Adaptive Systems Engineering: A Medical Paradigm for Practicing Systems Engineering

Douglas Hamelin, Ron Klingler, and Chris Dieckmann
Idaho National Laboratory

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Premise

- **The "traditional," holistic application of SE is not well suited to "rescue" projects from challenges that threaten imminent failure.**
- **The medical profession:**
  - Provides a *unique analogy for adaptive SE*
  - Offers a useful *paradigm for tailoring our "practice" of SE* to address the unexpected dynamics of the real world.



Personal Anecdote

- **August 2007**
  - *Chest pains* throughout the day
  - Emergency room visit for *X-rays and CT scan*
  - *Stress test and angiogram* to check for heart abnormalities
  - Result: *Elevated blood pressure*

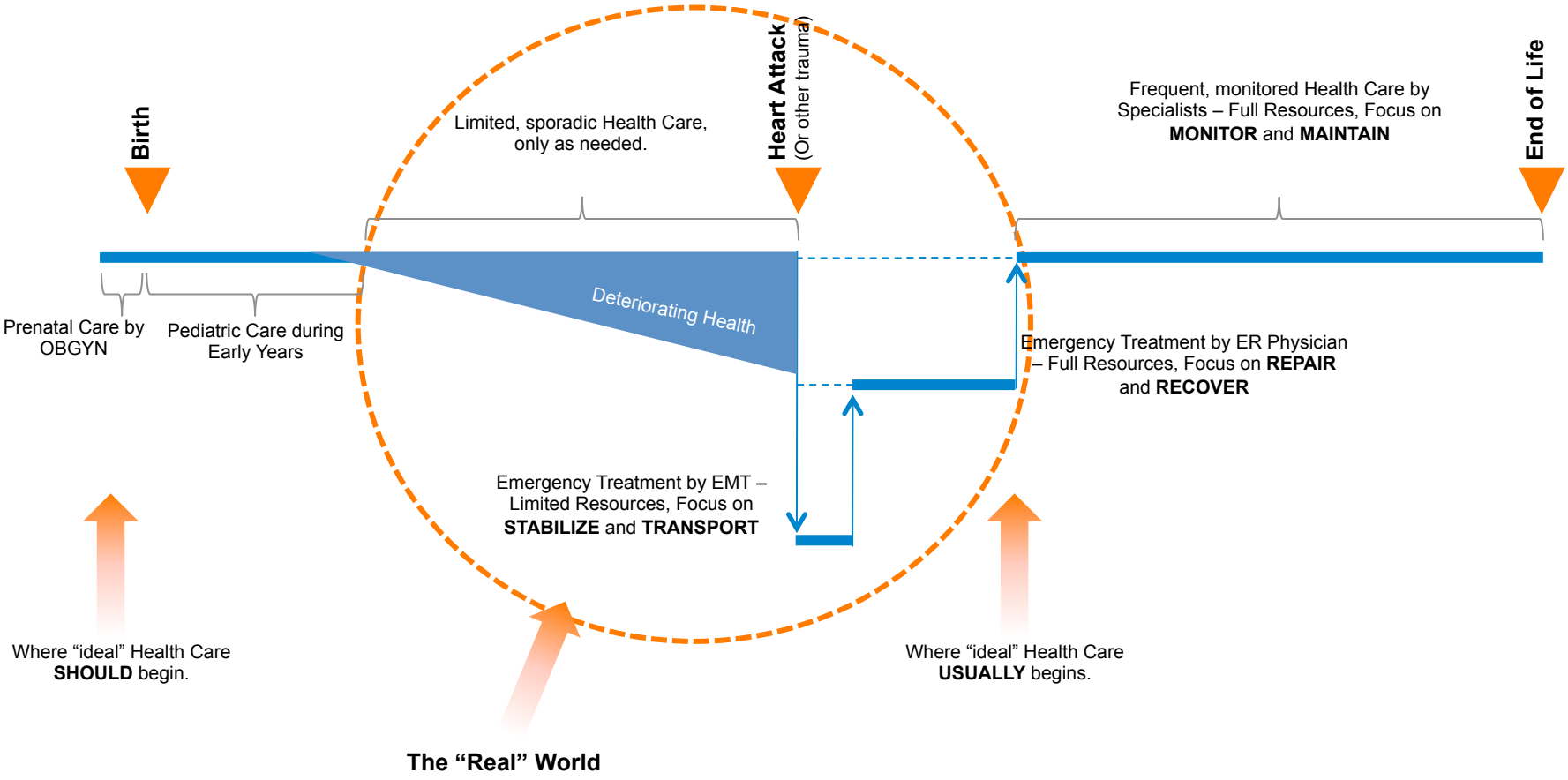
- **Why wasn't it discovered earlier?**
  - *Paradigms about health care* and it's intervention contributed to the condition NOT being discovered earlier

"Ideal" versus "Real" Lifetime Medical Care

- Child delivered by "trained, licensed" medical professional
- *Pediatrician engaged* early to ensure healthy development
- *Regular checkups* to assess illness and abnormalities
- *On-going consultation throughout a lifetime* to maintain physical and mental condition
- *Optimized physical and mental health* via ongoing assistance and intervention of medical professionals

- Frequency of medical care drops significantly after infancy
- *Body "seems" healthy*, so no need for doctor visit
- Often physically and nutritionally *"out of shape"*
- No real attempt to predict and plan for medical challenges
- Seek *medical intervention ONLY when there is a critical need*
- Patient challenged to change lifestyle and seek more frequent care

Lifetime Medical Care – An Illustration

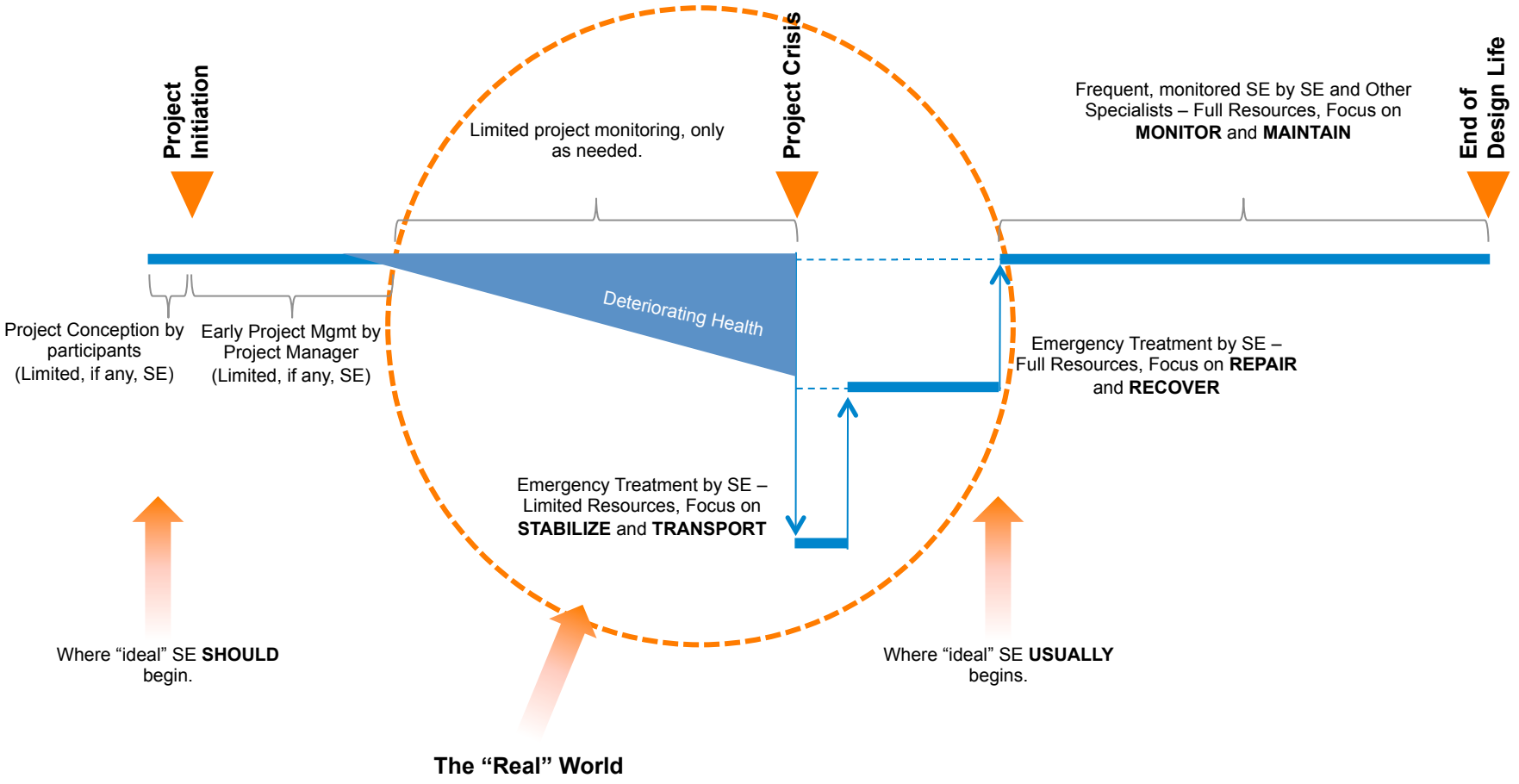


"Ideal" versus "Real" Project Lifecycle

- Project initiated by competent managers and engineers
- *SE engaged* early to establish parameters and guide progress
- *Routine assessment* to identify risks and mitigate problems
- *On-going SE assistance throughout the project lifecycle* to maintain project baselines
- *Optimized project health* via ongoing assistance and intervention of system professionals

- Attention to project plans and details declines after inception
- *Project "seems" healthy*, so no need for status assessments or the associated cost of SE involvement
- Often administratively and technically *"out of shape"*
- Minimal attempts to predict and plan for project challenges
- Seek *SE intervention ONLY when there is a critical need*
- Project challenged to change management approach, plan for potential setbacks, and/or recover from problems

Lifecycle Project Care – An Illustration



A New "Adaptive" SE Paradigm

- **Emergency Medicine**
  - *Assess and stabilize* deteriorating condition
  - *Preserve or restore* life
  - Transport for in-depth *diagnosis and treatment*
- **Adaptive SE**
  - *Assess and stabilize* deteriorating condition
  - *Preserve or restore* project
  - Rebaseline and plan for in-depth *assessment and correction*

Medical Triage

*A process of determining the **priority of patients' treatments** based on the **severity of their condition**. This rations patient treatment efficiently when **resources are insufficient** for all to be treated immediately.*

- **Classifies victims or deteriorating conditions into four categories:**
  - Those that are *beyond help*
  - Those that can be helped by *immediate stabilization and transport*
  - Those that need medical attention but whose *transport can be delayed*
  - Those with *minor injuries*, who need help less urgently and can wait until resources are available.

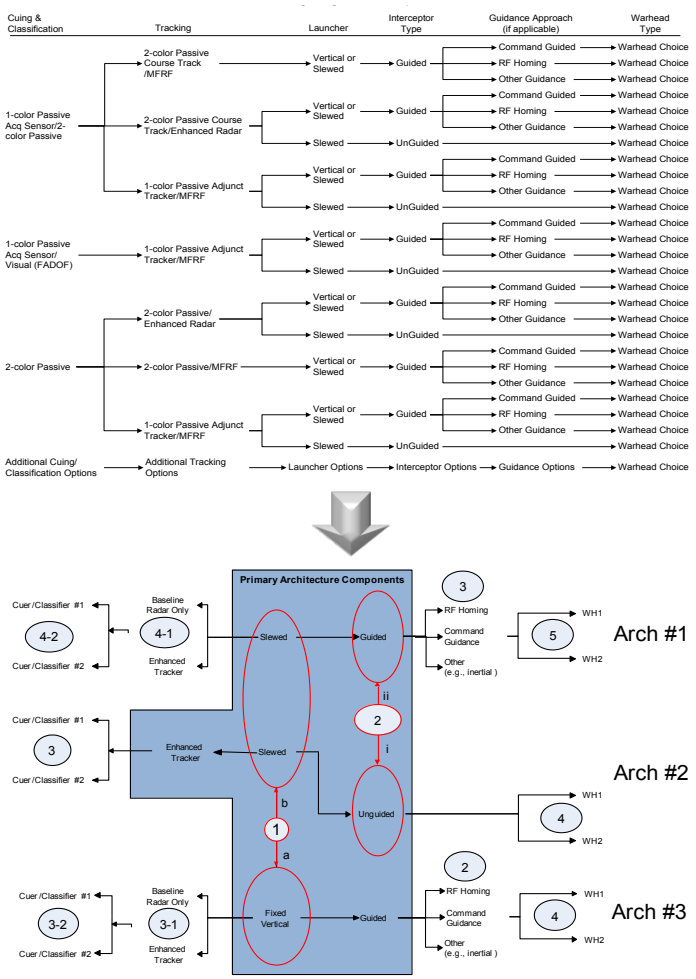
SE Triage

*A process (or practice) of determining the **priority of project treatments** based on the **severity of the project's condition**. This rations SE application to the project more efficiently when **resources are insufficient** for all conditions to be treated immediately.*

- **Classifies projects or deteriorating conditions into four categories:**
  - Those that are *beyond help*
  - Those that can be helped by *immediate stabilization and rebaselining*
  - Those that need medical attention but whose *rebaselining can be delayed*
  - Those with *minor setbacks*, who need help less urgently and can wait until resources are available.

Case Study –
U.S. Army Active Protection Systems Project

- **Challenge**
  - Many technology options and potential for mix and match towards different development path forward
  - Uncertainty in some technology areas creating instability in selecting overall approach
  - Schedule compressed
- **Approach**
  - Evaluate alternatives to the decision sequence to find best solution given different levels of uncertainty and affect on future choices
- **Capabilities**
  - Decision sequence analysis
  - Technology readiness
  - Decision readiness
  - Uncertainty analysis
  - Risk Management



Case Study –
U.S. Biomass Feedstock Project

- **Challenge**
  - Gaps exist between user requirements, project tasks, milestones, and deliverables.
  - Interrelationships between these project elements are not well understood.
- **Approach**
  - Establish a “big picture” view of project elements
  - Map requirements to project elements
  - Perform gap analyses to identify inconsistencies between project elements and requirements
- **Results**
  - Clarified view of project complexity for team members, customers, and industrial partners through functional diagramming and Zoned Analysis
  - Growing understanding of project requirements and their relationship to project elements
  - Enhanced out-year planning and funding

Changing our Paradigms

1. **Don't assume the Project "did it wrong," and don't force it to "start over"**
2. **Be cautious of the "quick fix" or "low hanging fruit"**
3. **Don't overwhelm the project with expensive technology and complicated processes**
4. ***Look for rescue-type situations*** **where you can have an immediate impact; don't shy away from an opportunity just because it isn't an "ideal" project.**

Our ability to ***adapt and respond to critical, emergent project needs*** will grow the reputation of SE among seasoned project managers and organizational professionals and set the foundation by which the more frequent practice of "ideal" SE and be realized.

Contacts

- **R. Douglas Hamelin**
  (208) 526-2337
  douglas.hamelin@inl.gov

- **Ron D. Klingler**
  (208) 526-0183
  ron.klingler@inl.gov

- **Christopher Dieckmann**
  (208) 526-5986
  chris.dieckmann@inl.gov

http://www.inl.gov/syseng