
  - "The ability to prepare and plan for, absorb or mitigate, recover from or successfully adapt to actual or potential adverse events" (INCOSE SE Handbook)
- Catastrophic power outage
  - Our definition: a widespread power outage of unknown duration, that is likely to exceed the nominal capacity of a backup power system

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Project Scope: Present

- Reference Model of
  - Single hospital facing catastrophic power loss
  - View hospital as closed system with minimal external interfaces, e.g.,
    - It will not be able to rely on the Internet
    - It will not be able to transfer patients to other hospitals
      - Or, send them to outpatient facilities

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Project Scope: Future

- Medium Term: broader threat spectrum
  - Multiple hospitals; multiple scenarios
    - Loss of water and other supplies
    - Cyber threats
    - Supply chain problems
- Long term: additional types of healthcare systems

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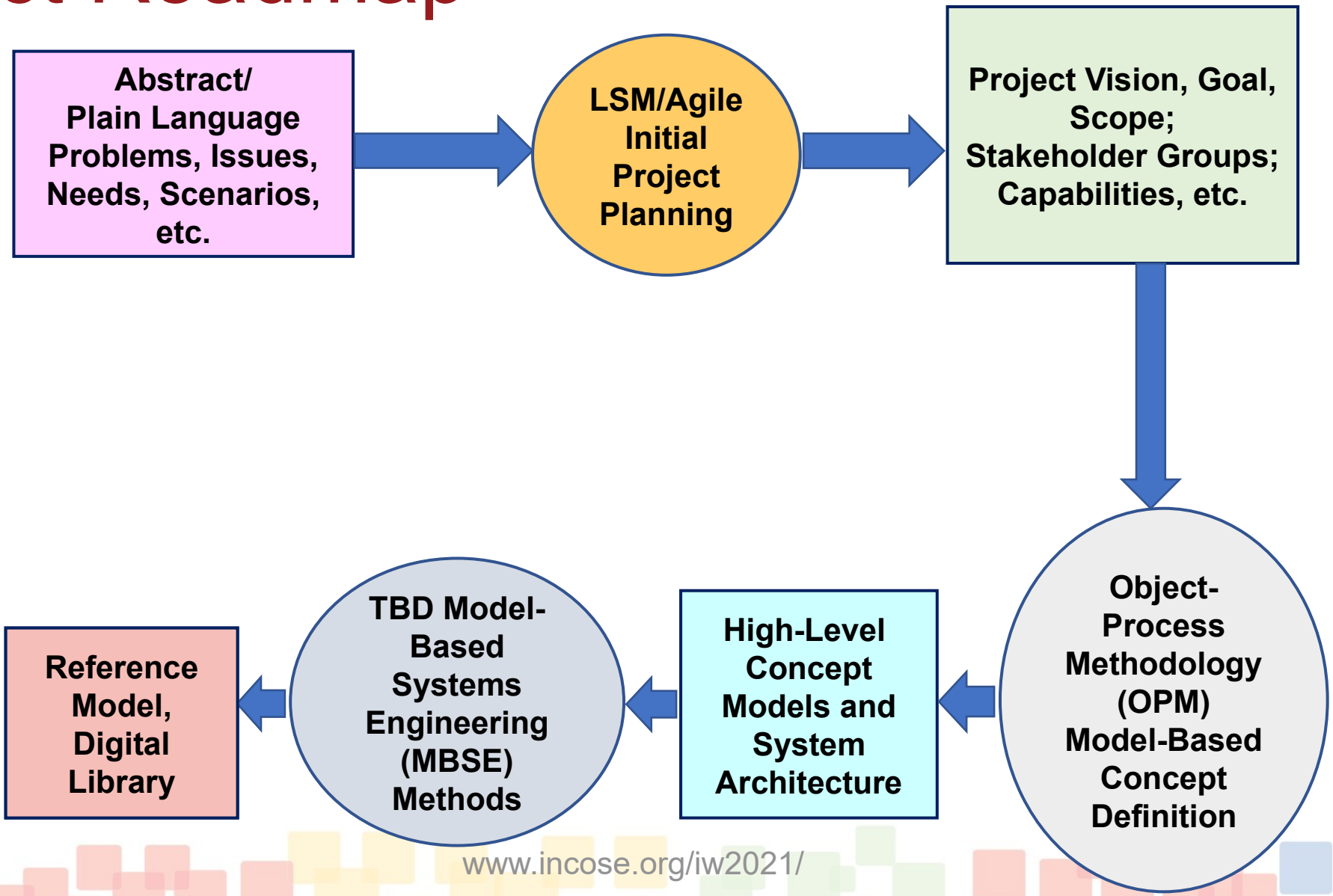
Project Roadmap



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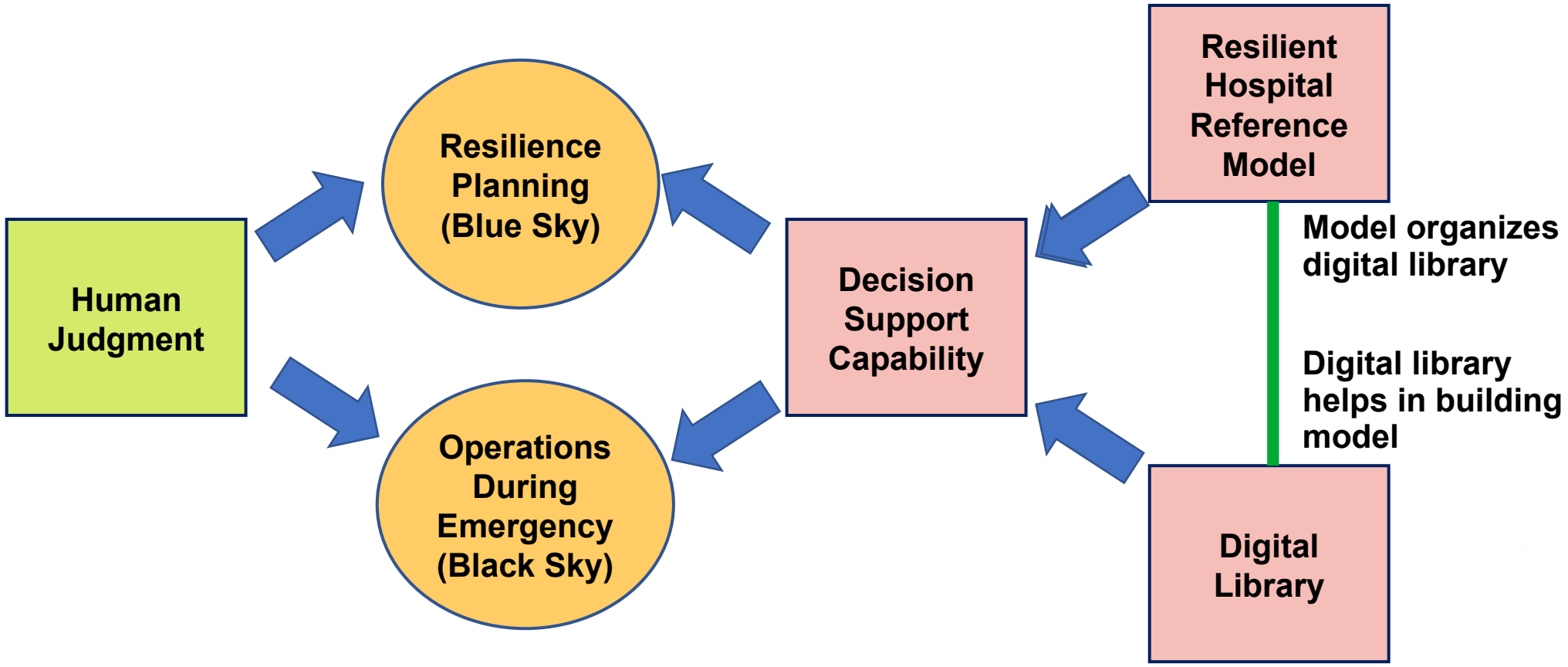
Using the Model and Library



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Modeling Techniques

- Object-Process Methodology (OPM)
- Systems Modeling Language (SysML)
  - Method may be OOSEM
- Arcadia
- Lifecycle Modeling Language (LML)

Object-Process Methodology

- Currently in use for concept analysis
  - Understandable by non-modelers
  - Powerful method and notation
  - Key feature: Object-Process Language (OPL)
    - Natural language summaries of Object-Process Diagrams
    - Tool (OPCloud) keeps diagrams and text in synch
- Developed by Dov Dori

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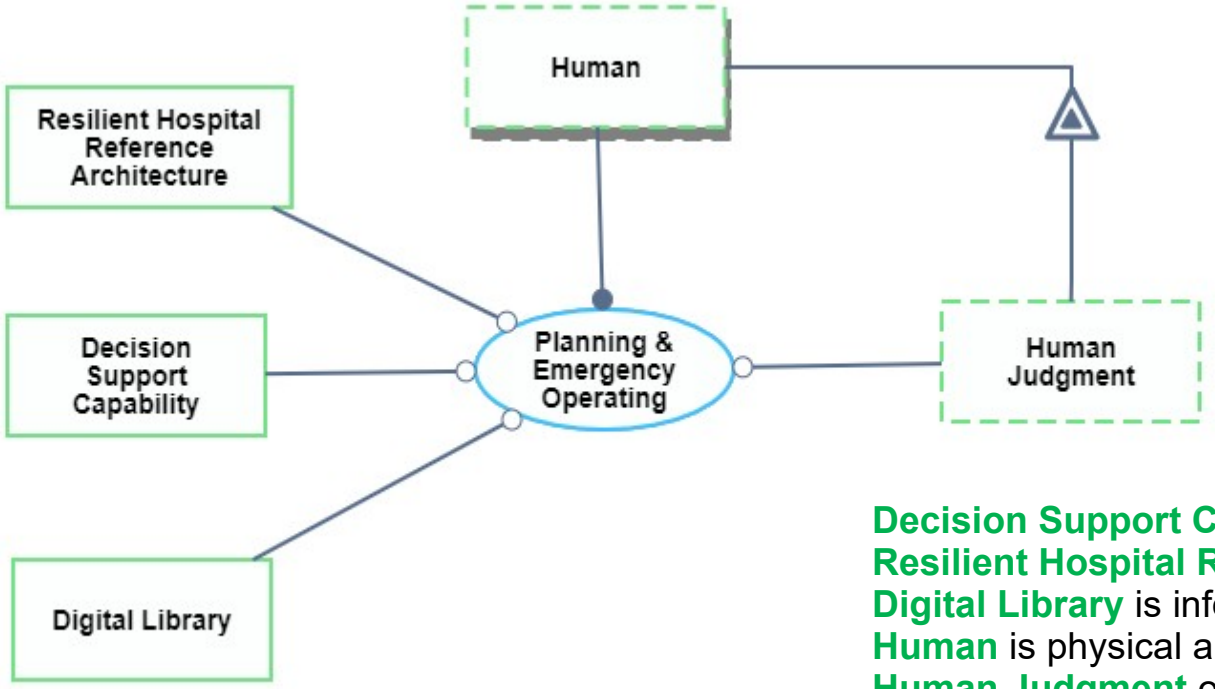
OPM Example: Diagram And Text



Decision Support Capability is informatical and systemic.
Resilient Hospital Reference Architecture is informatical and systemic.
Digital Library is informatical and systemic.
Human is physical and environmental.
Human Judgment of **Human** is informatical and environmental.
Human exhibits **Human Judgment**.
Planning & Emergency Operating is informatical and systemic.
Human handles **Planning & Emergency Operating**.
Planning & Emergency Operating requires **Decision Support Capability**, **Digital Library**, **Human Judgment** of **Human**, and **Resilient Hospital Reference Architecture**.

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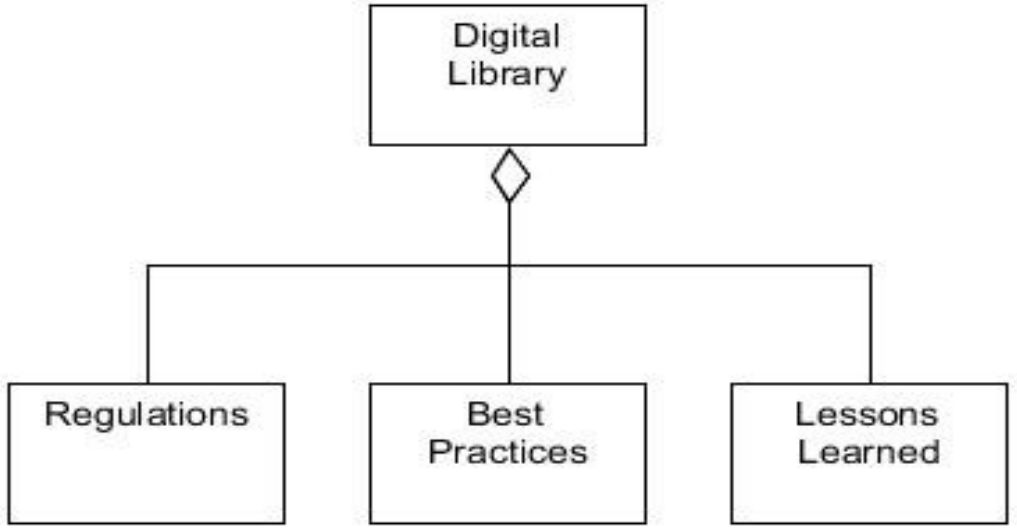
Digital Library



- Textual information
- Must have
  - Search capability
  - Process for updating

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Conclusions

- We are an ad-hoc volunteer group
- We are building
  - Resilient Hospital Reference Model
  - Digital library
- There are open issues
  - None are show stoppers

Open Issues

- Using our products with commercial Decision Support Systems
- Maintaining involvement of non-MBSE stakeholders
- Getting the right mix of domain experts to help

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