system design and management

Applying Systems Approach to Business Process Re-Engineering

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SDM ‘14

Presentation Outline

- USCG Financial Management (FM)
- Business Process Reengineering (BPR)
- Thesis Research Focus
- Application of STPA & SafetyHAT
- Hazard Mitigation
- Discussion

USCG Photographs

The United States Coast Guard

- Worldwide Operations 24/7/365
  - Missions
  - People
  - Equipment
  - Activities

Systems are characterized by the interaction of hardware, software, data, humans, processes & procedures

USCG Photographs

FM System Improvement & Business Process Re-engineering

- USCG Core Accounting System (CAS)
  - Primary FM software application
  - Used to record (and report) full-range of FM transactions
  - Significant reliability, supportability & auditability issues
  - Goal: replace owned/hosted w/ commercial off the shelf system (COTS)
- Business Process Re-engineering
  - Enhance delivery of mission support services
  - Align “mission support” and “operational” models
  - Improve internal controls of funds/resources
  - Sustain unqualified audit opinion

Thesis Research Questions

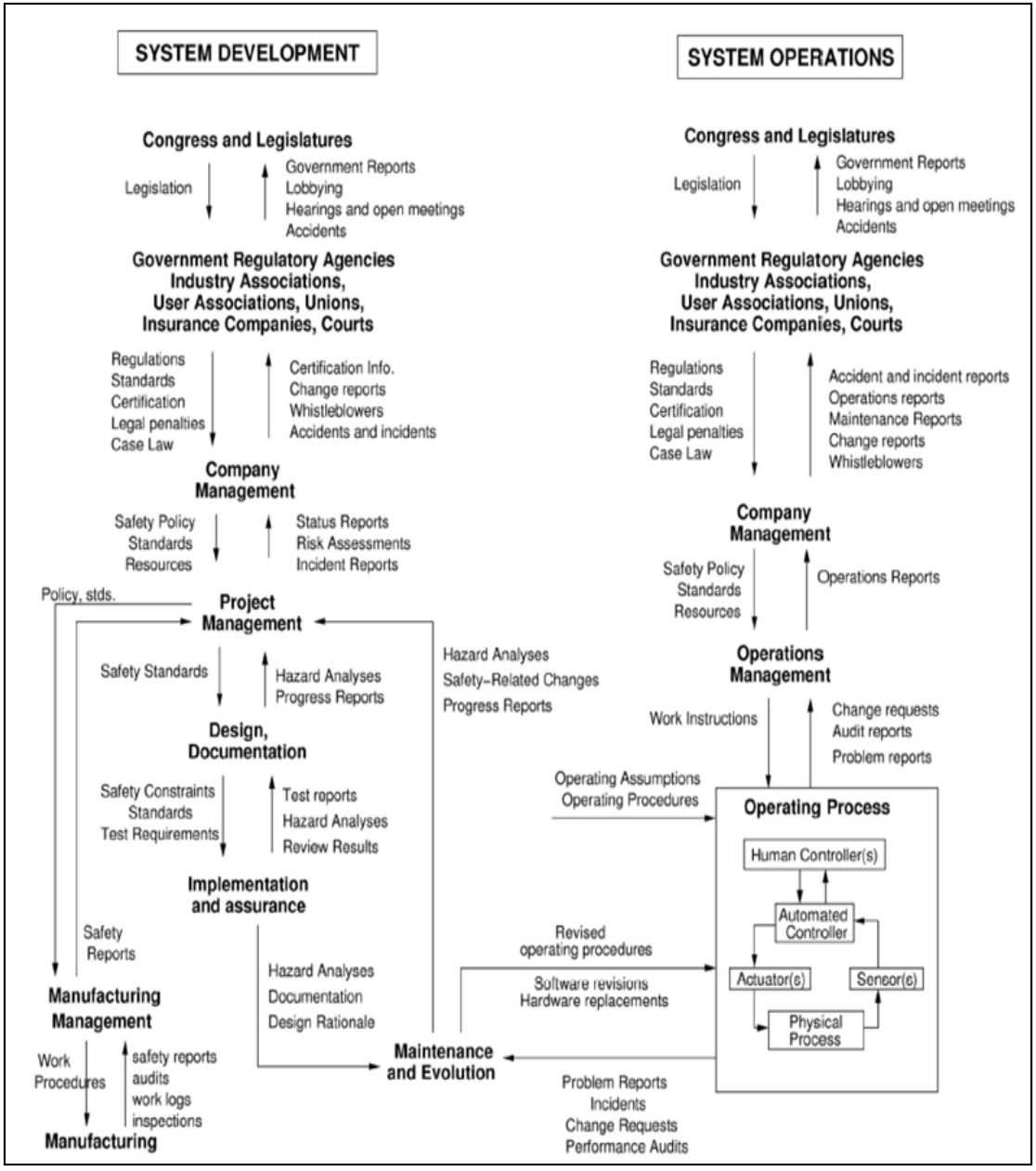
- What challenges will the USCG's new FM software application and re-engineered business processes create for front-line operating units?

- What system analysis methods may help identify the causal factors that create the challenges, and mitigate or abate them in the new USCG FM system?

Research focused on evaluation of front-line operational unit procurement activities

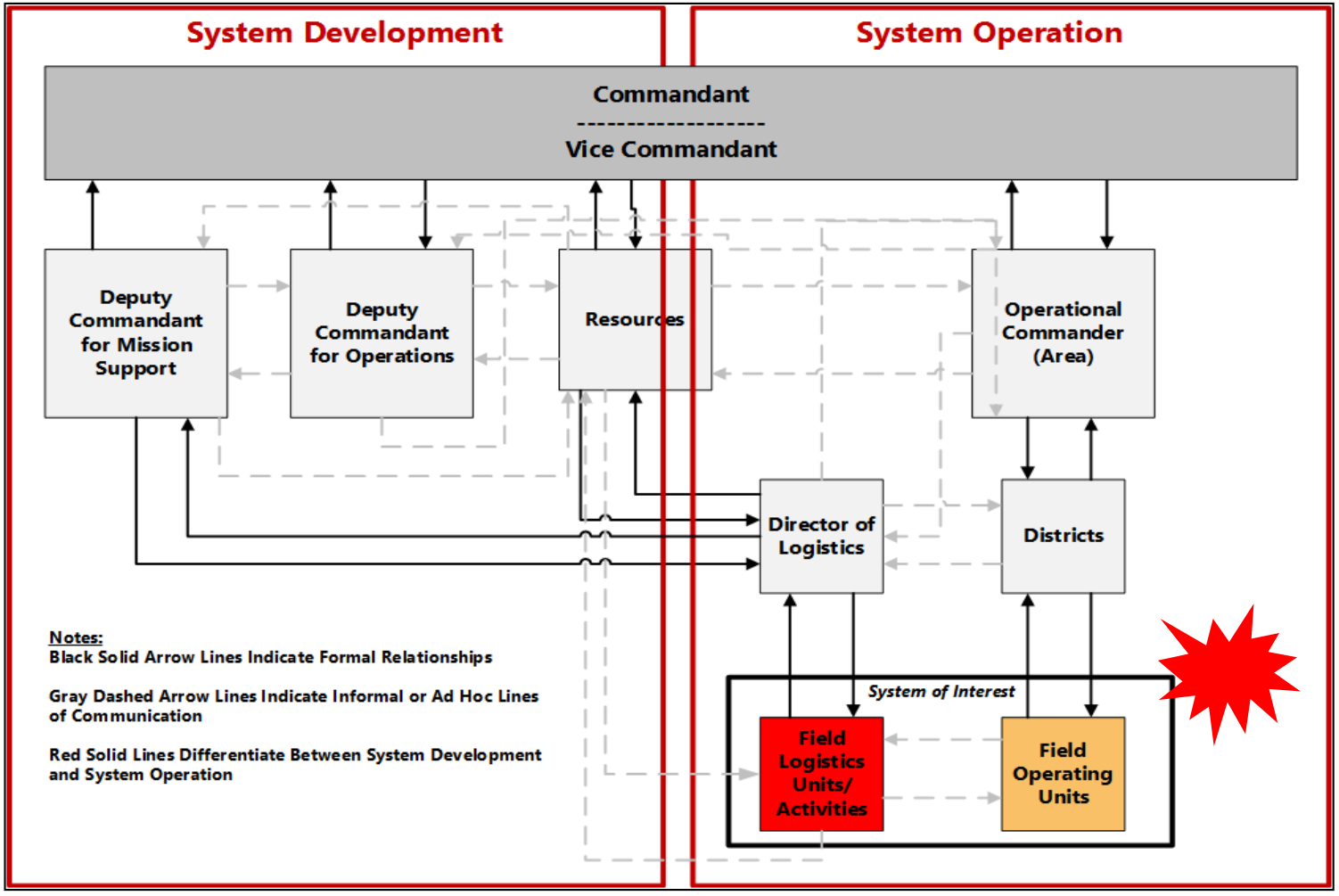
Why STPA?

- MIT-SDM curriculum
- Applicability to USCG FM System
- Availability of SafetyHAT



Leveson, Engineering a Safer World, 2012

Generalized USCG Control Structure



USCG FM System Control Diagram

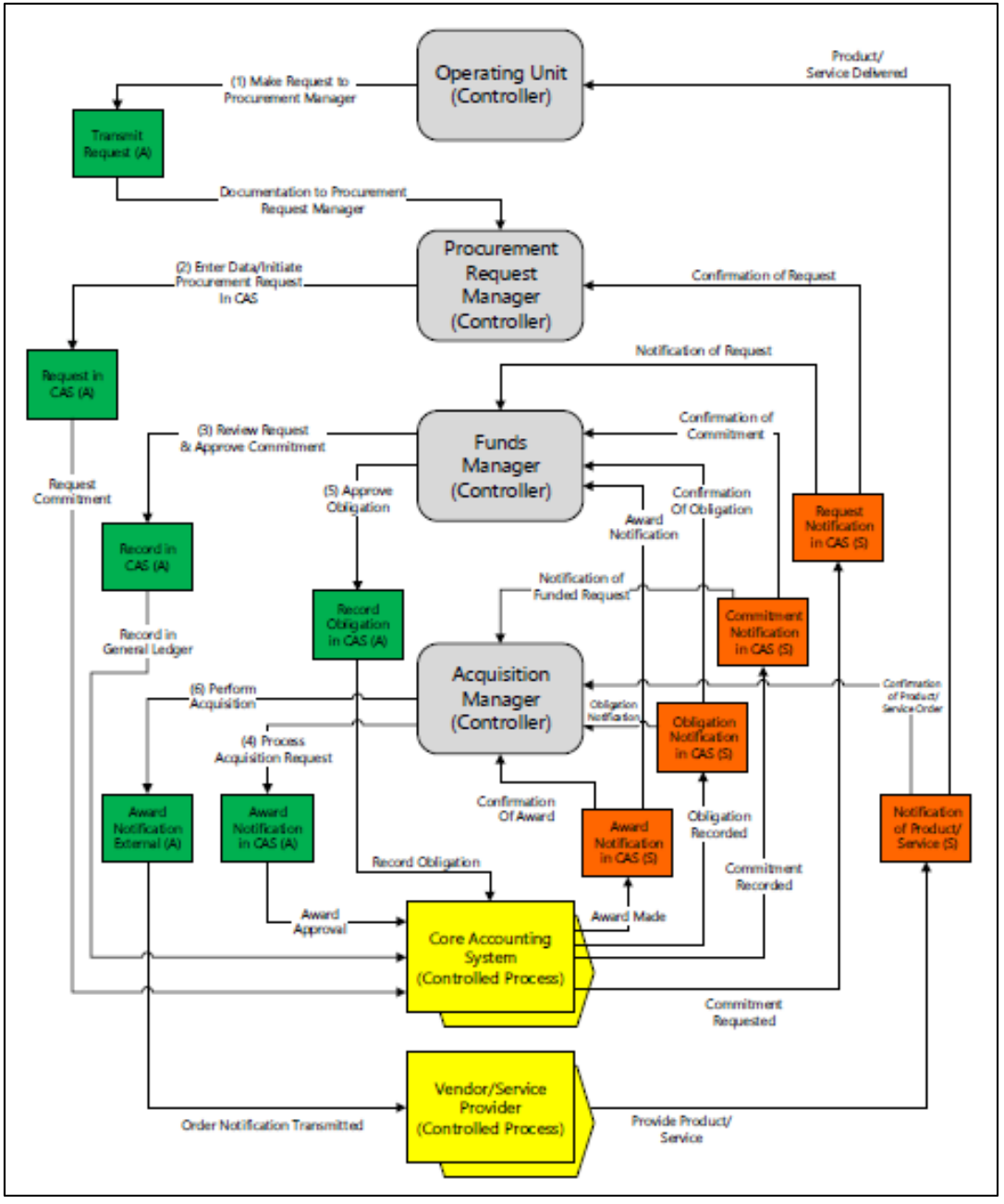
Research analyzed a generic product/service procurement transaction

Controller

Actuator

Sensor

Controlled Process



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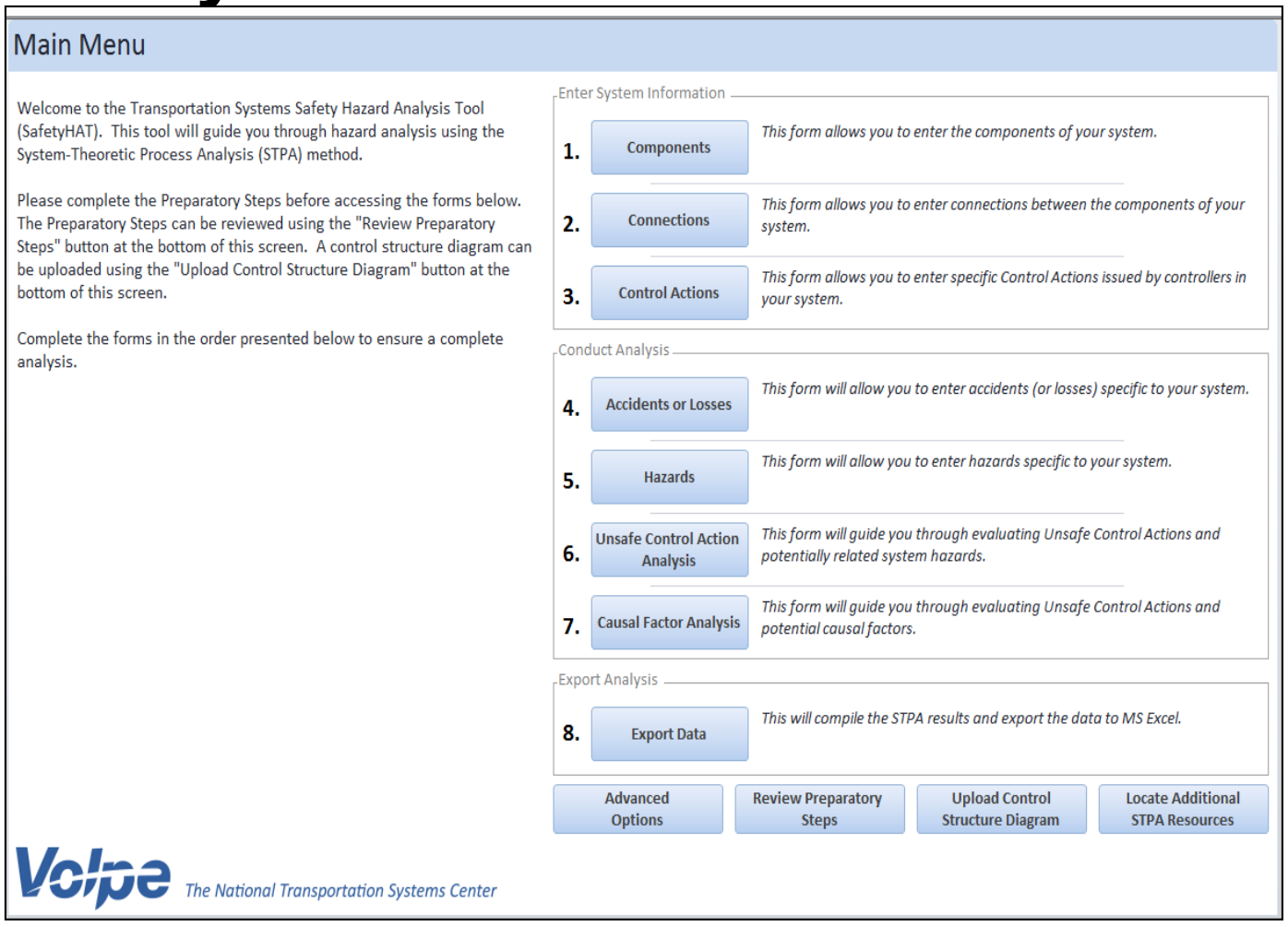
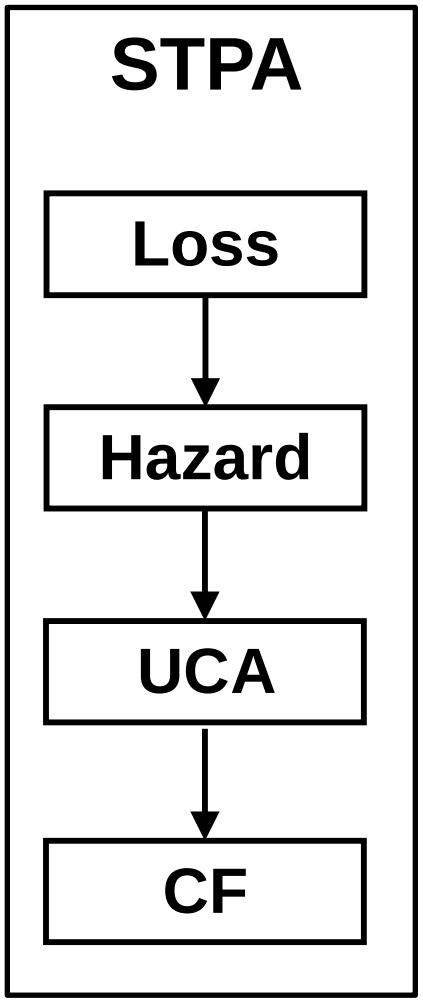
SafetyHAT

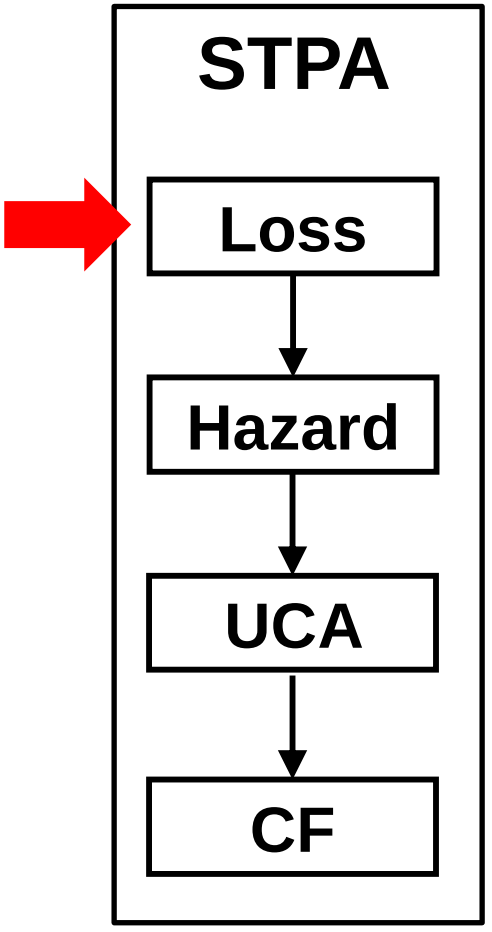

Main Menu
Welcome to the Transportation Systems Safety Hazard Analysis Tool (SafetyHAT). This tool will guide you through hazard analysis using the System-Theoretic Process Analysis (STPA) method.
Please complete the Preparatory Steps before accessing the forms below. The Preparatory Steps can be reviewed using the "Review Preparatory Steps" button at the bottom of this screen. A control structure diagram can be uploaded using the "Upload Control Structure Diagram" button at the bottom of this screen.
Complete the forms in the order presented below to ensure a complete analysis.
Enter System Information
1. Components
This form allows you to enter the components of your system.
2. Connections
This form allows you to enter connections between the components of your system.
3. Control Actions
This form allows you to enter specific Control Actions issued by controllers in your system.
Conduct Analysis
4. Accidents or Losses
This form will allow you to enter accidents (or losses) specific to your system.
5. Hazards
This form will allow you to enter hazards specific to your system.
6. Unsafe Control Action Analysis
This form will guide you through evaluating Unsafe Control Actions and potentially related system hazards.
7. Causal Factor Analysis
This form will guide you through evaluating Unsafe Control Actions and potential causal factors.
Export Analysis
8. Export Data
This will compile the STPA results and export the data to MS Excel.
Advanced Options
Review Preparatory Steps
Upload Control Structure Diagram
Locate Additional STPA Resources
Volpe
The National Transportation Systems Center


STPA
Loss
Hazard
UCA
CF

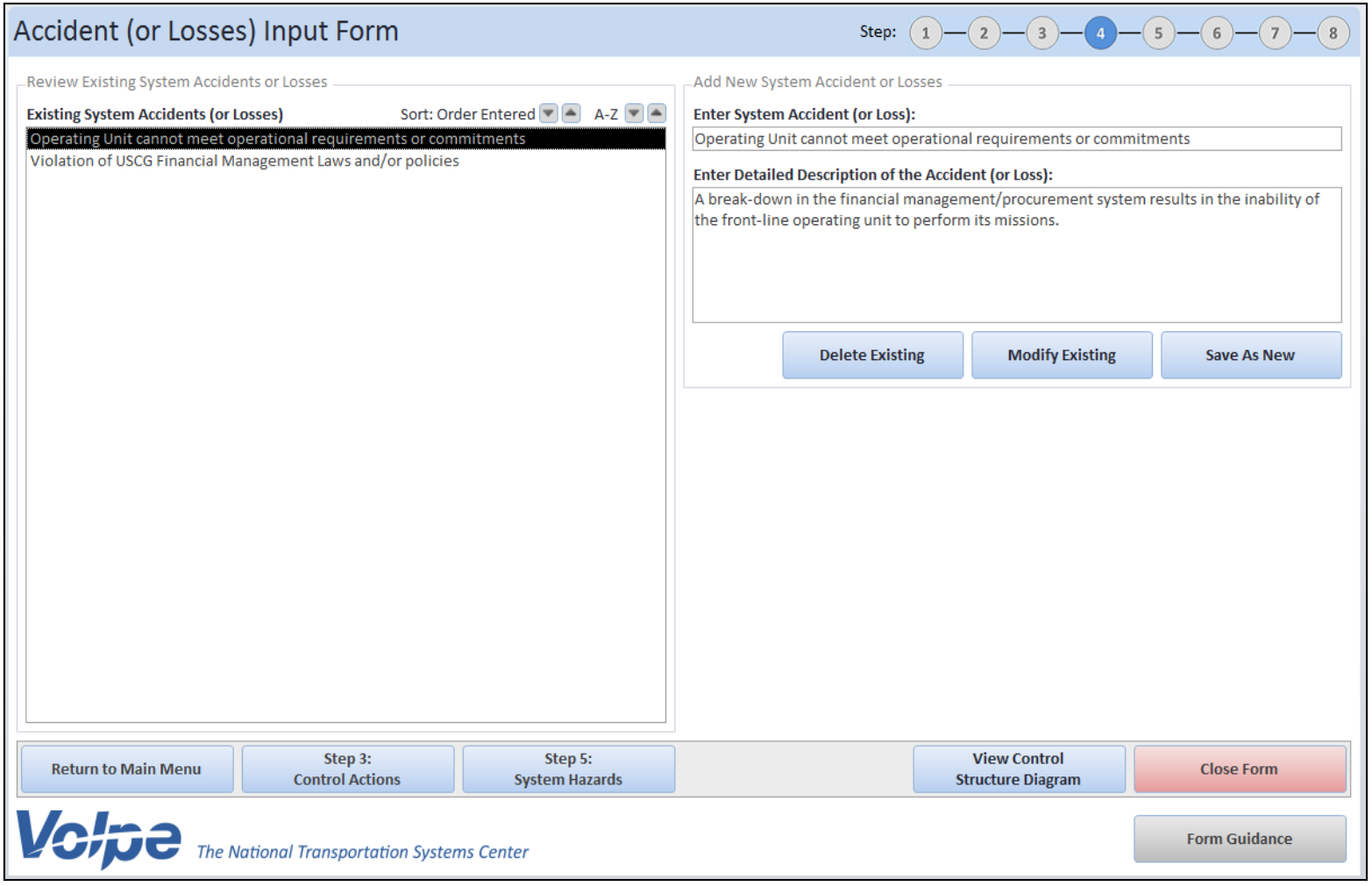
USCG System Losses (Accidents)

"Accident: An undesired or unplanned event that results in a loss, including loss of human life or human injury, property damage, environmental pollution, mission loss, etc." -Leveson

- Operating Unit cannot meet operational requirements or commitments.
- Violation of USCG Financial Management Laws and/or policies.



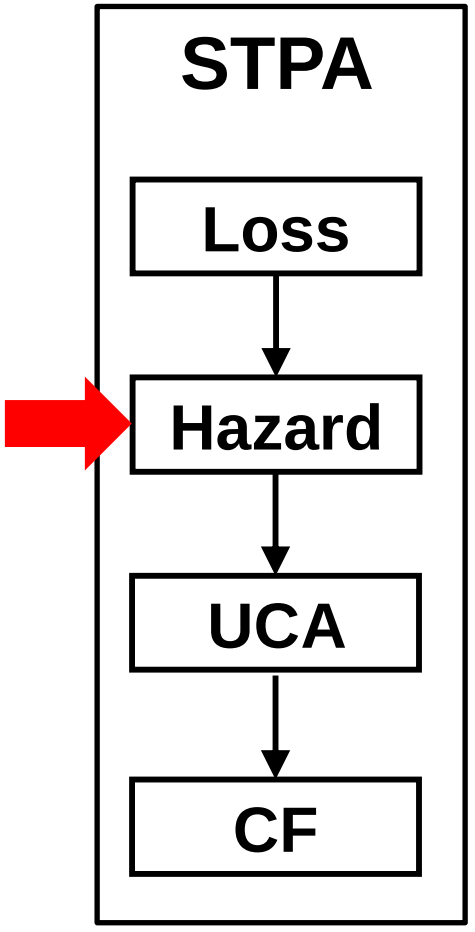
SafetyHAT Input Form (Step 4)



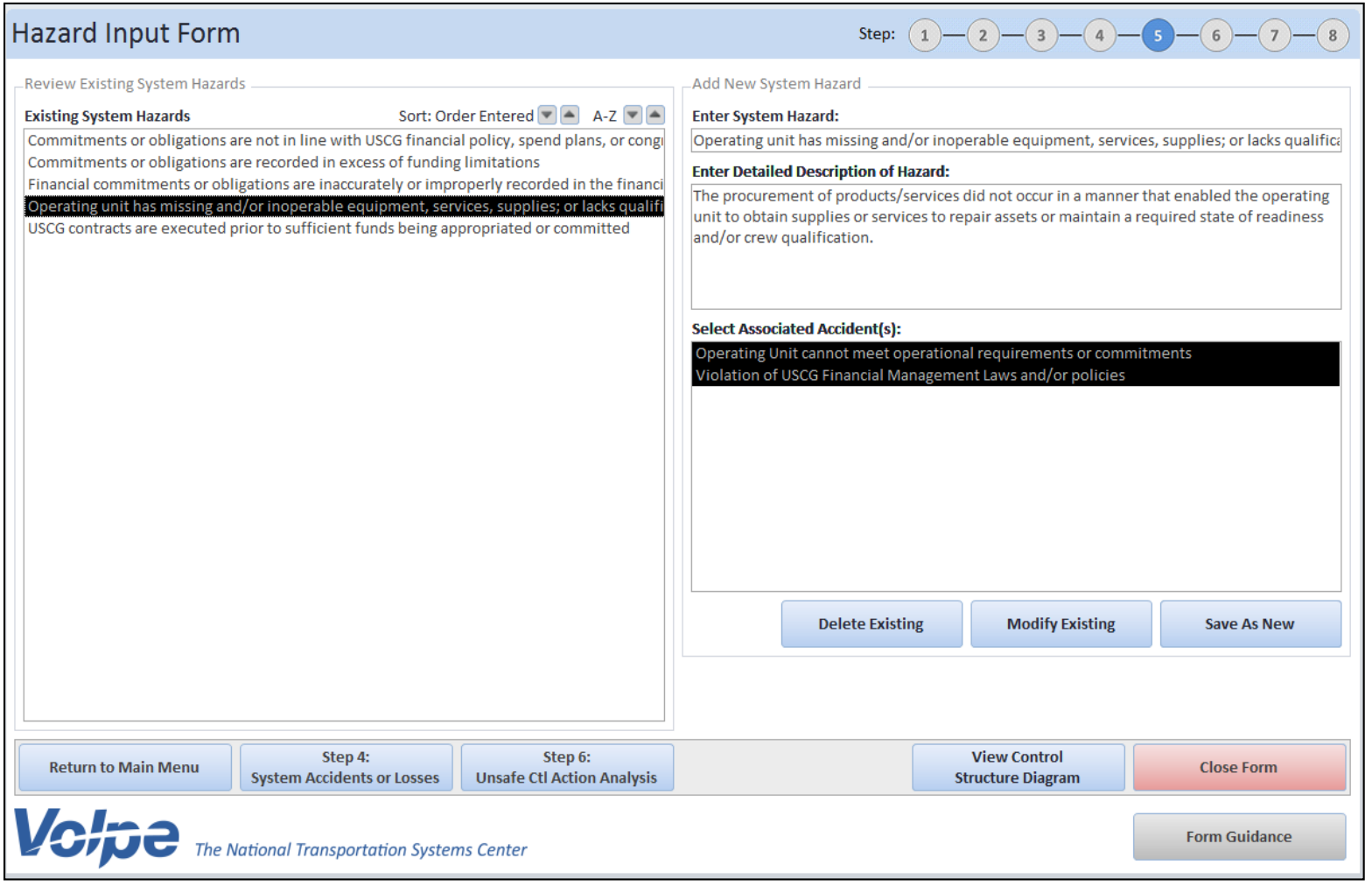
USCG System Hazards

"Hazard: A system state or set of conditions that, together with a particular set of worst-case environmental conditions, will lead to an accident (loss)." -Leveson

- Commitments or obligations are not in line with USCG financial policy
- Commitments or obligations are recorded in excess of funding limitations
- Operating unit has missing and/or inoperable equipment, services, or supplies; or lacks qualification
- USCG contracts are executed prior to sufficient funds being appropriated or committed

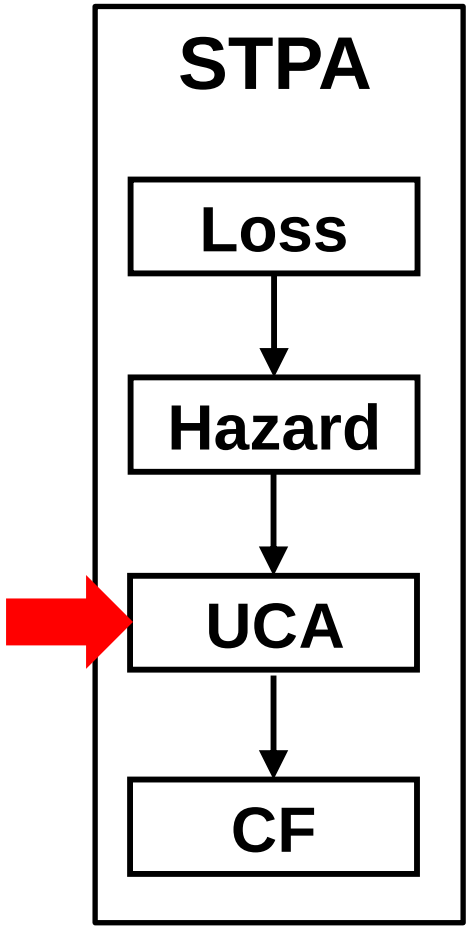


SafetyHAT Input Form (Step 5)

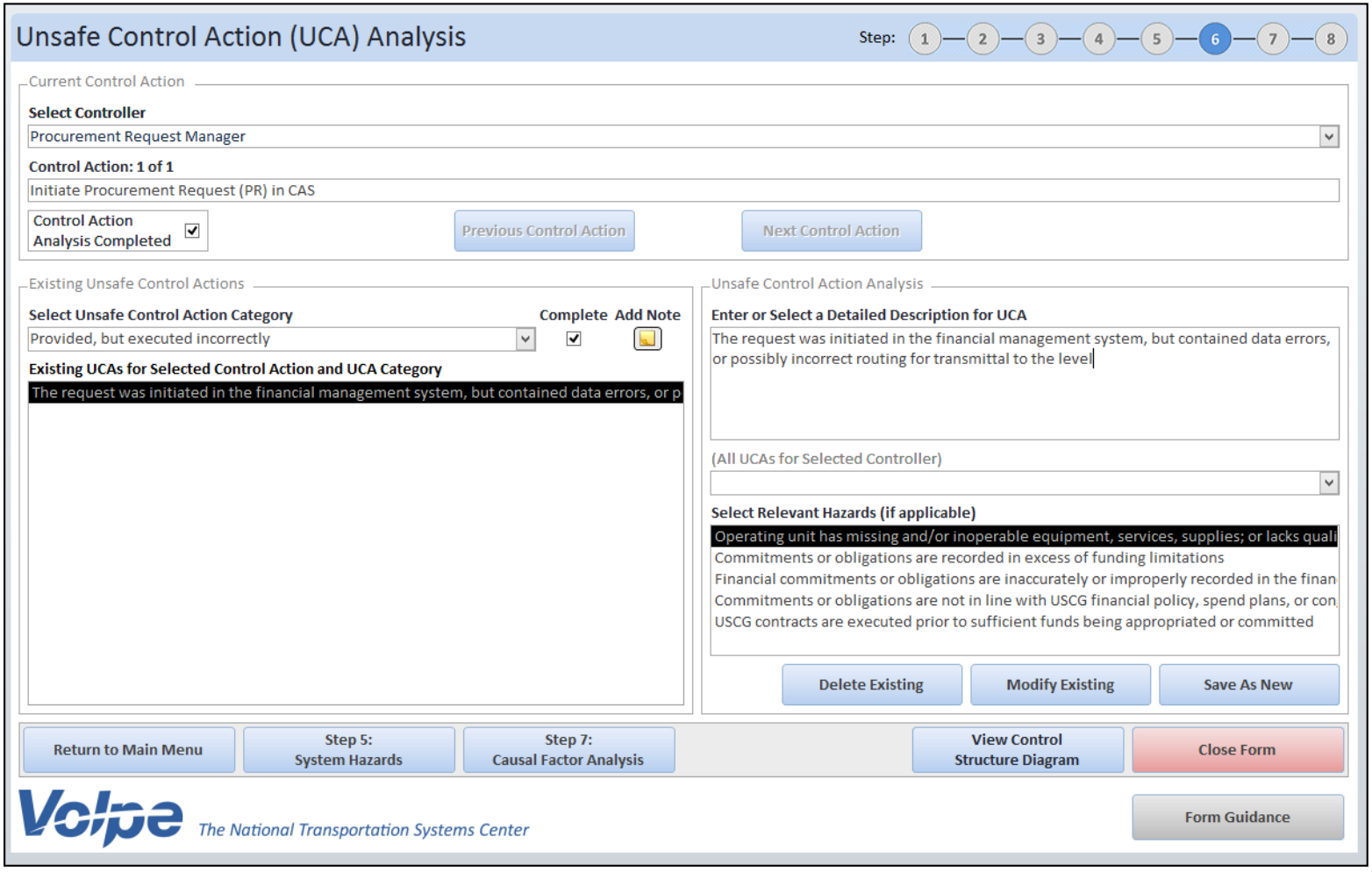


USCG Unsafe Control Action (example)

- The request was initiated in the financial management system, but contained data errors, or possibly incorrect routing for transmittal to the next level
- The product/service requested is incorrect--i.e. wrong vendor, incorrect funding level, wrong quantity, incorrect unit cost or total amount, or incorrect accounting information

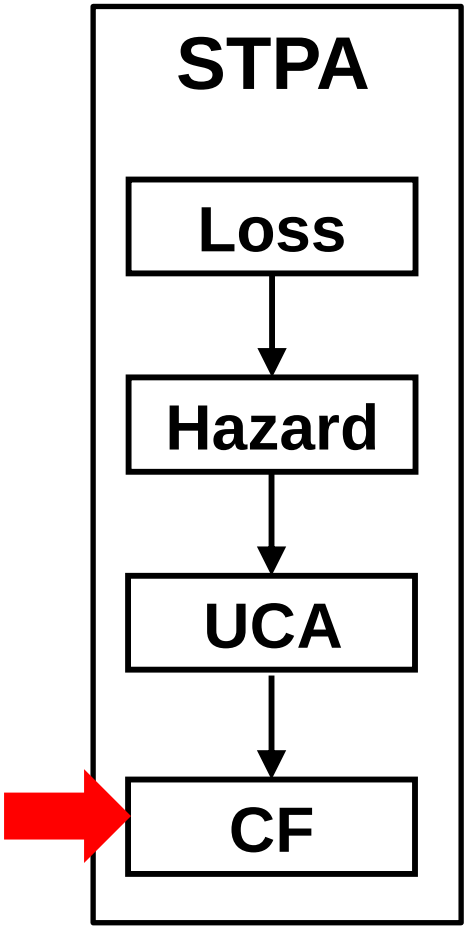


SafetyHAT Input Form (Step 6)



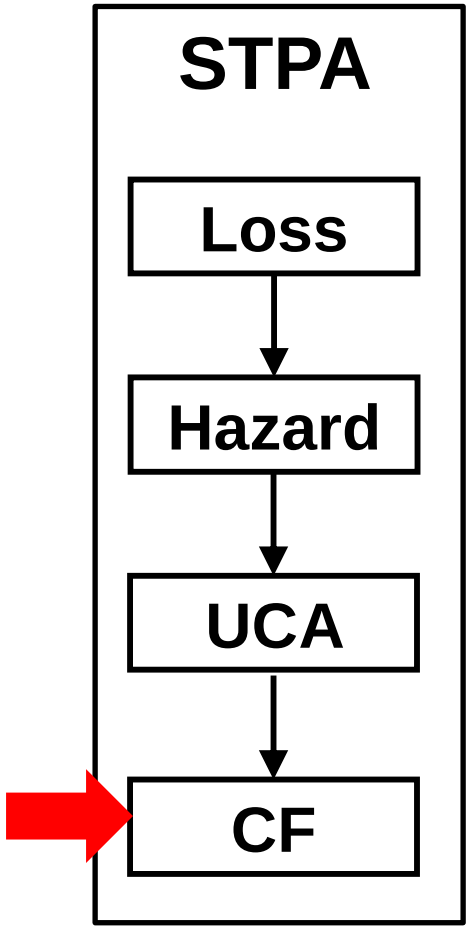
Causal Factors

- STPA with SafetyHAT revealed 205 causal factors
- SafetyHAT data export used to generate requirements & assign responsibility for hazard mitigation in the FM system
- Some causal factors related to changes over time; System Dynamics modeling used to quantify negative system impacts

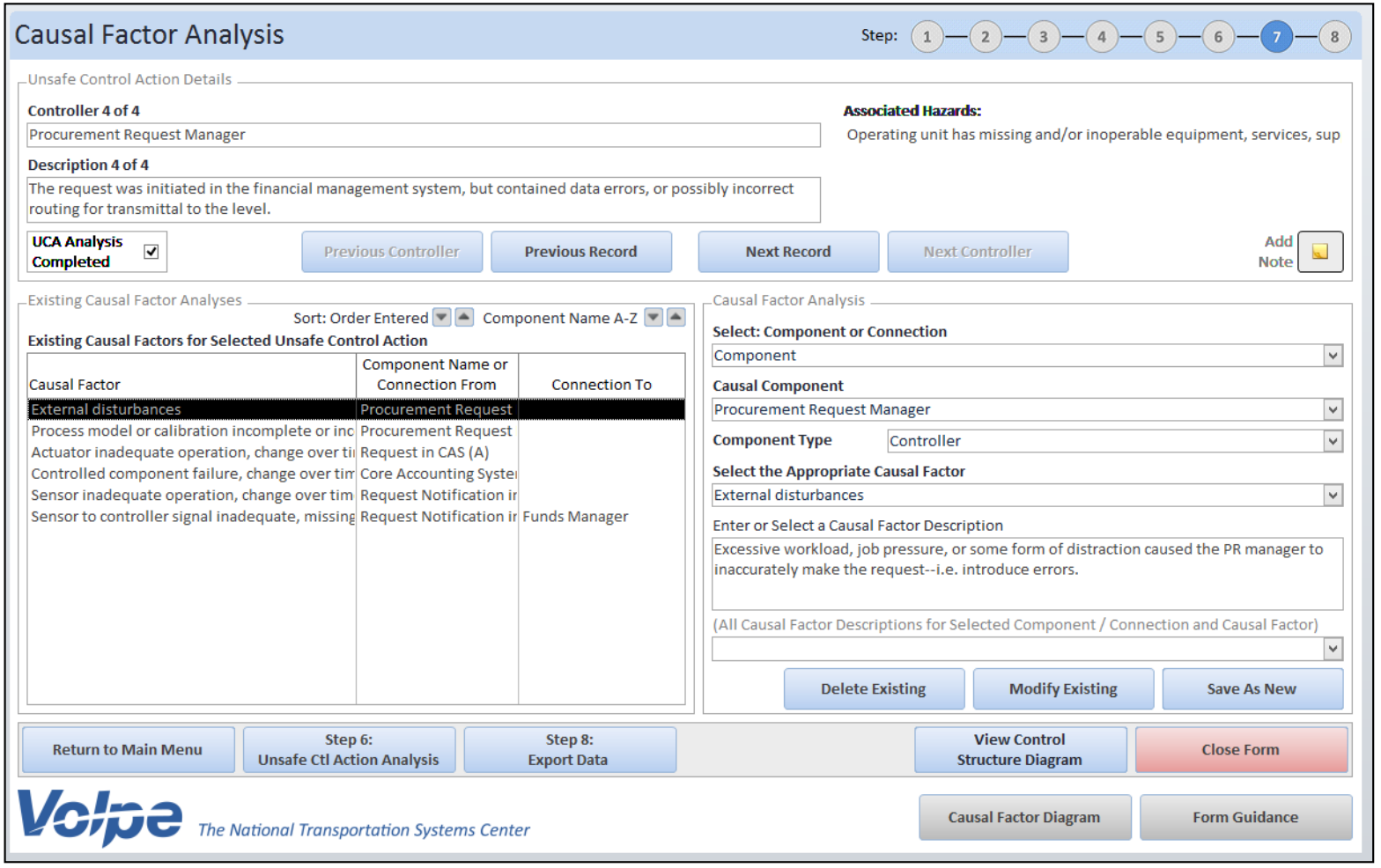


Causal Factors (examples)

- Excessive workload, job pressure, or distraction could prevent the funds manager from recording the obligation in CAS in a timely manner. (External Disturbances)
- Lack of training, poor job performance, improper prioritization of tasks, or lack of feedback regarding the status of the system prevented the service from being ordered within the required time. (Process Model)



SafetyHAT Causal Factor Analysis (Step 7)

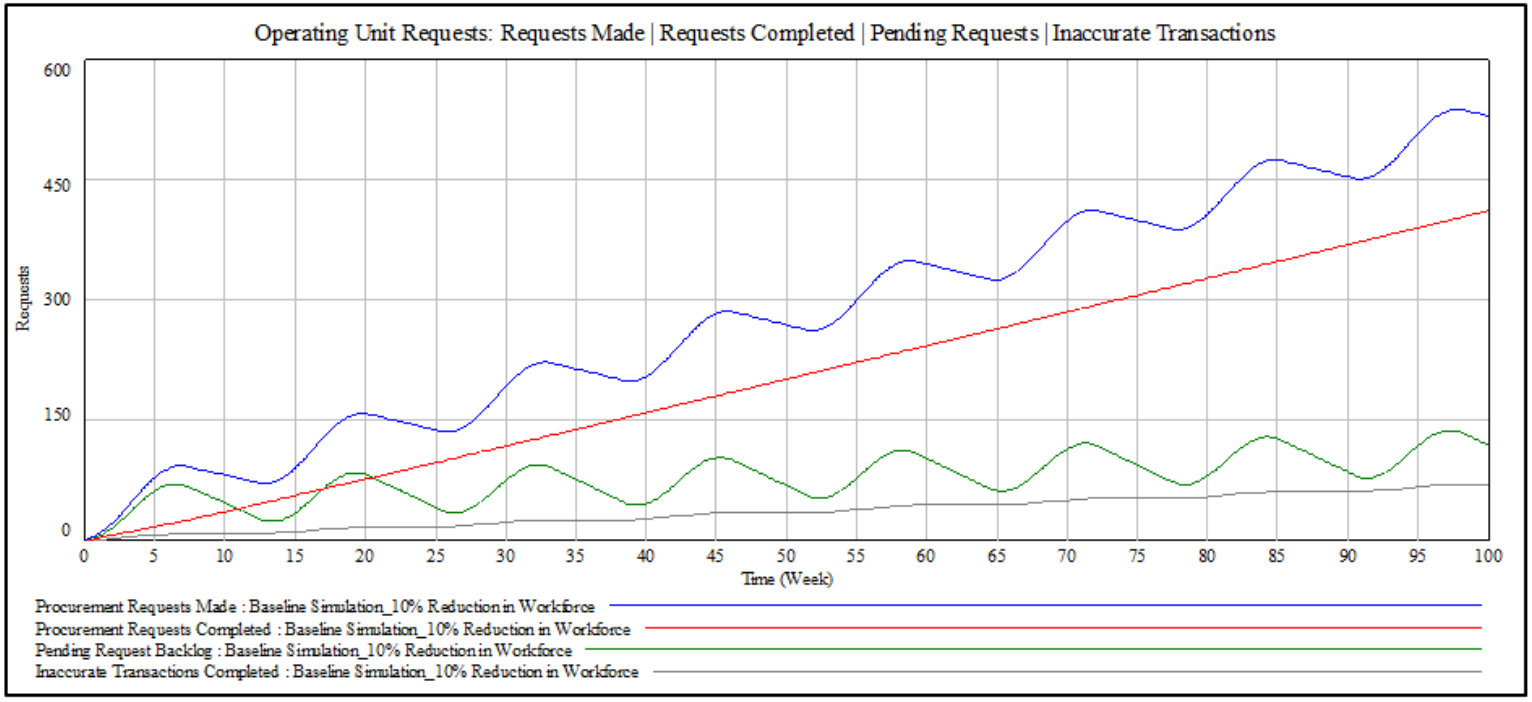


SafetyHAT Utility & Future Research

- SafetyHAT facilitated a very thorough review of a complex socio-technical system
  - Intuitively guides users through STPA
  - Easy to analyze results using Excel data export
  - Traceable requirements generation

SafetyHAT Utility & Future Research (con't)

- Causal Factor guidewords can be modified to analyze systems in other domains or applications
- Thesis research, including system dynamics modeling, will help inform the implementation of USCG FM application & BPR



Question & Discussion

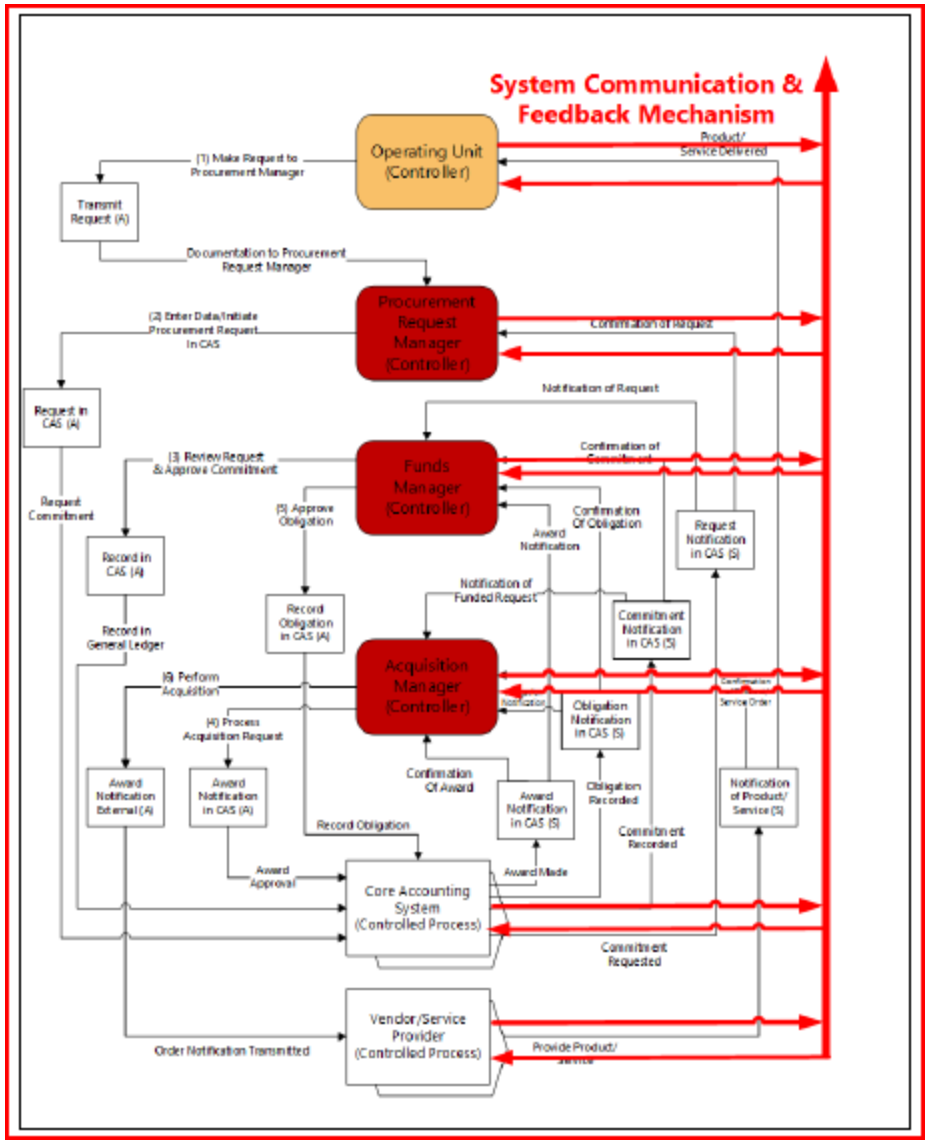
Background

Generalized Findings

- Hazard Analysis methodology proved useful for ID'ing deficiencies in a complex socio-technical systems
- Simulations provide valuable insight into system behavior
  - Informs design & resource allocation decisions
- Strong sponsorship critical to prepare the system for the changes that are needed
  - There must be a common understanding of the problem and consensus on how to resolve it
- The re-engineered CG system must have robust channels for feedback & communication

System Feedback

A robust communication & feedback mechanism is critical to achieve desirable system performance



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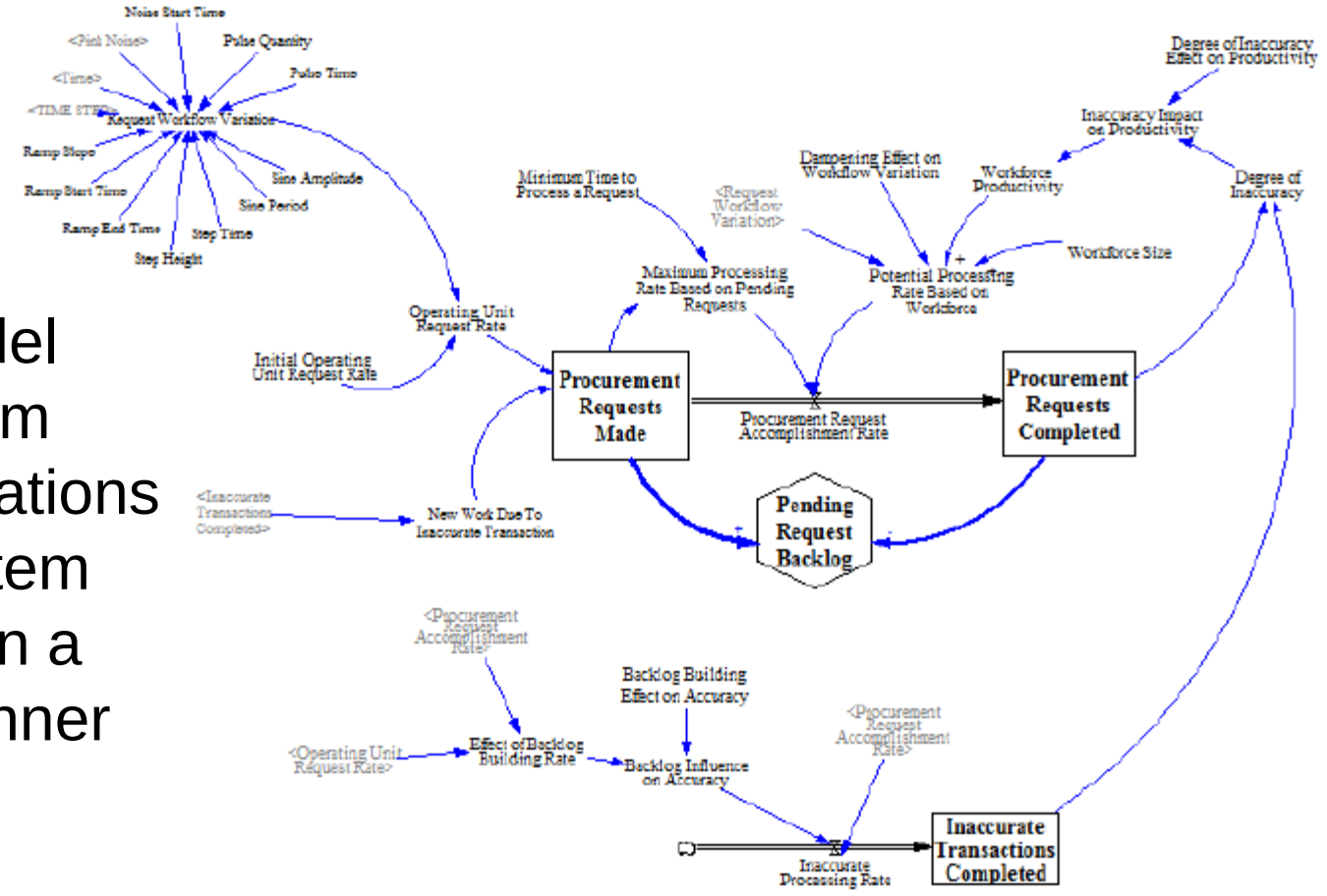
System Dynamics Model

Basic SD Model used to perform multiple simulations to access system performance in a predictive manner



Discussion Topics

Most significant challenges of the current state?

- System limitations
- Liabilities
- Inefficient processes /work-arounds
- Other…..?

Perceived hazards that exist in the “to-be” state?

- Resource constraints (workforce capacity, IT/network, BI)
- DOI Solution
- System feedback & communication mechanism
- Training (OFF and/or business processes)
- Metrics
- Other….?

Most significant challenges regarding implementation of the “to-be” state?