Systems Thinking Workshop

FHI 360 Conference Center
1825 Connecticut Ave NW 8th Floor, Washington, DC 20009

November 18, 2019

Dr. Brian Sauser (University of North Texas)
Dr. Jon Wade, (Stevens)
Kunal Batra (Stevens)
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30</td>
<td>Registration</td>
<td></td>
</tr>
<tr>
<td>10:00</td>
<td>Opening Remarks</td>
<td>Dr. Jon Wade</td>
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<tr>
<td>10:15</td>
<td>Why Systemigrams: Where do they fit in the Sea of System Diagrams</td>
<td>Dr. Brian Sauser</td>
</tr>
<tr>
<td>10:35</td>
<td>30-year Retro/Per-spective Methodology, Media, Message</td>
<td>Dr. Brian Sauser</td>
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<tr>
<td>10:55</td>
<td>Systemigram Examples</td>
<td>Dr. Brian Sauser</td>
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<tr>
<td>11:15</td>
<td>Break</td>
<td>All</td>
</tr>
<tr>
<td>11:25</td>
<td>SystemiTool 2.0: It’s not about the platform anymore</td>
<td>Dr. Jon Wade/Kunal Batra</td>
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<tr>
<td>12:00</td>
<td>Meeting Adjourned</td>
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Systems Thinking Workshop: Opening Remarks

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November 18, 2019

Dr. Jon Wade, (Stevens)
Growing Levels of System Complexity

Source: INCOSE Vision 2025
Good systems engineering relies on systems thinking...

- Think outside before inside.
- Think what and why before how.
- Think relationships not just elements.
- Think long term not just initial capability.
- Think loops not lines.

- Outside focus includes:
  - Understanding the stakeholders (business, technology, organizational, political)
  - Understanding the environment and the system context
  - Understanding key drivers and constraints, including historical and legacy constraints; mission and opportunity constraints, inclusive of cost and schedule
Essentially, all models are wrong, but some are useful.

George Edward Pelham Box (October 18, 1919 – March 28, 2013) was a British mathematician and professor of statistics at the University of Wisconsin, and a pioneer in the areas of quality control, time series analysis, design of experiments and Bayesian inference.
The World Today
Technology Is Transforming the Battlespace

- The proliferation of knowledge and technology erodes historic U.S. advantages
- Our near-peers are increasing their rate of investment in military R&D
- A hyper-competitive environment for National Security technologies
- The discriminators are speed and cycle time

- NSF 2015 data predicted R&D investment parity with China in 2020
- Feb 2018, NSB estimates China R&D investment parity with U.S. by end of 2018

- 2017 GLOBAL R&D FUNDING FORECAST WINTER 2017 Industrial Research Institute, R&D Magazine

R&D - Research & Development  
NSB - National Science Board

NDIA  June 6, 2019
Digital Engineering Overview

- What is Digital Engineering?
  - Combines model-based techniques, digital practices, and computing infrastructure
  - Enables delivery of high pay-off solutions to the warfighter at the speed of relevance

- Reforms Business Practices
  - Digital enterprise connects people, processes, data, and capabilities
  - Improves technical, contract, and business practices through an authoritative source of truth and digital artifacts

Modernizes how we design, operate, and sustain capabilities to outpace our adversaries
Digital engineering (DE):
• an engineering approach that captures and analyzes data that is in a digital format which is semantically rich and interconnected
• enables people to leverage the power of computing, visualization, and communication to significantly enhance efficiencies, quality, and innovation across the complex system development lifecycle

- Sandy Friedenthal, SERC DE Workshop, Nov. 15, 2019
How can systems thinking be supported effectively in a digital engineering environment?
SYSTEMS THINKING WORKSHOP

Brian Sauser
University of North Texas
November 18, 2019
SERC Research Review
“... I stand at the edge of the future with the universe as my systems’ boundary and standing beside me is what I believe will be the greatest of my Systems Shepards, John Boardman.”

Brian Sauser
Systems Thinking: Coping with 21st Century Problems
WHY SYSTEMIGRAMS

Where do they fit in the Sea of System Diagrams?
Diagram types used in systems studies

To show relationships between ideas or thoughts

At one point in time (static)

Objective Tree

At one point in time (dynamic)

Cognitive Map

Over Time

Multiple Cause Diagram

Relationship Diagram

Rich Picture

Rich Picture

Spray Diagram

System Map

Over Time (dynamic)

Input-Output Diagram

To show relationships between activities or processes

At one point in time (static)

Fishbone Diagram

Activity Sequence Diagram

Rich Pictures

Cartoon Storyboard

Relationship Diagram

Influence Diagram

Over Time (dynamic)

Decision Trees and Networks

Casual Loop Diagram

Systems Map

Rich Pictures

Flow Diagram

Multiple Cause Diagram

Rich Pictures

Sign Graph

“The breaking of a wave cannot explain the whole sea.”

~ Vladimir Nabokov
A new study led by Elinor Amit, an affiliate of the Psychology Department (Harvard University), shows that people create visual images to accompany their inner speech even when they are prompted to use verbal thinking, suggesting that visual thinking is deeply ingrained in the human brain while speech is a relatively recent evolutionary development.

A hybrid, from *systemic diagram*

- Takes lengthy documentation and distills it down to “concentrated text” (or prose) covering the salient points of the system

- This reduced text (or narrative) represents a description of the problem situation

- A visual systemigram is then constructed, decomposing the prose into the individual, related threads, showing the flow of information, resources and actions

**Systemigrams are powerful storytelling aids and are useful in providing a common foundation for group discussions**

**They do not remove the complexity from systems, but they can make complex systems understandable**
30-YEAR RETRO/PERSPECTIVE

Methodology, Media, Message
1990-2019

**Systemigrams**
- Papers: 402
- Citations: 5,997
- Cites/Year: 206.79
- Cites/Paper: 14.92
- Author/Paper: 2.53
- h-index: 31

**Barry Boehm**
- Papers: 744
- Citations: 29,568
- Cites/Year: 1019.59
- Cites/Paper: 39.74
- Author/Paper: 2.94
- h-index: 72

Data Source: Google Scholar
Data Compilation Tool: Harzing’s Publish or Perish
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<td>International Journal of Project Management</td>
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- Syst. thinking and Syst. Theory
- Man. Science and Ops. Research
- Modeling and Simulation
- K-12 learning environments
- Marketing
- Econ., Econometrics and Finance
- Comp. Science
- Geography, Planning and Dev.
- Medicine
- Nursing
- Health sciences (general)
- Business and Int'l. Man.
- Ind. and Manufacturing Eng.
- Info. Systems
- Hardware and Architecture
- Strategy and Management
- Decision Sciences
- Man. of Tech. and Innovation
BOARDMAN SOFT SYSTEMS METHODOLOGY

1. The problem situation: Unstructured
2. The problem situation: Expressed
3. Structured Text
4. Systemigram(s) Design
4a. Formal system concept
4b. Other systems thinking
5. Dramatization and Dialogue
6. Feasible, desirable changes
7. Action to improve the problem situation

Real World

Systems Thinking
SYSTEMIGRAM DESIGN RULES

• Primary sentence *(mainstay)* which supports the purpose of the system will read from top left to bottom right.
  • This is the anchor for the entire visualization
  • Until one understands the picture as a whole there is always the chance that confusion, not clarity, will arise
  • The other segments of the systemigram flow out of and back into this mainstay, connecting as needed with its landmark noun phrase nodes

“Whatever affects one directly, affects all indirectly. I can never be what I ought to be until you are what you ought to be. This is the interrelated structure of reality.”

~ Martin Luther King, Jr.
SYSTEMIGRAM DESIGN RULES

• Ideally there should be 15-25 nodes (less can make for a trivial system description, more can create clutter and illegibility)
  • For a node to be linked to another node n/2 links are necessary for an even number of nodes and (n+1)/2 links for an odd number.
  • For all nodes to be linked, n-1 links are necessary.
  • For all nodes to be linked to every other nodes n(n-1)/2 links are necessary for a non-planar graph.
  • With the number of nodes, it is possible to find the number of possible combinations: \(2^{n(n-1)/2}\).

“If I can reach further, it is by connecting with influential nodes”

~ Gohar F. Khan, Digital Analytics for Marketing
SYSTEMIGRAM DESIGN RULES

• No repetition of nodes
  • Redundant nodes loses the essence of relationships…

“Too much of anything is bad, but too much good whiskey is barely enough.”

~ Mark Twain
Systemigrams are systems

- Every system has a structure and process
- Structure is an arrangement of parts (nodes) and relationships (links)
  - Parts are nodes, represented by nouns and noun phrases
    - i.e. noun phrases (people, organizations, groups, artifacts, and conditions)
  - Relationships are links represented by verbs, and verb phrases (actions)
    - i.e. verb phrases (transformation, belonging, and being)

“In today’s busy and fast paced environment there are too many unseen forces at work, by just connecting the dots I win BIG.”

~ nick catricala
SYSTEMIGRAM DESIGN RULES

• No cross-over of links
  • A design rule that not only makes the systemigram cleaner and clearer to view, but also leads to the observance of an important heuristic in systems design.
  • For a systemigram of 20 nodes, the total number of possible links is 190, whereas the actual number will be about 30
  • This ratio is about 15%, which is held to be the optimal ratio of interfaces in a system relative to how many there could be.*

SYSTEMGRAM DESIGN RULES

• Beautification (e.g. shading and dashing of links and nodes)
  • should help the reader read the sentences in the diagram

• Exploit topology to depict why, how, what
  • (who, when, and where is built into system description)

“Consider a tree for a moment. As beautiful as trees are to look at, we don’t see what goes on underground - as they grow roots. Trees must develop deep roots in order to grow strong and produce their beauty. But we don’t see the roots. We just see and enjoy the beauty. In much the same way, what goes on inside of us is like the roots of a tree.”

~ Joyce Meyer
## Systemigrams vs Modeling Principles

<table>
<thead>
<tr>
<th>Principle</th>
<th>Systemigram Guidance</th>
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<tbody>
<tr>
<td>Correctness</td>
<td>• Mainstay which supports the purpose of the system reads from top left to bottom right</td>
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<tr>
<td></td>
<td>• Ideally there should be 15-25 nodes</td>
</tr>
<tr>
<td></td>
<td>• Nodes must contain noun phrases</td>
</tr>
<tr>
<td></td>
<td>• Links should contain verb phrases (to reduce trivial links)</td>
</tr>
<tr>
<td></td>
<td>• No repetition of nodes</td>
</tr>
<tr>
<td></td>
<td>• No cross-over of links</td>
</tr>
<tr>
<td>Relevance</td>
<td>• Remember that the model is really “theirs”.</td>
</tr>
<tr>
<td></td>
<td>• Remember that the model is not really “theirs”</td>
</tr>
<tr>
<td></td>
<td>• Remember that the model is not reality</td>
</tr>
<tr>
<td>Feasibility</td>
<td>• It should compare to reality (comparing 4 to 2 in the BSSM)</td>
</tr>
<tr>
<td>Clarity</td>
<td>• It should read well.</td>
</tr>
<tr>
<td></td>
<td>• Beautification (e.g. shading and dashing of links and nodes) should help the reader read the sentences in the diagram</td>
</tr>
<tr>
<td></td>
<td>• Exploit topology to depict why, how, and what (who, when, and where is built into system description)</td>
</tr>
<tr>
<td>Comparability</td>
<td>• It should compare to reality (comparing 4 to 2 in the BSSM)</td>
</tr>
<tr>
<td>Systematic Design</td>
<td>• Is it a system in its own right?</td>
</tr>
<tr>
<td></td>
<td>• Does every node (except for the beginning and ending nodes) have an input and an output?</td>
</tr>
<tr>
<td></td>
<td>• Can you follow any node to the end node?</td>
</tr>
<tr>
<td>Conciseness</td>
<td>• A model should be as simple as possible and no simpler</td>
</tr>
<tr>
<td></td>
<td>• No repetition of nodes</td>
</tr>
<tr>
<td></td>
<td>• No cross-over of links</td>
</tr>
</tbody>
</table>

“If someone throws a fit because you set boundaries, it’s just more evidence the boundary is needed.”

~ Unknown
SHOW ME THE ________

What is Resilience; Small Vessel Security; The SERC
• **Remember**: Viewing a systemigram in segments is like viewing only scenes in a movie, it is the compilation of scenes that tell the story.

• Key to systemigram modeling is the ability of the modeler to **decompose the model into scenes** that can **articulate a story** of what the systemigram represents (storyboarding).

• A completed systemigram then is not the end of the story, but the **basis for telling a story**.

• The story can be **told in a variety of ways** but all have the same generic format – to create a storyboard using carefully selected scenes, which are sub-nets of the systemigram.

• **Each scene represents a key part of the message** but by the same token it begins to tell a more detailed message which can only be amplified by having the right people listen to the systemigram story.
A bird doesn't sing because it has an answer, it sings because it has a song.

~ Maya Angelou

PREACHER

ENTERTAIN
The Script

TEACHER

INSPIRE
The Sermon

EDUCATE
The Lesson
WHAT IS RESILIENCE?
Initial Systemigram Based on Literature Review
Version 2.0 Based on Follow up Workshop
Version 3.0 Based on Final Workshop
WHAT IS RESILIENCE?
VERSION 3.0 MAINSTAY
SMALL VESSEL SECURITY
A systemigram was built of the DHS Small Vessel Security Strategy (SVSS) as defined by the respective strategy document (DHS, 2008a). This systemigram yielded 12 scenes. Each scene is a representation of a defining topic within the document: Purpose (Mainstay); Scope; Relationships to Other Strategies and Plans; Methodology; Importance to the Maritime Domain; Maritime Governance; Small Vessel Community; Small Vessel Risk; and Major Goals (A-D). Collectively, these scenes represent a systemic description of the SVSS.
Governance is to steer an organization or set of constituencies based on established or customary guidelines for actualizing a desired status*. Maritime Governance, as depicted in this scene, represents the stakeholders and their actualization of Risk Mitigation Alternatives and the Safety and Security Risks. A key observation of this scene is that the Small Vessel Community is absent.

This scene depicts the Small Vessel Community, but more noticeable, as articulated in the SVSS, the disconnect of the Small Vessel Community with the Maritime Governance and Maritime Security Partners. While this is a reality in practices, see (Roblich, 2009, December 9), the SVSS and other DHS documents, e.g. (DHS, 2010; DHS, 2011), explain that this is not a long-term objective of DHS or the SVSS.
Major Goal A is related to the DHS commitment to engaging the community as part of the enterprise (DHS, 2010) to maritime domain awareness.

A layered approach is adopted in the DHS SVSS Plan to create defense in depth against the potential small vessel threats. Comparing this approach to the scenes in the systemigram reveals some potential issues not effectively articulated by the Plan:

- Though the adversary actions by small vessels are identified over time, the Plan does not provide an analytic method to assess these risks, nor give any description of characteristics for each of the adversary actions.
- It is clearly stated that the small vessel community is one of the key components for the enterprise solution of small vessel threat; however, the Plan does not integrate this element when considering their interagency operations that support maritime homeland security.
Systemic Media Lab

DHS Small Vessel Security Strategy

Technology and Innovation

Risk Mitigation Alternatives

Security and Safety

(Threat x Vulnerability) x Consequence

Maritime Governance

Unified Effort

Coherent Plan with Layered Approach

DHS Legislation and Strategies

Cooperation

Coordination

Small Vessel Community (<300 gross tons)

Commercial Fishing

Recreational

Towing

Passenger

Steven Institute of Technology

Risk Scenarios

WBIEDs

Weapons Smuggling

Terrorist Smuggling

Waterborne Platform

Small Vessel Security Partners

Federal

State

Local

Tribal

Commercial

International

Maritime Security Partners

Adequate Security

Fundamental Freedoms

Economic Stability

Security Systems

Awareness

Regimes

Operations

Global Maritime Domain

U.S. Ports

Foreign Ports

Global Commons

Approaches

have limited interaction with

develop and leverage partnership with

that balance

to enhance

to detect, determine, and interdict

to mitigate

using a

based on

implement & monitor

select appropriate

to address

that influence

enhances and leverages

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Copyright 2011

Modeler: Brian Sauser
SYSTEMS ENGINEERING RESEARCH CENTER (SERC)
Enhanced Practice of SE on Complex Programs

Methods, Processes, & Tools

Active and Open Communities and Mechanisms

Quantitative Risk

Complexity-Based Risk

Leading Indicators

SE and Systems Management Transformation

Interactive Model-Centric SE

Graphical ConOps

V&V of Models & Simulations

Agile SE

Agile & Lean SE

Agility Enablers and Quantification

Cost Estimation for Software-Intensive Systems

Resilient Systems

Modularity & Flexibility

SRIs

Technology Assessment Framework

Evolutionary Acquisition

Architecture Assessment

Affordability & Value

Tradeoff Exploration
HOW DO YOU KNOW WHEN YOU’RE DONE?

• This process should be repeated until a successful outcome of a BSSM is achieved.

• Success is defined as:
  • (i) the people concerned, i.e. stakeholders, feel that the problem has been solved; and/or
  • (ii) the problem situation has been improved; and/or
  • (iii) insights have been gained.

Remember that the model is not really “theirs”! You constructed it from something that meant something to them but now means less than the model offers.

Remember that the model is really “theirs”. All you did was to present a fresh perspective on their system descriptions with hopefully some added value.

Remember that the model is not reality; rather it’s an insightful commentary on reality that serves the purpose of shaping future reality with greater effect.
“EVERY GREAT JOURNEY ENDS IN A PLACE YOU NEVER KNEW IT WOULD TAKE YOU WHEN YOU STARTED.”

John Boardman & Brian Sauser
Systemic Thinking: Building Maps for Worlds of Systems
Systems Thinking Workshop: SystemiTool 2.0

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Dr. Jon Wade, (Stevens)
Kunal Batra (Stevens)
Example: Defense Acquisition Programs
Combat veterans define demanding requirements for the next generation of military equipment to ensure a successful conflict outcome. The technical challenges of the requirements lead design engineers to propose use of new technologies in the equipment.

Defense firms, operating in a monopsony, compete for the right to develop and produce the technology by bidding optimistic cost and schedule estimates. These estimates are ultimately proven wrong and lead to program delays. Losing firms delay the program execution by filing protests.

The technology needed to meet the established requirements is not yet fully available requiring extensive research and development leading to delays.

Delays are exacerbated because Congress declined to appropriate any contingency funds or to pay for schedule slack. Delays also allow new military threats to emerge and the original requirements must be modified. The Program Manager, reluctantly, proposes a schedule slip—even though this will substantially raise overall costs.

Unit cost of the item to be produced has been significantly underestimated making it necessary to cut in half the total number of items to be produced. Politicalls seize the opportunity to reduce the production buy by another factor of two. Given the delays that have been suffered additional demands on the government’s overall budget begin to emerge so production is further curtailed in both rate and quantity. Unit costs skyrocket. The troubled program is finally terminated, due to widespread sticker shock

The military officers who served as requirements generators thus return to their field assignments where they prepare their troops to go into combat with now 40-year-old equipment.
Combat Veterans define demanding requirements for next generation military equipment to ensure successful conflict outcome.
Losers operating in Monopsony compete for Procurement of Development and Production of Next Generation Military Equipment by bidding.

Optimistic Estimates of Cost and Schedule ultimately leading to Program Delays.
New Technologies → Extensive Research and Development → leading to Program Delays

require →
Unit Cost

underestimated leading to cut

raises

Production
Combat Veterans

Unit Cost
leads to
Sticker Shock
which coupled with

Program Delays
results in
Program Cancellation

leading to under equipped
Digital engineering (DE):

• an engineering approach that captures and analyzes data that is in a digital format which is semantically rich and interconnected

• enables people to leverage the power of computing, visualization, and communication to significantly enhance efficiencies, quality, and innovation across the complex system development lifecycle

- Sandy Friedenthal, SERC DE Workshop, Nov. 15, 2019
A. Context – Systems Thinking
   1. Systems Perspectives
   2. Relationships
   3. Dynamics

B. Human Centricity – Design Thinking
   4. Design Thinking
   5. Identifying Opportunities
   6. Identifying Customer Needs
   7. Preliminary Product Specifications

D. Conceptualization – Systems Engineering
   8. Concept Design
   9. Concept of Operations
   10. Use Case Scenarios
   11. System Requirements
   12. Economics & Financial Analysis

E. Integration & Deliverables
   13. Project Presentations
   14. Final Report
Problem Statement: Why?

If I had only one hour to save the world, I would spend fifty-five minutes defining the problem, and only five minutes finding the solution.

— Albert Einstein

A problem well stated is a problem half-solved.

— Charles Kettering

If you define the problem correctly, you almost have the solution.

— Steve Jobs
A Root Definition is a structured description of a system. It is a clear statement of activities which take place (or might take place) in the organization being studied.

It consists of three elements: **what, how, why**

and is of the form:

**A System to do X, by (means of) Y, in order to achieve Z.**

X – **What** the System does  
Y – **How** it does it  
Z – **Why** it is being done

The '**what**' is the immediate aim of the system,  
The '**how**' is the high-level means of achieving that aim,  
The '**why**' is the longer-term aim of the purposeful activity.
CATWOE: Multiple Perspectives

• CUSTOMERS – who are the stakeholders, beneficiaries/victims?
• ACTOR(S) – who are the implementers?
• TRANSFORMATION – what does the system do?
• WORLD VIEW – what point of view justifies its existence to the customers?
• OWNER – who has the authority to change the system?
• ENVIRONMENT – what are the external constraints?
Systems and Software Engineering Division

School of Systems & Enterprises
Stevens Institute of Technology
Problem

There is a critical shortage of systems and software engineers who are capable of addressing the increasing complexity of the challenging systems problems that need to be addressed to ensure the well-being and sustainability of humankind.
Root Definition

Pioneer Systems and Software organization composed of top-notch, diverse faculty, which creates courses and workshops that are integrated in relevant, practitioner-based programs that are used to instruct high-quality students who are enabled to tackle complex problems of international significance.
## CATWOE

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<th>Area</th>
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<td>Enable national security &amp; prosperity</td>
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Systems Software Mission and Vision

Pioneer Systems & Software Division

Systems Engineering
Software Engineering

is comprised of

Top Notch, Diverse Faculty

T/TI Faculty
Adjuncts
Teaching Faculty
Research Faculty
Staff
Systems Software Mission and Vision

Pioneer Systems & Software Division
- Systems Engineering
- Software Engineering

Top Notch, Diverse Faculty
- Research Faculty
- Teaching Faculty
- Adjuncts
- Staff

Courses & workshops

Relevant, Practitioner-based Programs
- Integration
- Software Engineering
- Systems Engineering
- Cyber-Physical Systems

High Quality Students
- Full time
- Undergrad
- Masters
- PhD
- Part time

Used to instruct

Leading Orgs:
- DoD
- NGC
- LMCO
- ANSER
- Sandia
- FAA
- Others...

Tackle Relevant Problems of International Significance
Systems Software Mission and Vision

Pioneer Systems & Software Division
- Systems Engineering
- Software Engineering

is comprised of

Top Notch, Diverse Faculty
- Full-time Faculty
- Adjuncts
- Teaching Faculty
- Staff

collaborate with

Stevens Institute
- School of Engineering
- School of Business
- College of Arts & Letters

support

Courses & workshops

create

Relevant, Practitioner-based Programs
- Integration
- Software Engineering
- Cyber-Physical Systems

integrated in

used to instruct

High Quality Students
- Full-time
- Undergrad
- Masters
- PhD
- Part-time

Leading Orgs: DoD, NSA, LMCO, ANSER, Sandia, FAA, Others

Relevant Problems of International Significance

tackle
Systems Software Mission and Vision

Pioneer Systems & Software Division
- Systems Engineering
- Software Engineering

is comprised of

Top Notch, Diverse Faculty
- T/T Faculty
- Adjuncts
- Research Faculty
- Teaching Faculty
- Staff

establish relationships with

Highly Respected Partners
- Other universities
- Government agencies
- Corporations

collaborate with

Stevens Institute
- School of Engineering
- School of Business
- College of Arts & Letters

support

Courses & workshops

inform

Relevant, Practice-based Programs
- Integration
- Software Engineering
- Cyber-Physical Systems

provide

used to instruct

High Quality Students
- Full time
- Undergrad
- Masters PhD
- Part time

Leading Orgs:
- DoD
- NGC
- LMCO
- ANSER
- Sandia
- FAA
Others...

relevan problems of International Significance

 tackled
Digital engineering (DE):
• an engineering approach that captures and analyzes data that is in a digital format which is semantically rich and interconnected
• enables people to leverage the power of computing, visualization, and communication to significantly enhance efficiencies, quality, and innovation across the complex system development lifecycle

- Sandy Friedenthal, SERC DE Workshop, Nov. 15, 2019
Join us in making Systemitool the vehicle to integrate systems thinking with the SE digital engineering environment