2016 Innovation Crossover Event

Summary Report

Submitted by OVO Innovation

November 18, 2016

Contents

Executive Summary

OVO Innovation is pleased to present this report as a deliverable from the 2016 Innovation Crossover event held on 12-13 October 2016 sponsored by NSWC Crane.

The Innovation Crossover event had four main goals:

1. To foster and accelerate a decade of innovation across the region
2. Accelerate and enable the development of a vibrant innovation ecosystem across the region and the state.
3. Vastly speed the development of collaborative relationships, public-private partnerships, foundations and infrastructure to deliver advanced capability for technology clusters: DoD Technologies, Advanced Manufacturing, IT/Cyber and Life Sciences
4. Spark a wave of entrepreneurialism/innovative companies across the region, to create tech-based economic development and complement existing innovative economic activity.

This report, as one output of the event, is meant to provide input to the newly formed Applied Research Institute (ARI) (Appendix 1) possibly influencing future research activities.

OVO was awarded a contract to provide research reports on topics of interest within the four identified clusters and to facilitate the idea generation and concept development phases of the two day event. This report defines the idea generation and concept development activities within the Innovation Crossover event and documents a number of the leading concepts developed and selected by the participants.

The participants followed the OVO Innovation methodology for two key topics or challenges in the workshop tracks that were focused around each technology cluster. There was a significant amount of interaction and exchange, and the participants generated good ideas which led to interesting new concepts, some of which are highlighted in the body of the report. All concepts are documented in the Appendix.

Beyond the work within the breakouts aligned to technology clusters, there was a significant amount of formal and informal discussion across clusters, across research interests, and across the different constituents represented (government, industry and academia). This interaction should spark more collaboration and engagement. Areas of overlap between technology clusters that OVO identified are documented on pages 33 and 34 of this report.

The Innovation Crossover event was a significant success because it clearly created new conversations and relationships and set expectations for future engagements in both Indiana and the chosen technology clusters. We look forward to seeing the ideas documented here become the basis for new collaborations or research within the ARI and across Indiana.

Background

NSWC Crane and other organizations (academia, government, and industry) are interested in creating more economic development and more research opportunities to strengthen Indiana's economic base, create new jobs and create a greater sense of engagement and cooperation between these three important economic drivers.

The Southwest Central Indiana Steering committee commissioned a study by Battelle which identified a number of potential industries or technology clusters where further research and cooperation could lead to more economic development. From that study, four technology clusters were identified as the most promising, aligning with existing capabilities in the state, research focus in the state's universities and aligning to NSWC Crane's missions. These four clusters include:

- Department of Defense (DoD) Technologies
- Life Sciences
- Information Technology and Cybersecurity (IT/Cyber)
- Advanced Manufacturing

NSWC Crane sponsored the Innovation Crossover event to encourage more engagement, build relationships and networks across the three constituent groups (academia, government, and industry) and to identify potential research opportunities to seed thinking at the nascent Applied Research Institute, funded by the Lily Endowment. Planning for the Innovation Crossover event was guided by an Executive Steering Group (ESG) consisting of members from Indiana Office of Defense Development, Indiana University, Purdue University, University of Southern Indiana, Cook Group, and Radius Indiana.

The Innovation Crossover event had four main goals:

1. To foster and accelerate a decade of innovation across the region
2. Accelerate and enable the development of a vibrant innovation ecosystem across the region and the state.
3. Vastly speed the development of collaborative relationships, public-private partnerships, foundations and infrastructure to deliver advanced capability for technology clusters: DoD Technologies, Advanced Manufacturing, IT/Cyber and Life Sciences
4. Spark a wave of entrepreneurialism/innovative companies across the region, to create tech-based economic development and complement existing innovative economic activity.

The Innovation Crossover event included a two day agenda (Appendix 2) that included innovative speakers from a diverse group of organizations within industry, academia and government as well as panels to promote collaboration and innovation at the boundaries of the technology clusters. The panels consisted of 13 panelists each discussing innovative technology in five minute, rapid fire presentations. The SPARC Panel (Strengthening Partnerships to Assure Relationships and Collaborations) highlighted industries leading innovative technologies and the Relevant University Research Panel consisted of university researcher's cutting edge relevant university research.

The Innovation Crossover event agenda allowed for two full afternoons of breakout sessions, where the real innovation and collaboration took place. Breakout sessions were facilitated by a professional

facilitator, which tailored their innovation methodology to fit Crane, the state and regional objectives. Breakout sessions allowed the participants to frame the presented grand challenges, generate and capture ideas, and converge those ideas to the most promising for follow-on action to solutions of challenges.

In order to get the level of expertise in each technology cluster that was needed, Crane developed a Technical Track Working Group (TTWG) that was derived of researchers and subject matter experts with various backgrounds in one of the technology areas. This group was made up of members from Indiana University, Cook Group, Air Force Research Lab, Purdue University, Rolls-Royce, University of Southern Indiana, University of Kentucky, Rose-Hulman, University of Louisville, and Orthoworks. One major task for the TTWG was to narrow down the technology tracks into distinctive grand challenges within each of the technology tracks. These grand challenges served as the focus of the Innovation Crossover event.

NSWC Crane organized the event and planned presentations, short focused talks about leading research, informative sessions from key researchers and individuals from Naval research, and also planned for idea generation and idea development in the four cluster areas. What follows is a detailed report, compiled by OVO Innovation, based on the ideation results around each of the defined grand challenges.

OVO Innovation Process Defined

Before the deep examination of ideas and developed concepts in the four technology clusters, it is important to define the innovation process that OVO used to guide the Crossover attendees to generate ideas and develop concepts.

OVO has developed its innovation process for over a decade by working with private and public sector clients, leveraging the best practices of Creative Problem Solving (CPS) and its own experiences. The innovation process follows a defined methodology to drive the best results. This methodology defines an innovation process in the following major activities or phases:

- Defining a need or challenge to overcome
- Within that need or challenge, defining a key question to frame the idea discussion
- Conducting research in the market about new or emerging technologies or research, or with customers to identify key opportunities or needs
- Generating ideas using group norming methods, leveraging best practices, setting group expectations and facilitating discussion
- Evaluating ideas after they are generated using a standard evaluation mnemonic
- Ranking the evaluated ideas
- Selecting the best ideas and developing them further using a “concept” template which requires the development of a sketch, a flow chart or other descriptive definition of the idea as well as key features and challenges, and an elevator pitch, which provides the ability to define the ideas descriptively in a discussion
- Ranking the concepts based on participant expertise, technological feasibility, impact, alignment to the original challenge or need and research

In the following pages we'll examine each of these activities in more detail.

Defining a need or challenge

The Battelle study defined the most important technology clusters (Advanced Manufacturing, Life Sciences, IT/Cyber and DoD Technologies). These are important clusters but define very broad topics. To generate ideas effectively, we needed to narrow the scope to a need or challenge within these broad categories; otherwise, the teams would find it difficult to choose across clusters where there are many opportunities and needs.

Together with our NSWC Crane counterparts we defined two challenges or topics within each cluster. These challenges represent important areas of need or research, but don't define all of the needs or opportunities within the cluster. Narrowing the focus to a more specific need or challenge within the cluster meant that the event participants could quickly align around a need, rather than spend valuable and limited time debating the range of needs or opportunities within the cluster.

Framing Question

In the OVO Innovation idea generation methodology, and in good idea generation practice generally, it's common to create what's known as a "framing" question to align the participants. First, we seek an open ended, aspirational question to uncover more expansive, divergent ideas. Thus, this framing question typically begins with "How might we ..(solve a challenge or address a need)?" The question is meant to drive open debate and expand thinking to more creative and more divergent ideas, while also providing context and scope for the idea generators.

The framing question also provides reinforcement of the idea generators' purpose, and becomes one of the first tools used to evaluate ideas when the work shifts from divergent exploration to convergent problem solving.

Research

Good idea generation leverages insights into needs or opportunities. This insight is typically driven by research into customer needs, new technologies, emerging markets, or competitive actions. Too often experts will assume they know what is happening or what new technologies are likely to emerge, and will miss or ignore information that provides them with different perspectives. Research is always a component of good idea generation.

For the Innovation Crossover event, we leveraged the Battelle study to define the best clusters, then conducted research with subject matter experts (SMEs) selected by NSWC Crane to learn more about the needs and opportunities in the two topics selected within each cluster. OVO Innovation identified four lead facilitators who conducted research with the indicated SMEs and others in their respective topics (Advanced Manufacturing, Life Sciences, IT/Cyber and DoD Technologies). On September 28,

2016, these research reports were submitted to NSWC Crane and were subsequently made available on NSWC Crane's external content management site.

Idea Generation

Once the framing question was identified and the participants had reviewed the research, the next step was to prepare to generate ideas. In the OVO methodology, idea generation is usually prefaced by establishing a set of idea generation "rules" which help frame idea generation, set expectations with the participants and encourage divergent ideas. These rules are taken from Creative Problem Solving methodologies and include the following:

- Don't judge ideas while generating
- Encourage wild ideas
- Build on the ideas of others
- Seek quantity over quality
- Ideas belong to the group

Further, before we generated ideas we defined the idea generation technique we'd be using, called brainwriting – a nominal group technique that is useful in larger groups where experts or expertise may skew results. Brainwriting differs from brainstorming in that each participant writes down their ideas rather than calling them out to a scribe. After a few minutes of writing ideas, participants exchange papers to read the ideas that another person submitted, to build on or expand ideas already submitted and to add new ideas. Brainwriting simplifies documentation, reduces issues with expertise and allows more introspective participants an equal footing in idea generation.

OVO used a standard brainwriting template which we provided to the participants during brainwriting. A copy of this template has been included in Appendix 1.

Through this step we encouraged the participants to be "divergent", exploring opportunities, expanding their thinking, generating new and unusual ideas. In the next phase, ranking and evaluating, we shift to a convergent thinking model.

Evaluation

Once the idea generation is complete, our methodology calls for evaluating the ideas just generated using a common evaluation framework. Rather than allow each participant to rank or evaluate ideas based on their individual perspective, we provided the following evaluation criteria:

- Does the idea align to the framing statement?
- Does the idea align to the research conducted?
- Is the idea technically feasible (not necessarily immediately, but within a reasonable timeframe)?
- Does the idea have a significant impact if implemented?

Using these criteria, the teams evaluated their ideas and selected the top two or three ideas at each table within the technology cluster tracks.

Concept Development

Once the ideas were evaluated and the top ideas were identified, the OVO methodology requires the development of a concept. In our terminology, a concept is simply taking a nascent idea, usually nothing more than a few words, and contextualizing it through an image, a sketch, a flow chart or some other means. Further, a concept requires defining some key features or attributes, significant challenges and advantages over the status quo. This is a standard activity in our methodology and we provide a template to assist in the documentation of a concept. Also part of the concept is an elevator pitch, which helps the team arrive at a common description of the idea using a standard messaging template. A standard concept template and elevator pitch template are included in the Appendix 1.

Technology Clusters and Outcomes

The participants were divided for the breakout sessions into their respective clusters (Advanced Manufacturing, Life Sciences, IT/Cyber and DoD Technologies). The OVO representatives and master facilitators provided an overview of the methodology described above, and conducted the breakouts over the two days of the Innovation Crossover event. In the following pages we'll document the:

- Topics
- Framing statements
- Key ideas
- Top concepts

For each idea, as well as provide some summary commentary and identify key participants.

DoD Technologies

Because NSWC Crane is such an active contributor to research in Indiana, DoD technologies was selected as a top cluster. There were two identified challenges within the DoD Technologies Cluster: Trusted Electronics and Sensor Data Fusion.

Original topics (challenges) in DoD Technologies

- First Challenge: **Trusted Electronics**. This topic deals with the challenge of acquiring semiconductor components from foreign manufacturers and validating that the components are legitimate, have not been tampered with, and have no additional malicious content.
  Detailed challenge statement: We are interested in discovering methods to validate existing electronics components and systems to confirm that they are of the quality and capability that is reported, to ensure these components and systems can do what they were specified to do and have not been altered, tampered with, modified or hacked, without destroying the component or system. Full spectrum of Trusted electronics capabilities ranging from anti-tamper technologies, counterfeit detection, component engineering, radiation-hardened microelectronics, radiation-hardened component design, independent validation and verification of microelectronic component performance, Radio Frequency (RF) microelectronics, Printed Circuit Board technologies, and failure and material analysis

- Second Challenge: **Sensor Data Fusion**. This topic addresses the rapidly expanding number of sensors and data sources and the challenge of normalizing all of the data generated and analyzing it to drive better decisions.
- Detailed challenge statement: Data fusion techniques combine data from multiple sensors and related information from associated databases to achieve improved accuracy and more specific inferences than could be achieved by the use of a single sensor alone. Briefly, we can define

data fusion as a combination of multiple sources to obtain improved information; in this context, improved information means less expensive, higher quality, or more relevant information. Data fusion techniques have been extensively employed on multi-sensor environments with the aim of fusing and aggregating data from different sensors. *The goal of using data fusion in multi-sensor environments is to obtain a lower detection error probability and a higher reliability by using data from multiple distributed sources.* Cognitive, Distributed, Active and Passive Electromagnetic Sensing with Cooperative Electronic Attack. Includes High Fidelity Computational/EM (CEM) Modeling. Specific need: Sensors and track data fusion.

These challenges were defined by NSWC Crane originally, and were presented to the Crossover participants by their OVO facilitator, which led to the following "framing" questions.

Framing questions

- **Trusted Electronics**: *How might we characterize and quantify the capability and functionality of an Integrated Circuit (IC) with testable measure parameters?*

- **Sensor Data Fusion**: *How might we dynamically simplify, aggregate and synchronize the data stream to enable time appropriate decision making, based on an open hardware/software architecture for data fusion?*

These framing questions were developed by the participants as one of the first activities and served as a benchmark for further idea generation and idea evaluation.

Observations – Trusted Electronics

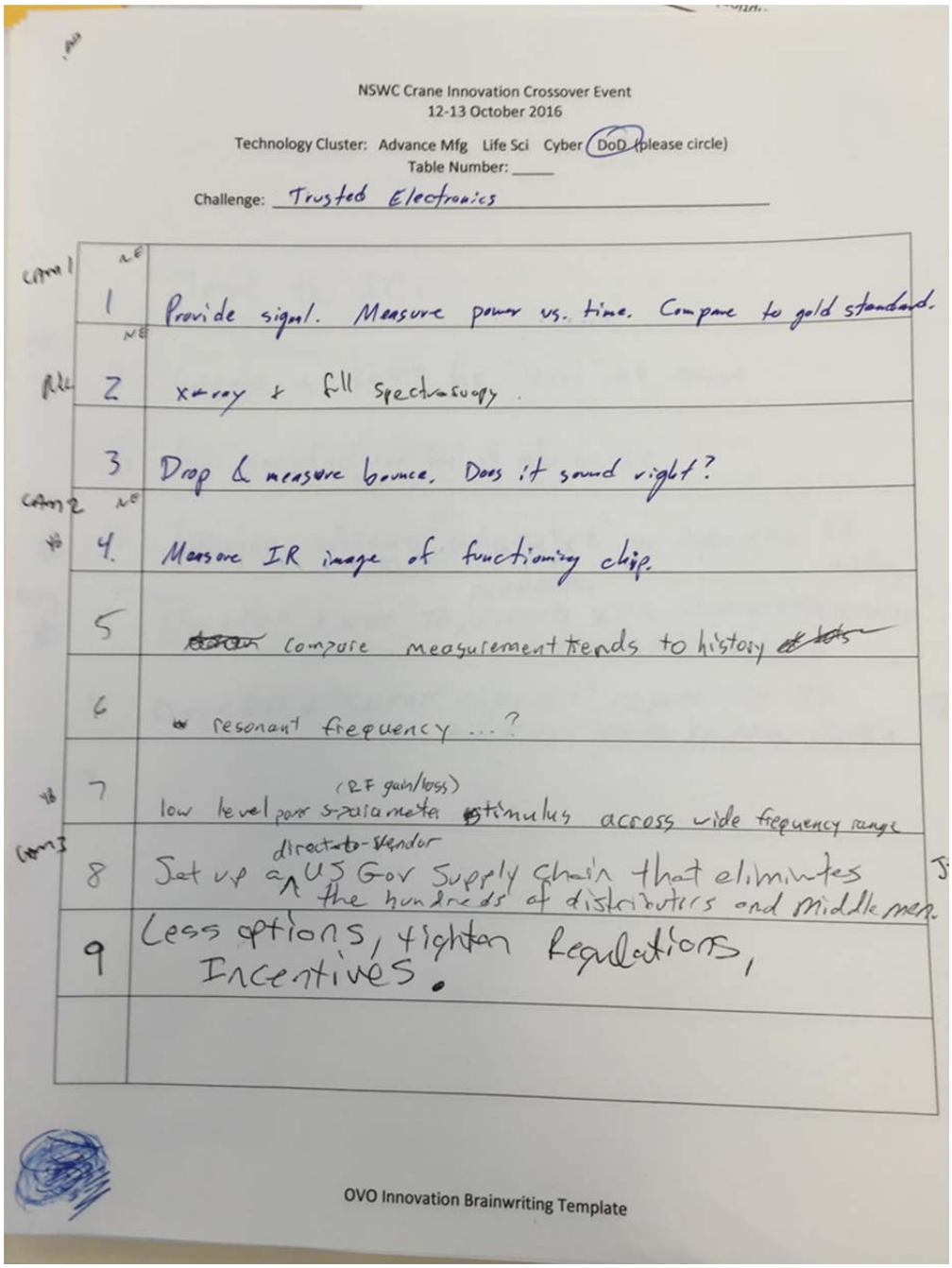
- The topic of counterfeit or compromised electronics covers a very broad spectrum, from cloning to tampering to counterfeiting and even obsolescent electronics. Further, the goal is to quickly identify and validate these components without damaging or destroying them.
- Overcoming the obstacles of trusted electronics is vital, and is really an existential challenge since so much of our systems and economy are dependent on electronics, both in the military sphere as well as the civilian economy.

Observations – Sensor data fusion

- The participants struggled to adequately define how to aggregate and normalize data from so many different types of sensors, and so many types of data streams, especially given the lack of standards.

Sample ideas

Trusted Electronics brainwriting example



NSWC Crane Innovation Crossover Event
12-13 October 2016

Technology Cluster: Advance Mfg Life Sci Cyber (DoD) (please circle)
Table Number: ____

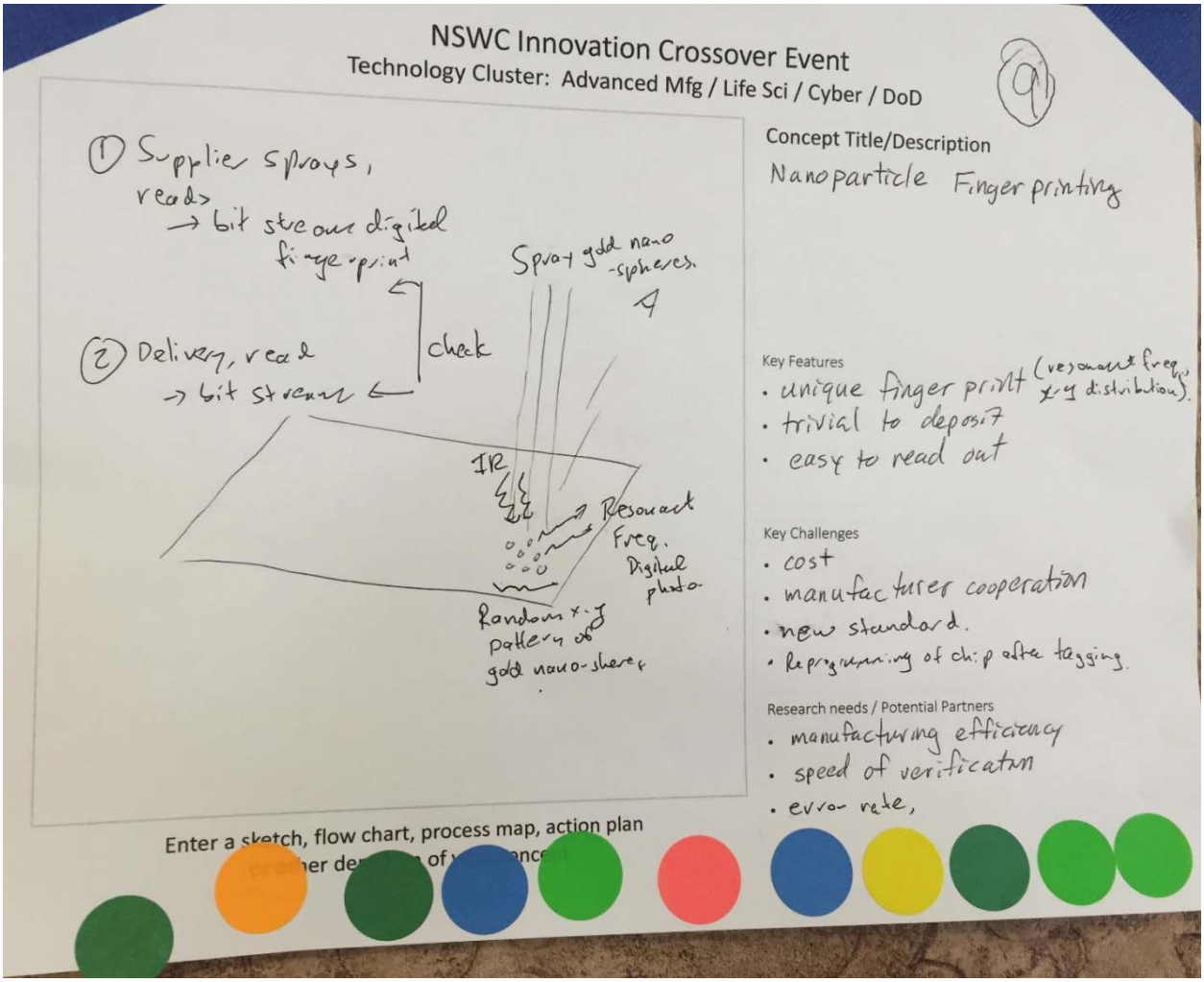
Challenge: Trusted Electronics

1	Provide signal. Measure power vs. time. Compare to gold standard.
2	x-ray + full spectroscopy.
3	Drop & measure bounce. Does it sound right?
4.	Measure IR image of functioning chip.
5	~~Scan~~ compare measurement trends to history ~~of bots~~
6	~~w~~ resonant frequency ...?
7	low level (RF gain/loss) ~~pow~~ parameter ~~stimulus~~ across wide frequency range
8	Set up a direct-to-vendor US Gov Supply Chain that eliminates the hundreds of distributors and middlemen.
9	Less options, tighten Regulations, Incentives.

OVO Innovation Brainwriting Template

Top Concepts

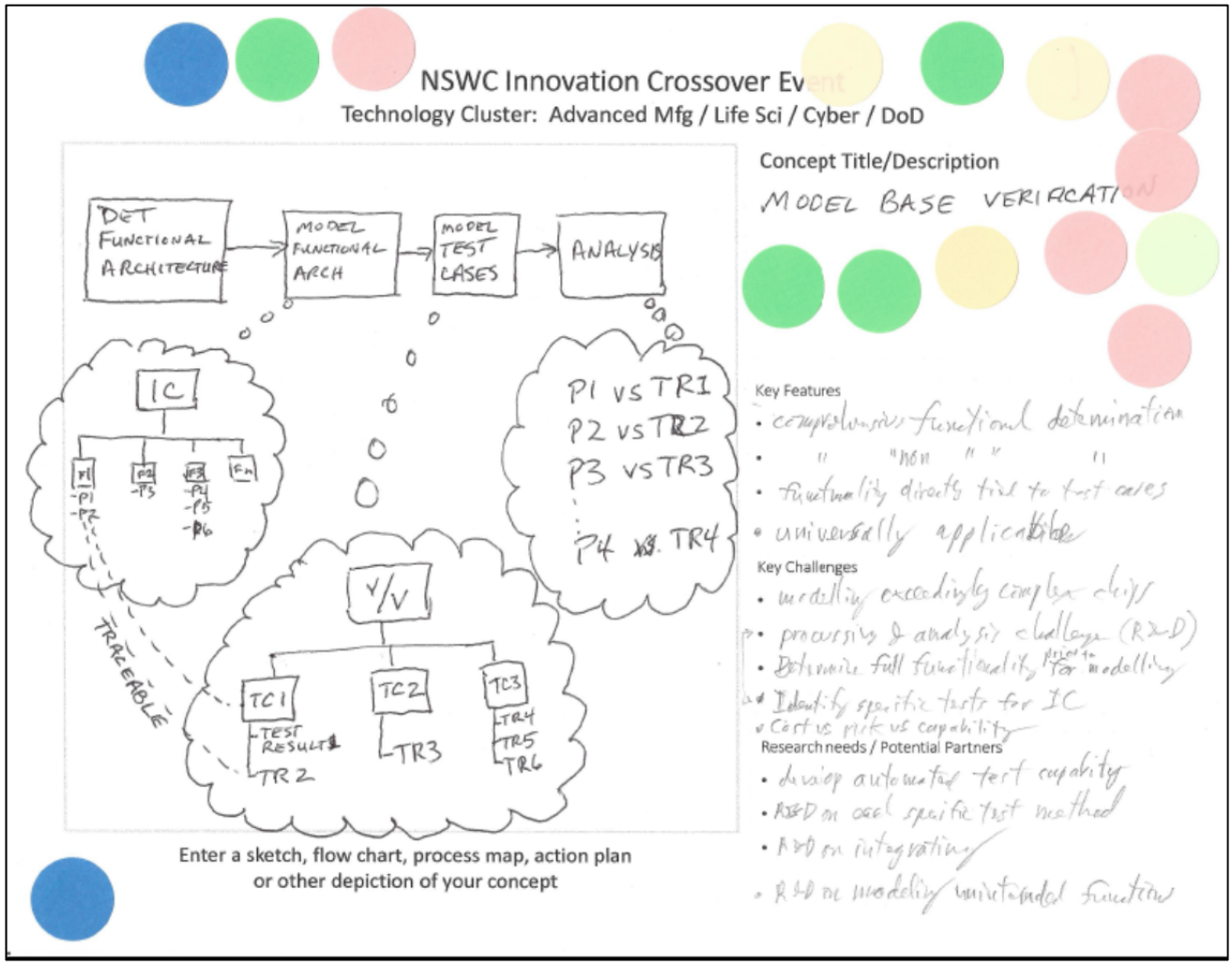
Within Trusted Electronics, there were two concepts that seemed most compelling. The first indicated a method to fingerprint semiconductor components using nanoparticles.



The Elevator pitch for this concept:

For chip customers with a need for secure verification who need secure chips that are prone to counterfeiting, our fingerprinting method provides unique, fast, and easy identification and certification that can be digitized. Unlike current labelling methods, our Nanoparticle fingerprinting concept offers a difficult to reproduce tag that is unique, fast, and easy to reproduce.

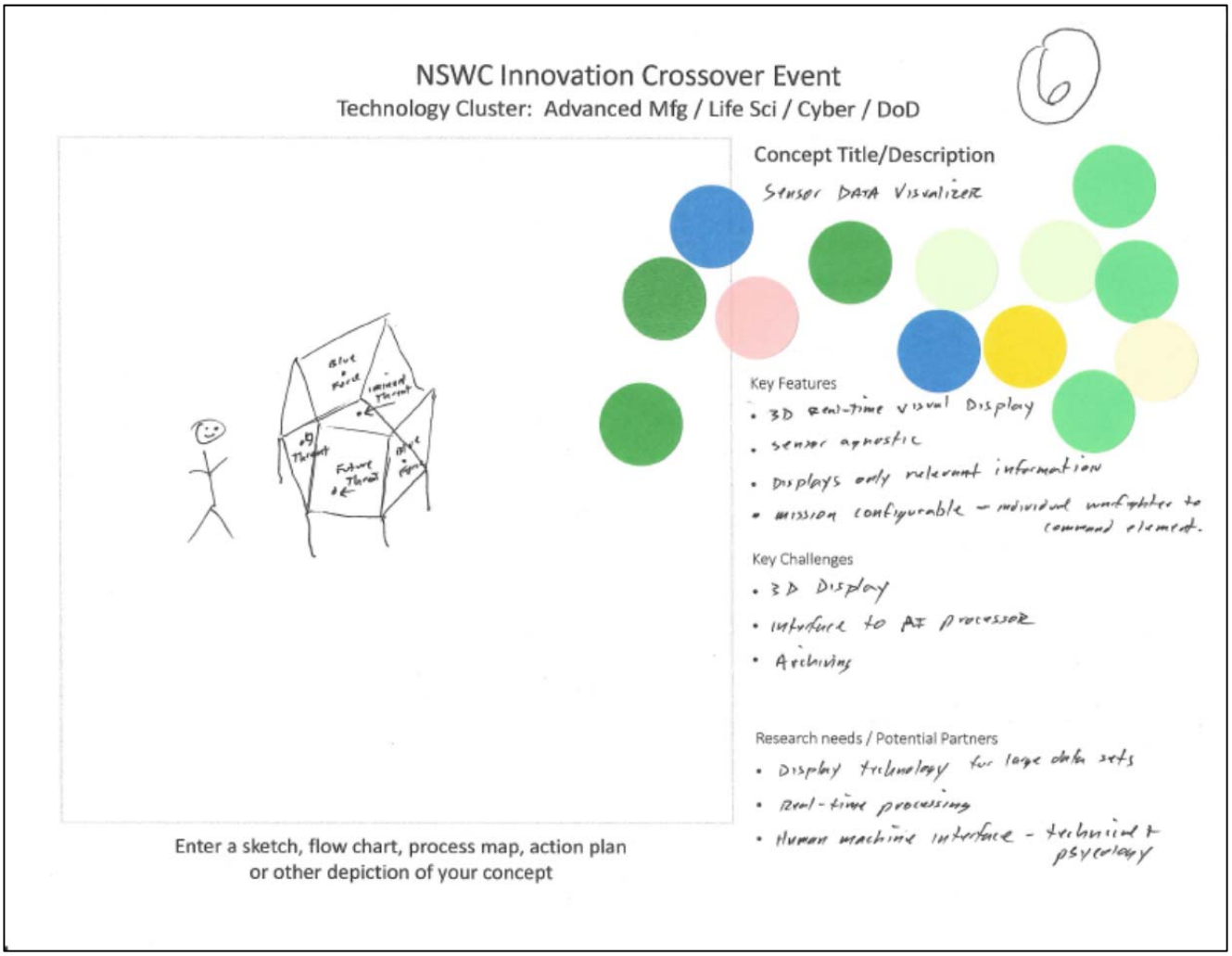
The second Trusted Electronics concept was focused on model based verification.



<u>The Elevator pitch for this concept:</u>

For critical electronics customers who need to identify and remove ICs that are not authentic, our Model based Verification process thoroughly assesses IC functionality. Unlike incomplete individual tests, our model based verification process offers all-encompassing assessment that is 100% accurate with no false detections.

The top concept for the Sensor Data Fusion topic was related to the visualization of the data.



<u>The Elevator pitch for this concept:</u>
For battlefield commanders who need to identify targets that represent threats our data visualization provides real time 3-D visualization of the battle space. Unlike stand-alone Common Operating Pictures (COPs), our data visualizer offers fused display of relevant information for timely engagement decisions.

Engaged Participants
We noted that several participants who were particularly engaged in a positive way:

- Darren Crum, NSWC Crane
- Matthew Gadlage, NSWC Crane
- Shamus McNamara, University of Louisville
- Dr. David Stargel, ARFL
- Donald Kessler, University of Dayton
- Yunus Balogan, NSWC Crane
- Jonathan Poggie, Purdue

IT/Cyber

Cluster: IT/Cyber
The IT/Cyber cluster is composed of two topics: Machine Learning and Cybersecurity. Both topics have broad areas of research being conducted across the nation and stand to significantly impact people's lives around the globe.

Topic: Machine Learning
NSWC Crane provided problem definition for Machine Learning (research phase):

> Context: A key challenge of moving deep learning forward is to make it more computationally feasible as the current state-of-the-art requires a significant amount of training data and CPU cycles. These should also be discussed with respect to where we draw the boundary on what AI should or should not be used for in certain decisions. Further, applying new machine learning techniques/technologies to real-world applications where the system currently depends on continual operator input, database access, data downloads, etc.

After interviews with the Subject Matter Experts (SMEs) and subsequent reporting (see research report), NSWC Crane selected the following focus for Machine Learning for the conference:

Machine Learning: Explainability

- Explaining how the machine made the decision it made.
- The machine might be very successful at addressing a problem, but it can't explain how it did it or explain a new decision point.
- Most operators need a justification, not just a black box decision, especially if the situation is new.
- Explanations help humans make better decisions. A recommendation needs to be scrutable—capable of being understood. Otherwise humans cannot tell if there is a flaw in the explanation.
- We need greater explainability and we need to predict the bounds under which the algorithm will work.
- We need to know what performance we can sacrifice for confident answers.

Framing Question
During the first session at the conference, the participants created the following framing question:

Machine Learning: Explainability Framing Question

How might we create an interrogation standard that allows us to determine why a specific decision or outcome occurred in a machine learning system (optionally within a specific time frame)?

Sample Ideas

The participants generated many ideas during the brainwriting process. The following are a sample of ideas generated.

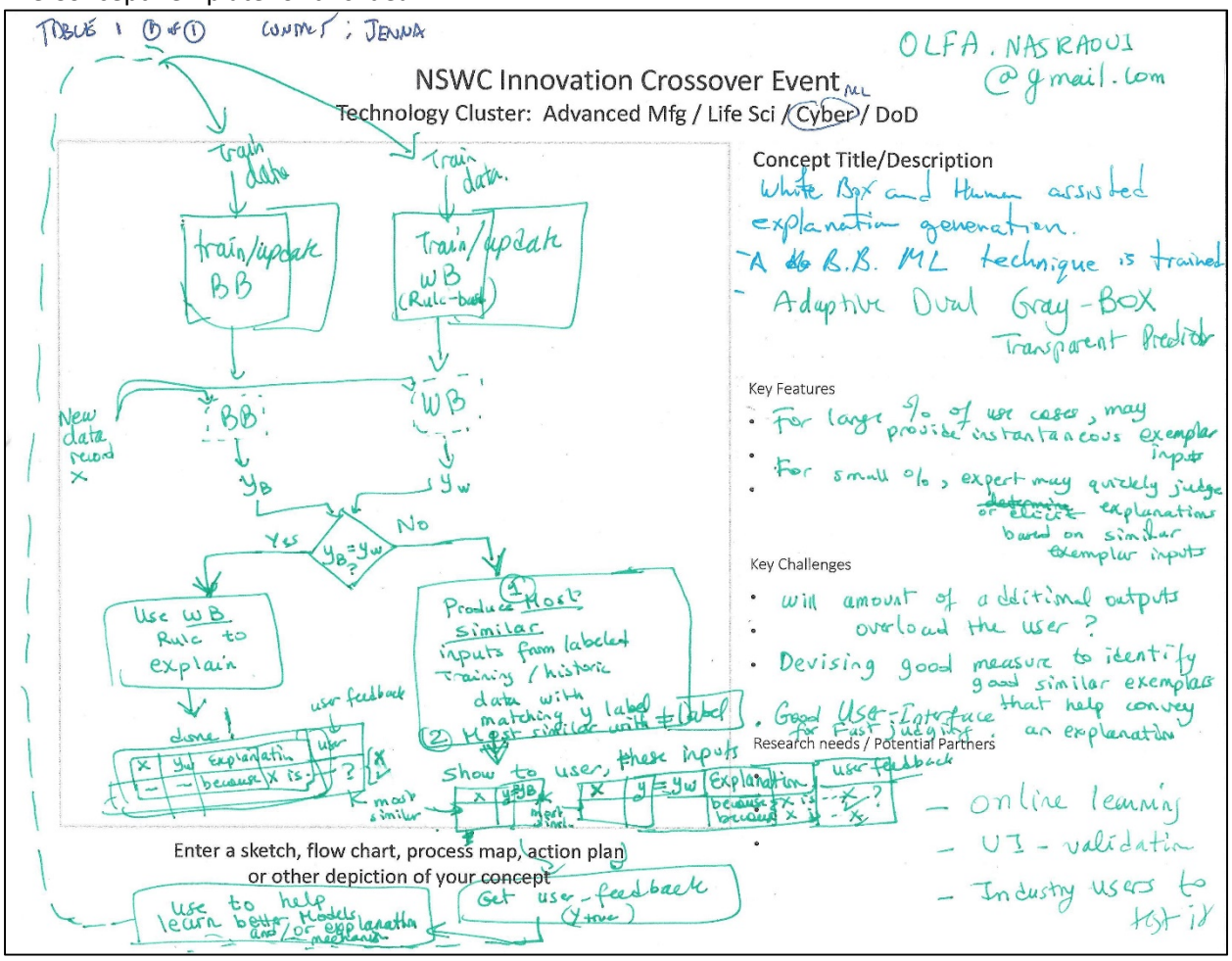
- What if the standard includes a stream of consciousness indicating what the computer was thinking along the way—an audit file?
- Ask what events led up to the specific decision/outcome—what trends are easily observable?
- Have users identify related exemplars to query if the machine learning has a related response to explore boundary conditions.
- For stochastic machine learning provide a probability distribution of responses.
- Change one input dimension by delta x and observe the change in output by delta y to learn white box rules that map new observations. Use these rules to support explanation generation process.
- Use active learning to explore when an explainable [result] diverges from an unexplainable [result].
- Machine learns how to generate an output that can be explained based on user feedback.
- Set up the computer so while answering the question, it will also answer an opposite question
- Change one factor at a time for sensitivity exploration
- Given a set of data, learn the concept many times (e.g., deep learning). Take the resulting classifiers and use them as inputs to a new learning algorithm to a much smaller state space to force concepts onto smaller state representations (get rid of very low probability events).
- Use deep learning to train something—then label all decisions with "reasons" based on human experts that "learn" with a second machine to both solve original problem and provide reasons.
- [Create a] debugging mode controlled by administrator access. Build in flags to halt for human input.
- Machine should provide a sensitivity analysis on the inputs to provide the answer to why.
- Publish a standard in IEEE format. Gather similar standards used today. Query aerospace and automotive industries on best practices.
- Start with a simple problem, use learning machine to simulate answer and test—use both black box and white box to cross validate. Repeat for numerous simple examples to develop model and then apply to more complex problems.
- Create standard questions and record output to map the machine's internally programmed logic.
- Create a pair of machines, where each machine's output predicts the other machine's input.
- Decision evaluations could be run automatically after the artificial intelligence (AI)/machine learning (ML) box has made the decision. This would not add latency to the process but would provide reviewable material to a) improve the process, b) provide us with the "this is why" info.
- Apply psychological theory of manipulating witness to a machine

Top Concepts

After discussion and ranking, the participants generated four concepts for Machine Learning Explainability. The following summarizes two of those concepts:

Adaptive Dual Gray Box Transparent Predictor
The Adaptive Dual Gray Box Transparent Predictor uses two machine learning systems—one white box (rule based) system whose underlying reasoning is understood, and one black box, which is the machine under test. Each system is trained with data and the outputs are compared. If the outputs are similar then the white box is used to explain the black box. If the outputs are not similar then a set of procedures is used to help the user understand the reasoning and to provide feedback that helps find better models and/or explanation mechanisms in the black box system.

The Concept Template for this idea:



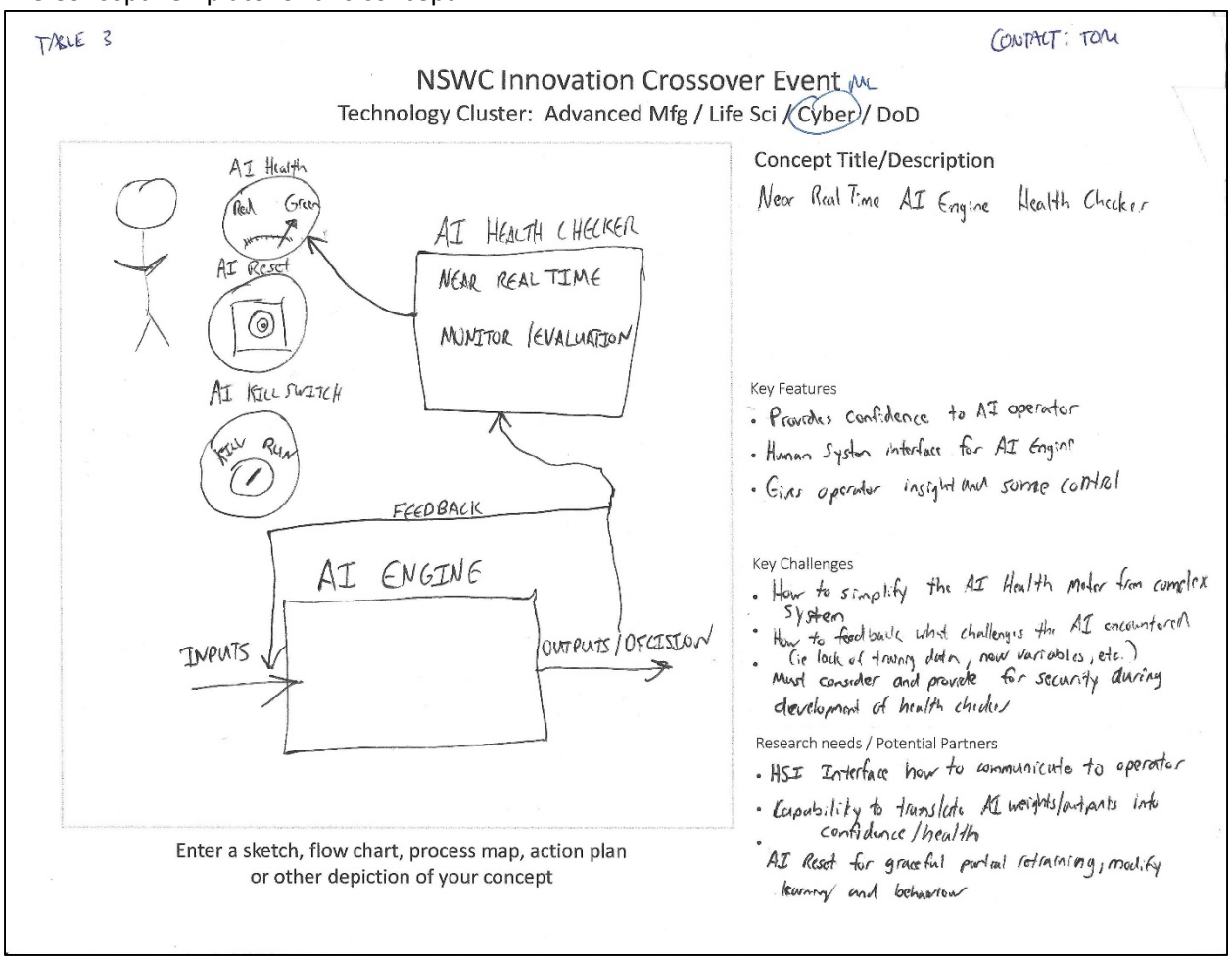
The Elevator pitch for this concept:
For organizations and users/decision makers/operators who need to act on machine learning output that needs explainability along with predictions, our Adaptive Dual Gray Box Transparent Predictor leverages black box power with white box transparency and optional user feedback. Unlike opaque

black boxes, our Adaptive Dual Gray Box Transparent Predictor offers additional confidence of black box performance with white box explanations for the majority of cases and leverages user feedback/show and tell displays to improve the system.

Near Real Time AI Engine Health Checker

The Near Real Time AI Engine Health Checker provides near real time monitoring and evaluation of a machine learning system. It provides confidence to the AI operator, a human system interface for the AI engine, and gives the operator insight and some control over the machine learning system.

The Concept Template for this concept:



The Elevator Pitch for this concept

For anyone using an AI/ML decision making autonomous systems (e.g., Navy Countermeasure systems, drone flight decisions, self-driving cars) who need to explain how an AI decision was made, our independent parallel running box translates the ever-changing AI weights into human-understandable language; plus an identifier of where/when in the decision tree process the final decision became definite. Unlike current or slow case-by-case reverse-engineering, our AI Health Checker offers secure feedback on each and every AI made decision in a timely manner while not adding decision-making time latency.

Topic: Cybersecurity

NSWC Crane provided problem definition for Cybersecurity (research phase):

> Context: Making cyberinfrastructure relevant and useful. We face an increasing diversity in cyberinfrastructure (research IT) hardware systems and delivery mechanisms (supercomputers, clouds, containers, etc.) This increase in diversity comes at the same time as ever increasing needs for utility of cyberinfrastructure systems across many diverse areas of research, development, and commerce. There is a real challenge in meeting critical needs for US security and global leadership in an environment of such great change. Be sure to examine vulnerabilities between hardware, software and wireless communications as part of this challenge.

After interviews with the Subject Matter Experts (SMEs) and subsequent reporting (see research report), NSWC Crane selected the following focus for Cybersecurity for the conference:

Cybersecurity: Addressing Systems Level Testing

- How do we test at the system level instead of at the component (e.g., hardware, software, communications, physical) levels to ensure that the system (including interfaces between components) is secure?
  - Most vulnerability analyses are focused on a specific component level.
  - Individual components are becoming too complex to completely test
  - Testing technology has been unable to keep up with the increase in scaling and complexity of systems
  - Testing at the hardware, software, communications, and physical levels ignores vulnerabilities in the interfaces between components
  - Addressing vulnerabilities at individual levels lags attacks
  - The speed at which new devices are introduced limits our ability to keep up with vulnerabilities
- Scalability, completeness, and accuracy all suffer from increased complexity. We need to address these at the system level.

Framing Question

During the first session at the conference, the participants created the following framing questions:

Cybersecurity: System Level Testing Framing Questions

1. *How can we build accurate virtual machines that can be deployed in a cyber range to model/simulate an entire system?*
2. *How might we take a system built from components that each adhere to a security specification and ensure that the integrated system adheres to an independent security specification in a way that allows us to do one or more of the following:*
   – Produce a set of test-cases that verify that the system satisfies the resulting security model
   – Provide proof of compliance
   – Show counter-examples in logic
   – Provide inputs and outputs which denote flaws in security

Ideas

The participants generated many ideas during the brainwriting process. The following are a sample of ideas generated.

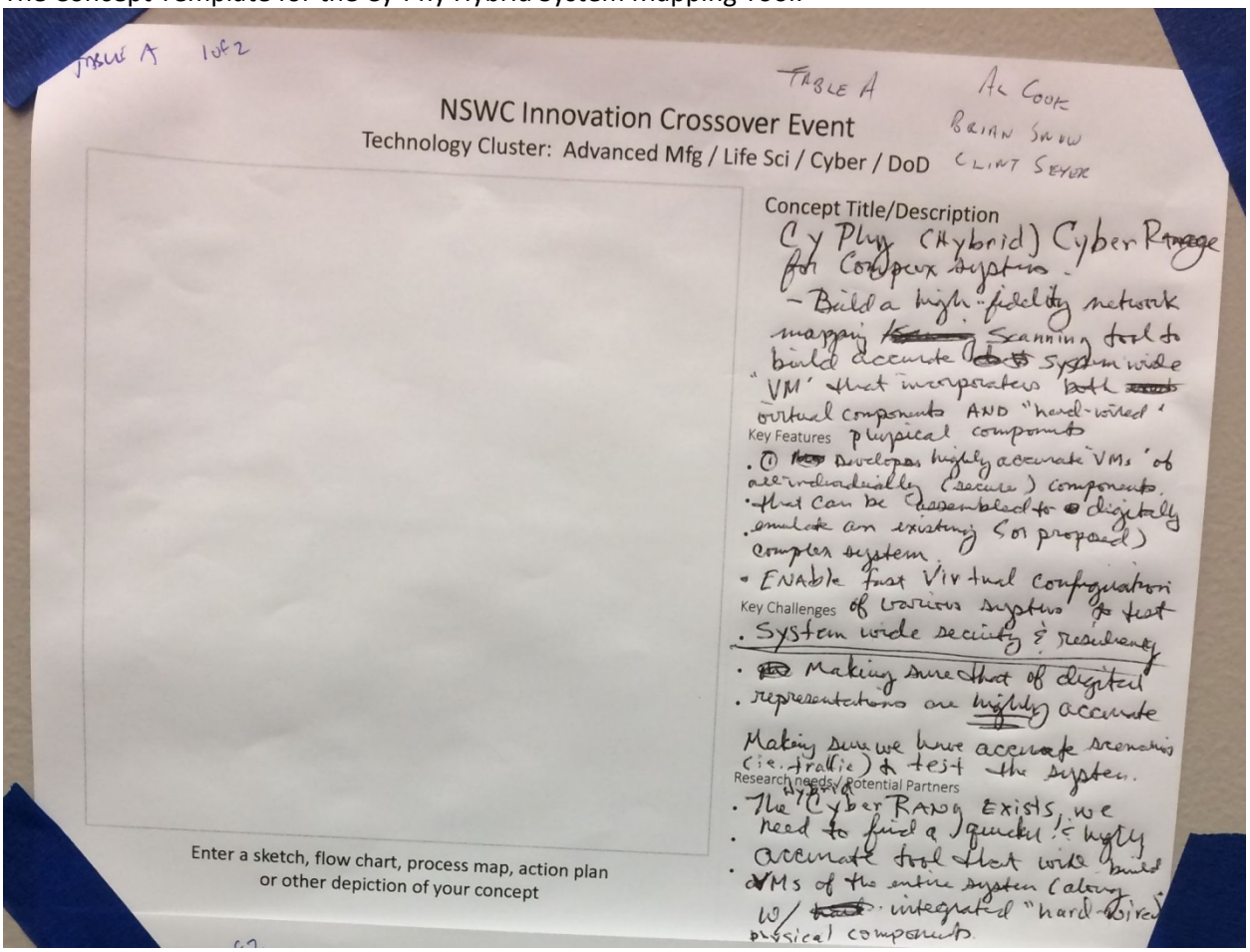
- Build a machine that tests the input/output (I/O) of a component and automatically constructs a virtual machine
- Integrate real hardware into the simulation when accurate virtual machines (VMs) do not exist.
- Build a system to autonomously scan map your existing complex system (component-by-component) to accurately develop a virtual machine of the entire system.
- Define the end state for both hardware, software connections. Use end state to develop a self-test which verifies integrity.
- Develop accurate load (combination of inputs) that are used to test the VM system for accurate in-state performance.
- Red team machine language code that seek vulnerabilities (opposition force)
- Build/elicit a graph that models component dependencies/linages inside the system
- Perturb the middle stage connections for many input cases and report the outputs. Observe the impact of the perturbations in each node. This will assign a score of vulnerability to each link. Used to construct a weighted/directed graph and find the most vulnerable paths. (See brainwriting sheet for more details).
- Develop a formal language for defining many practical and common security problems.
- Leverage the Joint Test Action Group for ICs/Circuit board with like standards for software subsystems to create a system level self-check to check conformance to security specs.
- Through many tests, capture data observed at system level outputs for given input patterns. Train an explainable machine learning system to predict, score risk, and explain potential flaws. (See idea sheet for more details)

After discussion and ranking, the participants generated three concepts for Cybersecurity Addressing Systems Level Testing topic. The following summarizes the concept reported at the final conference large group session:

Cy-Phy Hybrid System Mapping Tool

The Cy-Phy Hybrid System Mapping Tool is a tool for testing a system in a cyber range. It is a high fidelity network mapping scanning tool to build an accurate system-wide virtual machine that incorporates both virtual components and hard-wired physical components. It develops highly accurate VMs of all individually secure components that can be assembled to digitally emulate an existing or proposed complex system.

The Concept Template for the Cy-Phy Hybrid System Mapping Tool:



<u>Elevator pitch for this concept:</u>

For those in DoD and industry who need to test system-wide security for a cyber-physical system, our Cy-Phy Hybrid Cyber Range provides a complex mapping tool that combines virtual and real hardware in a complex environment. Unlike existing solutions, our Cy-Phy Hybrid Cyber Range offers a universal environment that brings together components and systems in a complex environment.

Recommendations from Participants

The participants recommended looking at the possibility of combining the two focused challenges of this cluster; namely, to investigate using an explainable machine learning system to detect system level security anomalies in a secure system, which might include the interfaces between secure components as well as the overall system.

Engaged Participants

We noted that several participants who were particularly engaged in a positive way:

- Olfa Nasraoui, University of Louisville
- Bob Cruise, NSWC Crane
- Mark Linderman
- Brian Snow
- Clint Seyer
- Joel Rasmus, Purdue University (instrumental in the Cy-Phy concept)

Contact information

The IT/Cyber cluster had three co-facilitators who facilitated at the following tables:

- Jenna Dix facilitated table 1 for Machine Learning
- Al Cook facilitated Table 2 for Machine Learning and Table A for Cybersecurity
- Tom Wappes facilitated Table 3 for Machine Learning and Table B for Cybersecurity

Advanced Manufacturing

Indiana has a history of advanced manufacturing capabilities and several major manufacturers were represented in the Innovation Crossover event, including Rolls-Royce and General Electric. Additive manufacturing and manufacturing process optimization are important to these industry leaders, as well as to academic researchers and to the government.

Cluster: Advanced Manufacturing
The Advanced Manufacturing cluster is composed of two topics: Manufacturing Process (Sustainability/Total Life Cycle) and Additive Manufacturing. Both topics have broad areas of research being conducted across the nation and stand to significantly impact the speed, quality, and effectiveness of current manufacturing efforts.

Topic: Manufacturing Process (Sustainability/Total Life Cycle)
NSWC Crane provided problem definition for **Manufacturing Process (Sustainability/Total Life Cycle)**:

> Context: Total life cycle (sustainable manufacturing) based modeling and simulation tools to evaluate manufacturability, sustainability, maintainability, reparability, reusability, and recyclability. This modeling and optimization process will help prioritize which products are most effective to build based on total life cycle costs.

After interviews with the Subject Matter Experts (SMEs) and subsequent reporting (see research report), NSWC Crane selected the following focus for Machine Learning for the conference:

Manufacturing Process (Sustainability/Total Life Cycle): **Total Life Cycle Predictive Modeling**

- Initial capital outlay cost is only a portion of the costs over an asset's life cycle that needs to be considered in making the right choice for asset investment.
- Consideration of the costs over the whole life of an asset provides a sound basis for decision-making.
- Not all of the 6Rs (recycle, reuse, rethink, refuse, reduce and repair) are easily measured.
- Need for improved sustainability evaluation methods, as well as for improved predictive models and optimization methods, to aid decision-making and selection of novel product and process designs for sustainable manufacturing.
- Metrics-based product/process evaluation for sustainability and manufacturing innovation
- Value creation for economic, society, and environment

Framing Question
During the first session at the conference, the participants created the following framing question:

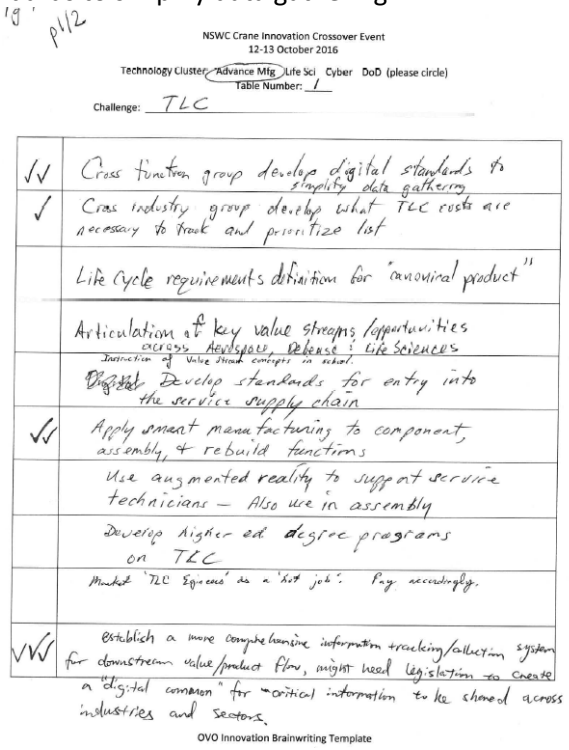
Manufacturing Process (Sustainability/Total Life Cycle):
Total Life Cycle Manufacturing Predictive Modeling Framing Question

How might we digitize the design, manufacture, and service after-market (still maintaining intellectual property) processes to enable, across the supply chain, predictive and reactive life cycle decision?

Sample Ideas

The participants generated many ideas during the brainwriting process. The following are a sample of ideas generated.

- Develop a digital 'birth certificate' that tags a physical part with its 'digital twin' or avatar to track it through its life cycle and connects its life cycle data 'asset by asset'.
- Integrate RFID chips with full history of each component for accurate tracking and recycle.
- Cross functional group develop digital standards to simplify data gathering.
- Apply smart manufacturing components, assembly, and rebuild functions.
- Incentivize data rights in contracts to ensure companies are expected to provide information.
- More comprehensive information tracking/allocation system for downstream value/product flow. Might need legislation to create a 'digital common' for 'critical information; to be shared across industries and sectors
- Develop methods of digital version control across many collaborators.
- Develop model based enterprise solutions for tagging life cycle information to digital twin of parts
- Develop virtual production environment standards to help accelerate digitization of supply chain to enable digital life cycle iteration.



NSWC Crane Innovation Crossover Event
12-13 October 2016

Technology Cluster: ~~Advance Mfg~~ Life Sci Cyber DoD (please circle)
Table Number: 1

Challenge: TLC

√√	Cross function group develop digital standards to simplify data gathering
√	Cross industry group develop what TLC costs are necessary to track and prioritize list
	Life cycle requirements definition for "canonical product"
	Articulation of key value streams/opportunities across Aerospace, Defense & Life Sciences Intersection of value stream concepts in action!
	Develop standards for entry into the service supply chain
√√	Apply smart manufacturing to component, assembly, & rebuild functions
	Use augmented reality to support service technicians — Also use in assembly
	Develop higher ed degree programs on TLC
	Market 'TLC Engineer' as a 'hot job'. Pay accordingly.
√√	Establish a more comprehensive information tracking/collection system for downstream value/product flow, might need legislation to create a "digital common" for "critical information to be shared across industries and sectors.

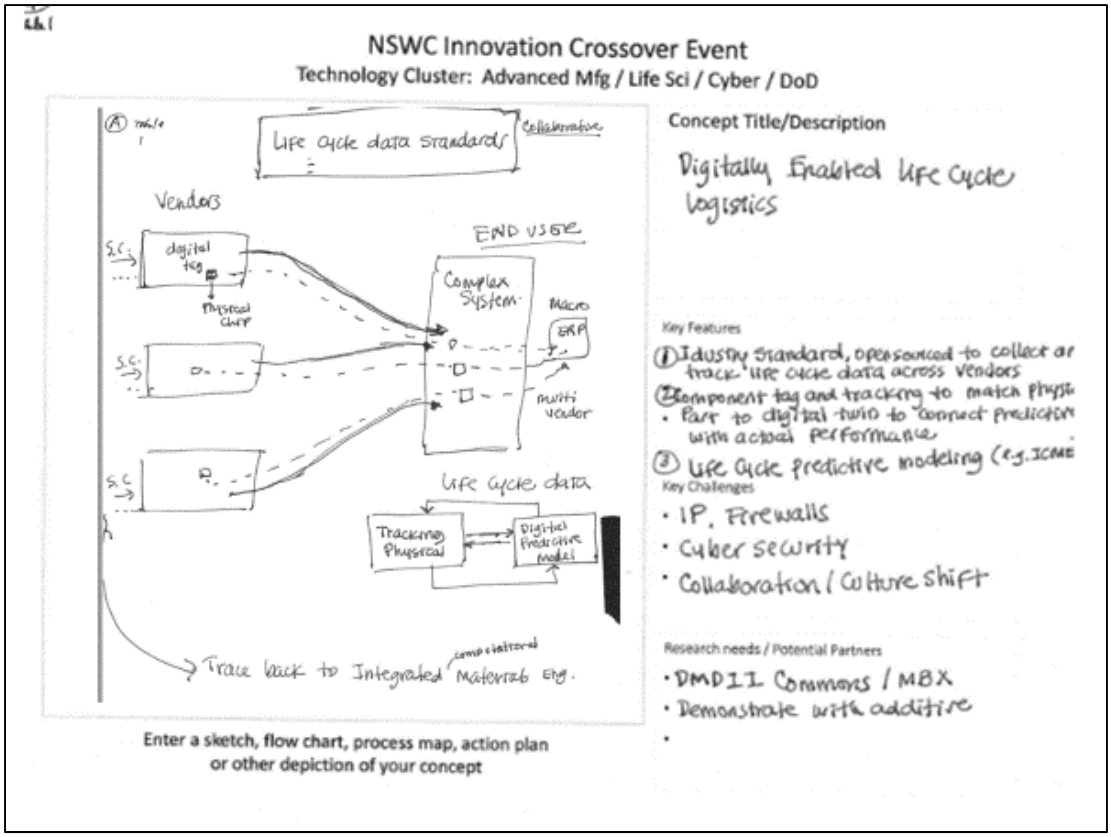
OVO Innovation Brainwriting Template

Top Concepts

After discussion and ranking, the participants generated two concepts for Total Life Cycle Manufacturing Predictive Modeling. The following summarizes two of the concepts:

Digitally Enabled Life Cycle Logistics

The Concept Template for this idea:

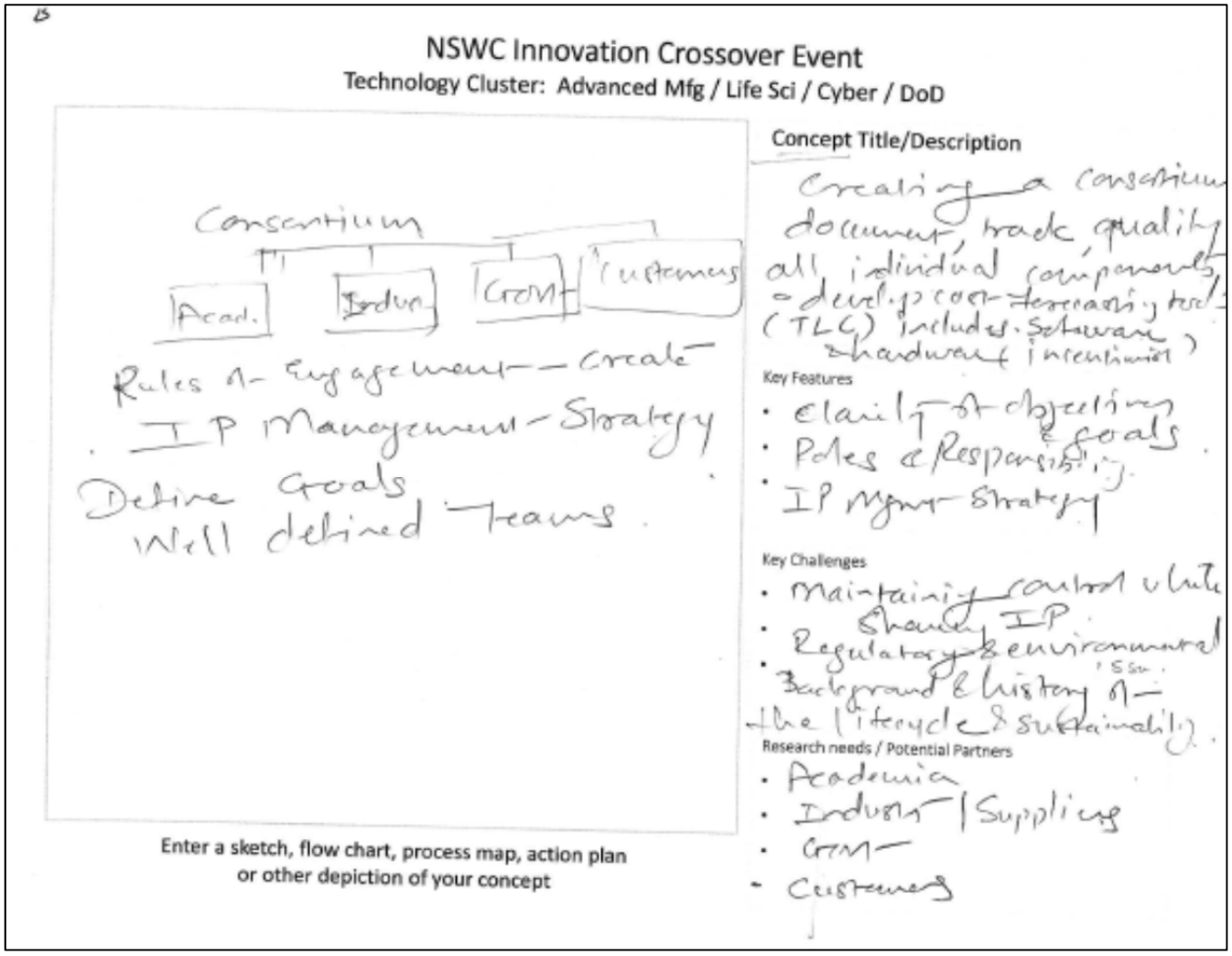


The Elevator pitch for this concept:

For complex manufacturing systems who need to manage life cycle costs, our digitally enabled life cycle logistics create an industry standard that collects and tracks life cycle data for long term optimal performance at the lowest cost. Unlike historically stove-piped environments and product teams. Our digitally enabled life cycle logistics offers matching digital tagging for individual components in complex systems to physical/real performance for real time life cycle management across vendors and predictive modeling validation.

V^2C (verification, validation and certification) Consortium

The Concept Template for this concept:



The Elevator Pitch

For end user manufacturing industry that needs to identify life cycle costs (specifically within aerospace industry), our consortium will provide verification, validation and certification. Unlike fragmented data, our consortium offers verification, validation, and certification.

Topic: Additive Manufacturing

NSWC Crane provided problem definition for Additive Manufacturing (research phase):

Context: Full integration of additive manufacturing into the digital manufacturing enterprise. This could mean converting completely to additive manufacturing where appropriate or considering how to integrate additive manufacturing on an existing production line. Further:

- Where or when is additive appropriate?
- What products or components can be best manufactured in an additive process?
- What materials are required in order to manufacture mission critical components?
- What is the best approach to qualify or certify components made by additive manufacturing?

After interviews with the Subject Matter Experts (SMEs) and subsequent reporting (see research report), NSWC Crane selected the following focus for Additive Manufacturing for the conference:

Additive Manufacturing: Qualification of Machine & Parts

- Additive is essentially creating individual parts with multiple variables that can change each time.
- Beside distortion and shrinkage, other quality issues can occur, such as porosity, delamination of layers, poor surface finish and thermal stresses.
- The resulting process is difficult to qualify for parts that require stringent qualification and verification.
- Many industries cannot fully leverage since they are not able to meet the stringent qualification and verification requirements.
- Qualifying and freezing a machine is cost prohibitive and difficult to manage
- Requirements for in-situ monitoring, correction, and inspection are being researched but still remain a challenge

Framing Question

During the first session at the conference, the participants created the following framing questions:

Additive Manufacturing: Qualification of Machine & Parts Framing Question

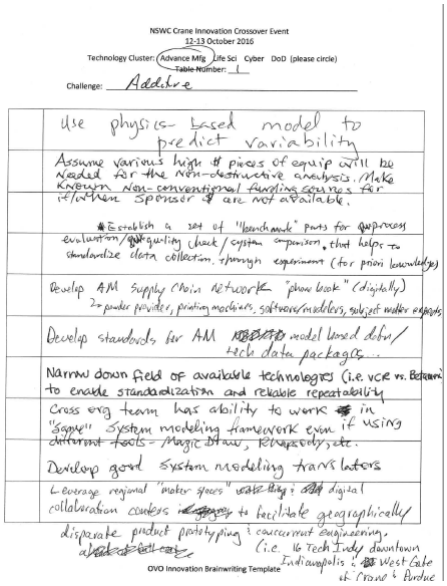
How do we enable the tools and rules to diminish risk, predict and test structural, and therefore, performance variability?

- *How might we develop nondestructive evaluation tools that could better interrogate components and uncover hidden defects?*
- *How might we develop digital tools to monitor additive manufacturing insitu?*

Ideas

The participants generated many ideas during the brainwriting process. The following are a sample of ideas generated.

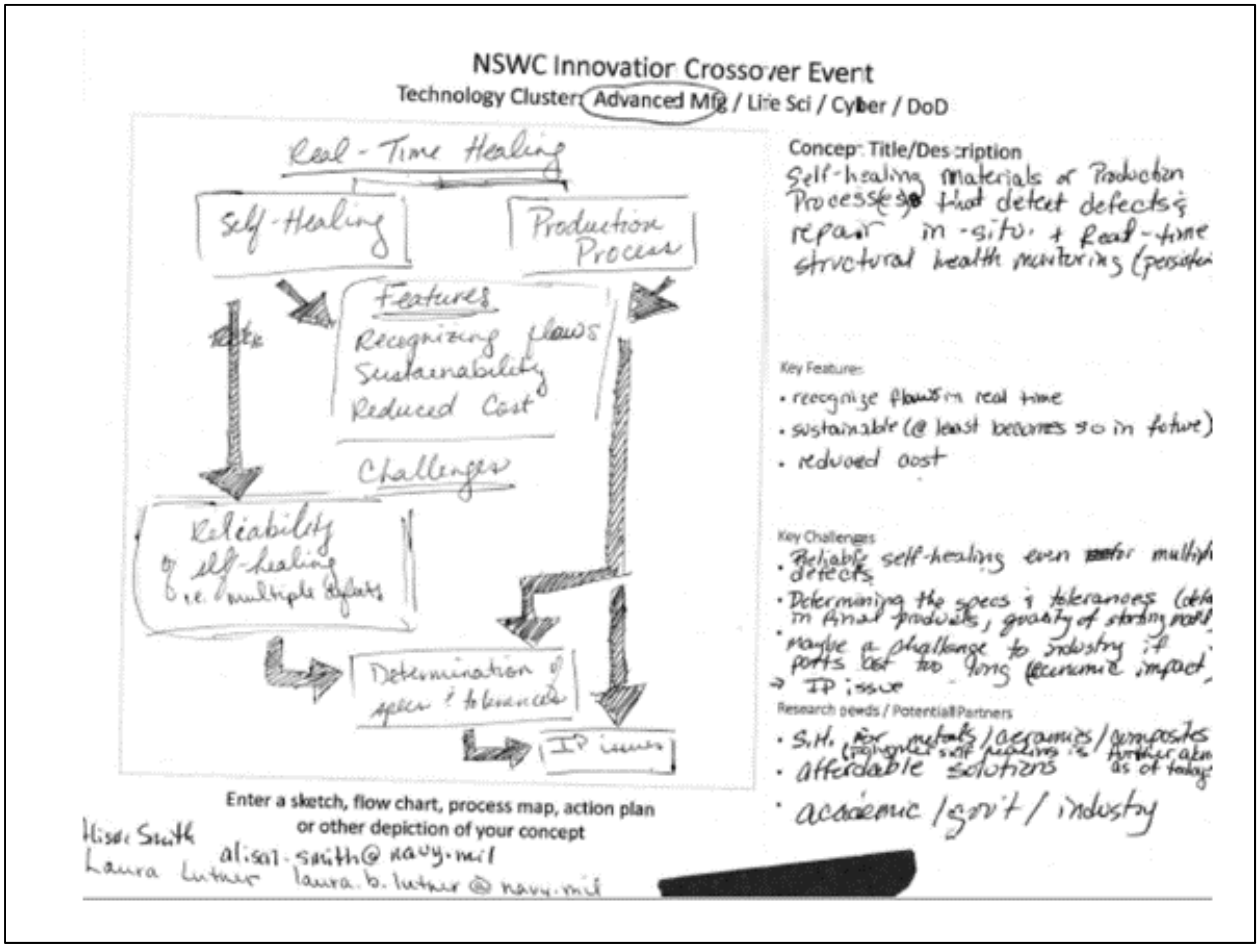
- Leverage regional 'maker spaces' and digital collaboration centers to facilitate geographically disparate product prototyping and concurrent engineering (e.g., 16 Tech Indy downtown Indianapolis and West Gate of Crane, Purdue, University of Indiana, Southern Indiana University, etc.)
- Enable use of product data files usable in one AM printer info
- Leverage trade schools and Purdue Polytechnic to support training for workforce in use of 3D additive printer technology – physical and digital.
- Enhance additive manufacturing (AM) technologies to improve bonding between layers of material to achieve better performance.
- Embed digital sensors and trackers to process and produce parts to intrinsically monitor performance.
- Define output measures relevant to component
- Develop models to connect input variables to key relevant outputs, eliminating the need for destructive test if input is controlled to desired output.



After discussion and ranking, the participants generated three concepts for Additive Manufacturing addressing the Qualification of Machine and Parts question. The following summarizes the concept reported at the final conference large group session:

Real Time Healing

The Concept Template:



Elevator pitch:

For Additive manufacturers, suppliers, and users who need to develop solutions that reduce risks and overall cost through increase materials reliability, our self-healing materials or healing production processes provide reduced costs and sustainable methods to repair materials in real time. Unlike manual quality checks, our real time healing offers insitu materials repair and/or monitoring to yield materials that are safer, last longer, and are sustainable.

Recommendations from Participants

The participants recommended looking at the intersection across all four of the sectors. For example, as we digitize more of the manufacturing process or digitize for additive, it will create risks for cyber security.

Engaged Participants:
A number of participants were very engaged in the discussion. Some names of those that would be interested in additional discussion were:

- Sunita Chavan (Air Force Research Laboratory)(AFRL)
- I.S. Jawahi (Kentucky)
- John Matlik (Rolls Royce)
- Allison Smith (Crane)
- Laura Luther (Crane)
- Daniela Vidal (USI)
- Rachel Wiseman (Crane)

Contact information
Each facilitator assigned a contact for each concept template/elevator pitch, as indicated on the paper sheets and can answer questions regarding the concepts and tables.
Co-facilitators from Crane were:

- Perri Bateman
- Jerrica Rogers
- Sam Frank

Attendance
It should be noted that there was a significant variance in participation between each of the sessions. During the initial session we had approximately 30 participants, with approximately 10 participants by the end of the day two. One key risk in the decline of participants is that there was less diversity in thought and input as we were developing the concepts and pitches.

Life Sciences

The Battelle study identified Life Sciences as a strong candidate for further research and collaboration across the state.

Original topics (challenges) in Life Sciences/Biomedical

- First Challenge: Non-radiative based imaging
- Second Challenge: Informatics technologies
- Third Challenge: Cellular and molecular disease mechanisms
    - Third challenge dropped from further development (see "Observations – Research", below)

These challenges were defined by NSWC Crane originally, and were presented to the Crossover participants by their OVO facilitator, which led to the following "framing" questions.

Framing questions

- Imaging: How might we develop an imaging system that mimics canine capabilities to detect certain diseases or conditions?
- Informatics: How might we leverage consumer technology for real-time monitoring of bio-informatics for individual or population level health monitoring and diagnostics?

These framing questions served as a benchmark for further idea generation and idea evaluation.

Observations – imaging sessions

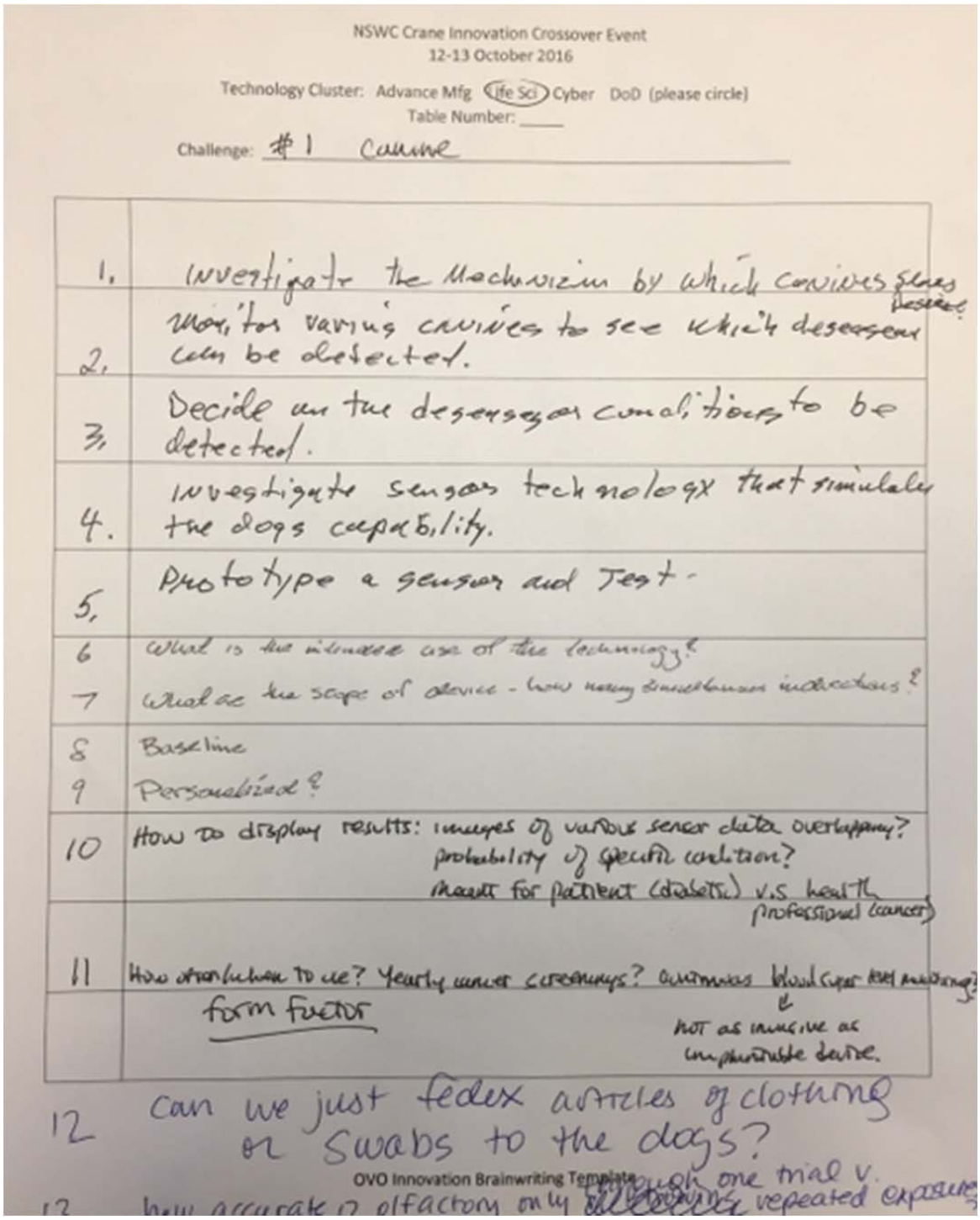
- Framing question: *How can we develop an imaging system that mimics canine capabilities to detect certain diseases or conditions?*
- Participants were aware of limitations of most imaging technologies; focus moved from new imaging technologies to reducing the exposure to ionizing radiation instead
- The idea of mimicking canine abilities to detect diseases was one of the last to be put forth, but generated the most excitement in the group
- The concept generation found the group converging on multiple manifestations of a scanner
    - Most involved monitoring/sensing patient's breath; although the "Toiletron 3000" was aimed at gastro-intestinal (GI)/microbiome monitoring
    - Mobility was a topic applicable to all ideas
    - One engineer took his concept to a "litmus paper" kind of product called "Smell-o-Vision"

- The team did not start idea generation on the second topic in the third session due to time constraints
- Topic of reaching low-income patients was recurring theme (non-consumers of medical technology)

Observations – informatics sessions

- Framing question: *How might we leverage consumer technology for real-time monitoring of bio-informatics for individual or population level health monitoring and diagnostics?*
- This session went much more smoothly as the group was familiar with the process and with each other. This was almost entirely done as one small group; concepts were generated in groups of two or three.
    - Photo Meal Calorie Counter (This was the top concept vote-getter)
    - Smart Sox
    - Smart Air Filter Monitor (two iterations, one for home, other for business/public spaces)
- The team seemed more comfortable with the topic than in the first session
- Discussion of "Smart Cities" was recurring theme

Sample Ideas



NSWC Crane Innovation Crossover Event
12-13 October 2016

Technology Cluster: Advance Mfg (Life Sci) Cyber DoD (please circle)
Table Number: ____

Challenge: #1 Canine

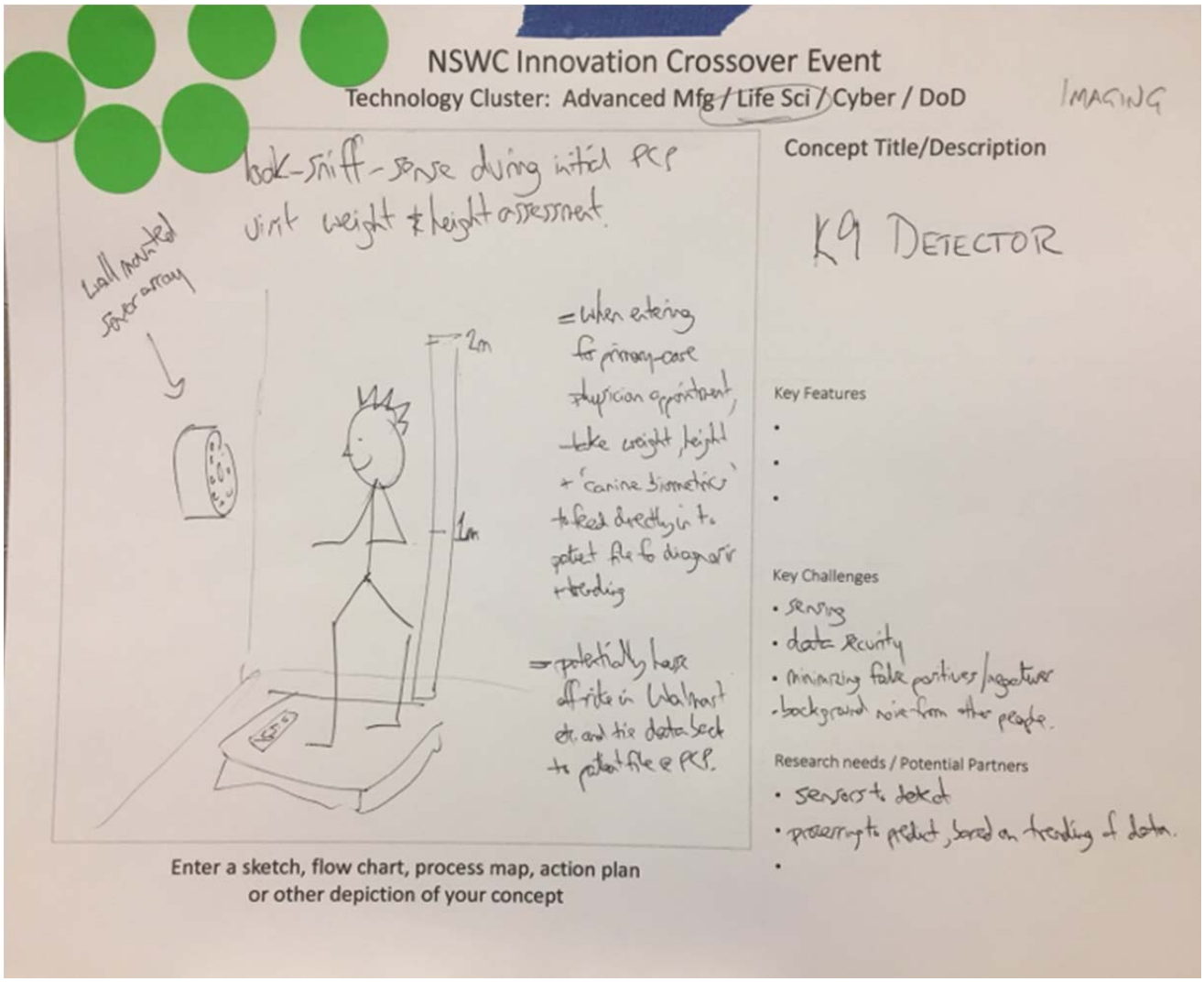
1.	Investigate the Mechanism by which canines detect disease
2.	Monitor varying canines to see which diseases can be detected.
3.	Decide on the diseases conditions to be detected.
4.	Investigate sensor technology that simulates the dogs capability.
5.	Prototype a sensor and Test.
6	What is the ultimate use of the technology?
7	What is the scope of device - how many simultaneous indications?
8	Baseline
9	Personalized?
10	How to display results: images of various sensor data overlapping? probability of specific condition? Report for patient (diabetic) v.s. health professional (cancer)
11	How often/when to use? Yearly cancer screenings? Continuous Blood sugar test reading? form factor → not as invasive as implantable device.
12	Can we just fedex articles of clothing or swabs to the dogs?
13	How accurate is olfactory only through one trial v. repeated exposure

OVO Innovation Brainwriting Template

Top Concepts

(all concepts captured in Appendix)

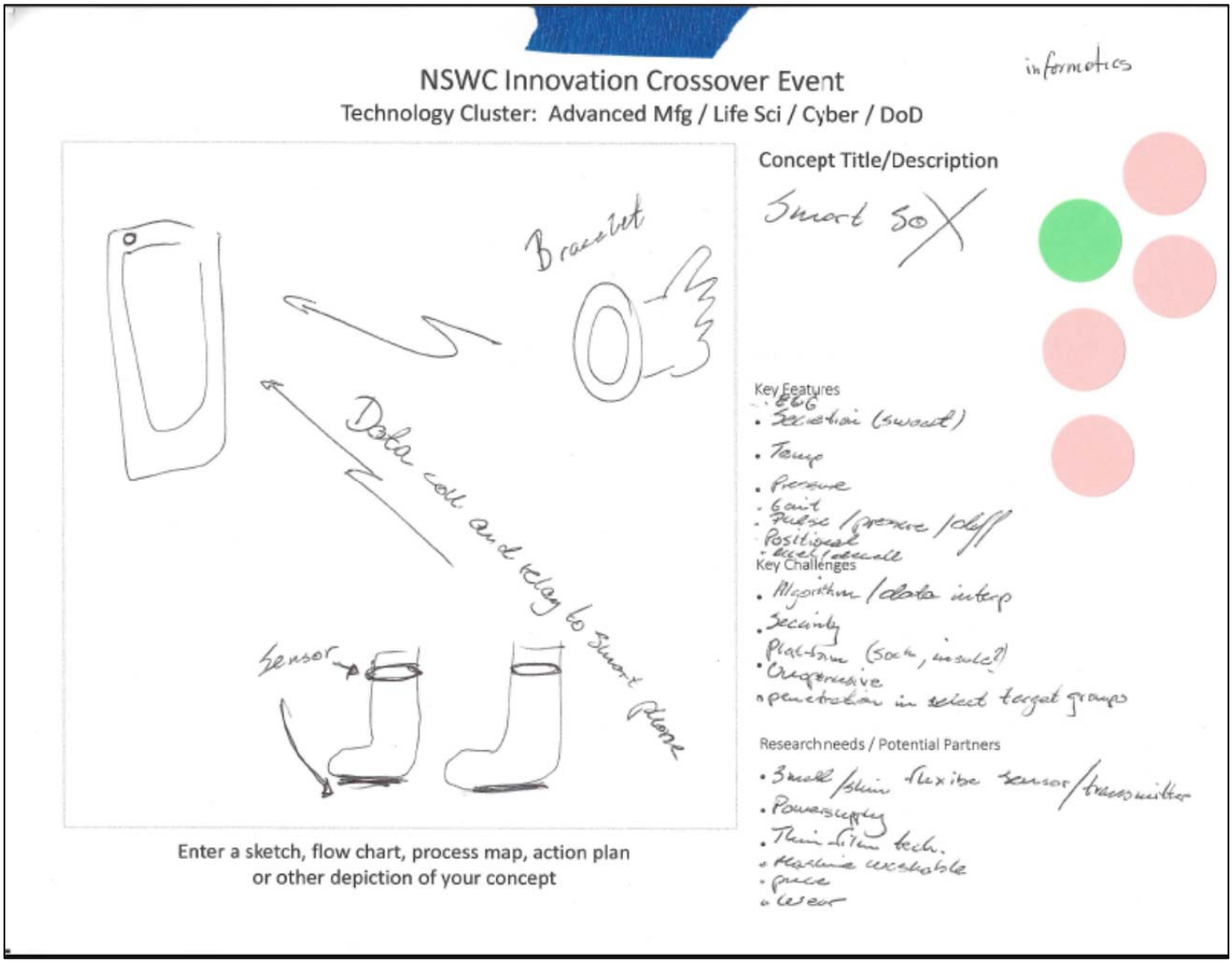
The top concept in Life Sciences for imaging revolved around detecting diseases or illness using non-invasive means – for example, considering how dogs can detect diseases like diabetes or cancer.



<u>The Elevator pitch for this concept:</u>

For anyone who might get cancer, who needs to minimize ionizing radiation and needs non-invasive cancer detection our K-9 cancer catcher is a rapid, non-invasive detection system. Unlike other cancer diagnostic systems our K-9 cancer catcher offers earlier detection and localization of all cancers without risk.

Another top concept in the Life Sciences track was in Informatics, using smart socks and other devices to measure the differences in blood pressure in different locations on the body.



<u>The Elevator pitch for this concept:</u>

For anyone who wishes to monitor vital signs that inform health status our Smart Sox/bracelet system monitors and reports a vast array of health related inputs. Unlike current fitness monitors our Smart Sox system offers integration of an array of health data for real time monitoring of general health status.

Crossover ideas / Crosswalk

A component of the Innovation Crossover event was to encourage communication and engagement within the four technology clusters (Advanced Manufacturing, Life Sciences, DoD Technologies and IT/Cyber), but an equally important consideration was identifying overlaps or areas where research or technologies cross these artificial barriers. In fact, the final session of the conference was left open to allow participants who had been providing ideas and expertise in one cluster to visit and review the concepts generated by participants in other clusters. This was done to recognize the potential of overlaps and to encourage more collaboration across the clusters.

There were some notable areas of overlap, mostly relating to or spawned from the DoD Technologies cluster. From our research, from discussions in the breakouts and during the Crosswalk, it was clear that the Sensor Data Fusion topic had a lot of overlap with both of the IT/Cyber topics: Cybersecurity and Machine Learning.

Overlaps between DoD Technologies and IT/Cyber

The overlap between Sensor Data Fusion and Cybersecurity occurred as participants began to discuss the validity of sensor data. If we are to make decisions based on what sensors report, then we need to be able to trust that the sensors are reporting accurate data, or that the data hasn't been compromised or hacked. Thus, the data stream created by sensors must be considered a cybersecurity issue.

The overlap between Sensor Data Fusion and Machine learning occurred as participants discussed the analysis of the increasing volume of data sensors and the Internet of Things (IoT) create. There is far too much data for humans to process effectively, and increasingly the management of the sensor data becomes a big data problem. This is where Machine Learning intersects with Sensor Data Fusion. We need to build machine learning algorithms to normalize, manage and interpret the data, because the data streams and data complexities are so large that only machines can quickly process the data into information and then into insight.

Overlaps between DoD Technologies and Life Sciences

There was one potential overlap identified between the Life Sciences topics and DoD Technologies, in that the Life Sciences topic on Imaging relied extensively on sensors, which again leads to a need for Sensor Data Fusion. As the use of sensors increases in Life Science applications, both in the practitioner's office and in remote medicine, the ability to quickly and accurately collect all of the sensor information and combine it with other information, leading to insight, diagnosis and prognosis is key.

Overlaps between DoD Technologies and Advanced Manufacturing

There was one noted overlap between Advanced Manufacturing and DoD Technologies, in the area of Trusted Electronics. It was noted that most semiconductor manufacturing is, in effect, an additive manufacturing process (that is, building semiconductors is complete partially through deposition). The potential overlap with Additive Manufacturing was an interest in exploring whether or not we could scale additive manufacturing to manufacture individual chips or components, rather than relying on a large semiconductor fab.

Overlaps between IT/Cyber and Life Sciences

Two potential overlaps were noted between Cybersecurity topics and Life Sciences. First, both of the Life Sciences topics (Medical Imaging and Medical Informatics) rely on data and information. Both of the Life Sciences topics have the potential to generate a lot of data, which may need to be assessed in a "big data" environment, leading to the overlap with Machine Learning.

Equally, since Life Sciences topics are data rich and dependent on correct and accurate data, there were notable overlaps between the generation and use of medical data and the issue of Cybersecurity. For example, if we collect medical information about soldiers in the field and hope to monitor and even provide medical advice or even medicines remotely, we must know that the data is accurate and secure.

Overlap between IT/Cyber and Advanced Manufacturing

The potential overlap that was noted between Advanced Manufacturing and IT Cyber was once again in Cybersecurity. Additive Manufacturing relies on accurate descriptions of physical products in a data file. If a part's data file is compromised or changed, the part could be manufactured incorrectly or compromised. Thus, cybersecurity – protecting the validity of design data used in Additive Manufacturing – is an area of overlap between Advanced Manufacturing and Cybersecurity.

There were no reported or evident overlaps between Advanced Manufacturing and Life Sciences. We can stipulate that the topics and framing within these clusters didn't provide for overlap, even though there may be potential overlap (for example, 3-D printing a medicine or bandage).

Conclusion

During the Innovation Crossover event, several of the stated goals were clearly achieved: greater alignment within the constituents and stakeholders within NSWC Crane's footprint in Southcentral Indiana and the greater region, and good idea generation and concept development.

This document represents the deliverable for the final goal, an input to the Applied Research Institute (ARI) which may inform future research.

More important than this deliverable is the engagement demonstrated by the attendees, their willingness to learn a new innovation methodology and work with their industry, government, and academic partners to try to generate new ideas. The energy and enthusiasm that was evident in the general sessions and during the workshop sessions was undeniable. The Innovation Crossover event had excellent outcomes and sets a high bar for future interactions.

It will be important to follow up this event with more engagement, more networking, more research opportunities to demonstrate that the event is not a "one time" offering but only the beginning of more engagement and relationship building to create more research and more economic development. Participants in the event made it clear that while the event was a great success, they expect more engagement in the future, and look to NSWC Crane and others to convene the participants and help communicate research opportunities and needs. These research opportunities will spawn new innovations that have impact on both military customers as well as civilian products and services. Work in Sensor Data Fusion, for example, may improve our military's ability to identify threats and take autonomous actions, but will also improve the capacity and safety of autonomous vehicles that consumers will own and use.

NSWC Crane, the ARI and its constituent partners in government, academia and industry have initiated relationships and networks that can definitely drive more research, more innovation and more job creation throughout Indiana. The Innovation Crossover 2016 event is an important first step.

Appendices

Appendix 1: ARI Overview

Appendix 2: Innovation Crossover Agenda

Appendix 3: OVO Templates

Appendix 4: Top Concepts from clusters

Appendix 5: Innovation Crossover Press Release

Appendix 6: Innovation Crossover Event Blog

Appendix 1 – ARI Overview

Overview

The Applied Research Institute (ARI) is a key pillar of the *Strategic Plan for Economic and Community Prosperity in Southwest Central Indiana* enabled by an initial grant of $16.2 million from the Lilly Endowment. The ARI – now in the final stages of formation – will consist of academia, industry, federal laboratories, and government stakeholders committed to advancing technology and fostering talent in strategic sectors poised for growth.

The ARI, as enabled by its network and partners, will perform applied research and pursue major federal and industry partnership opportunities in areas participants' technical strengths overlap and complement one another. All of these areas represent emerging and fast-growing markets valued in the billions of dollars. ARI will bring together endowed chairs, eminent scholars, nationally recognized research scientists, and technical experts to transfer ideas from the labs to products consumers demand. Initially, core ARI technical focuses include multi-spectral data fusion and security (cyber), high density power storage and management, advanced material science, and microelectronics technology and security.

Access to shared infrastructure will foster technology transfer and equip researchers with the tools they need to develop breakthrough technologies. Participants will leverage leading-edge infrastructure from across the ARI network, including universities, the Battery Innovation Center, West Gate Academy, and over $4.5 billion worth of leading edge laboratories, equipment, and infrastructure at NSWC Crane.

In an effort to more fully realize the economic benefits and technology creation enabled by NSWC Crane, the program will facilitate the exchange, among all institutions, of faculty from Indiana's research universities and NSWC Crane researchers. ARI will increase the opportunities for NSWC Crane personnel to pursue advanced degrees with Indiana's research universities and allow graduate students from the universities to conduct research at the base.

Public-private partnerships yield value in a number of ways to their host region. They are an intrinsic part of any strategy to foster economic growth and enable collaboration among key stakeholders aiming to cooperate on shared interests.

As the ARI's central hub, Southwest Central Indiana is poised to attract industry technology leaders from across the state and nation to conduct joint applied research alongside regional stakeholders. Beyond their direct financial commitment to ARI in terms of cost share on projects, industry stakeholders will send employees to the hub to participate in reviews of programs, meet with partners, and utilize shared infrastructure. As the recent Battelle study observes, as similar public-private partnerships matured, industry and university stakeholders often increase capital expenditures and/or R&D investments in the region surrounding the hub to more quickly transfer technology into commercial product lines and to take advantage of a well-trained workforce equipped with tacit knowledge from working on projects spearheaded by the institute.

Simply put, ARI places Southwest Central Indiana among an elite group of regions across the nation that are home to prestigious public-private partnerships spearheaded by industry leaders. Beyond defense and commercial applications, technologies and talent developed and nurtured under the ARI hold tremendous potential for economic growth and prosperity for the region.

Appendix 2 – Innovation Crossover Agenda

2016 Innovation Crossover Conference

Day 1	
8:00-8:20a	Welcome Mr. Duane Embree, Director, IODD (Confirmed)
8:20-9:00a	Key Note Dr. Chris Fall, White House Office of Science and Technology Policy (Confirmed)
9:00-10:15a	SPARC Panel
10:15-10:30a	Break
10:30-11:45a	Industry Panel Dr. Matt Waninger (MED Institute)-Confirmed Eric Matteson (GE)-Confirmed Dr. John Matlik (Rolls Royce)-Confirmed
11:45-12:30p	Lunch

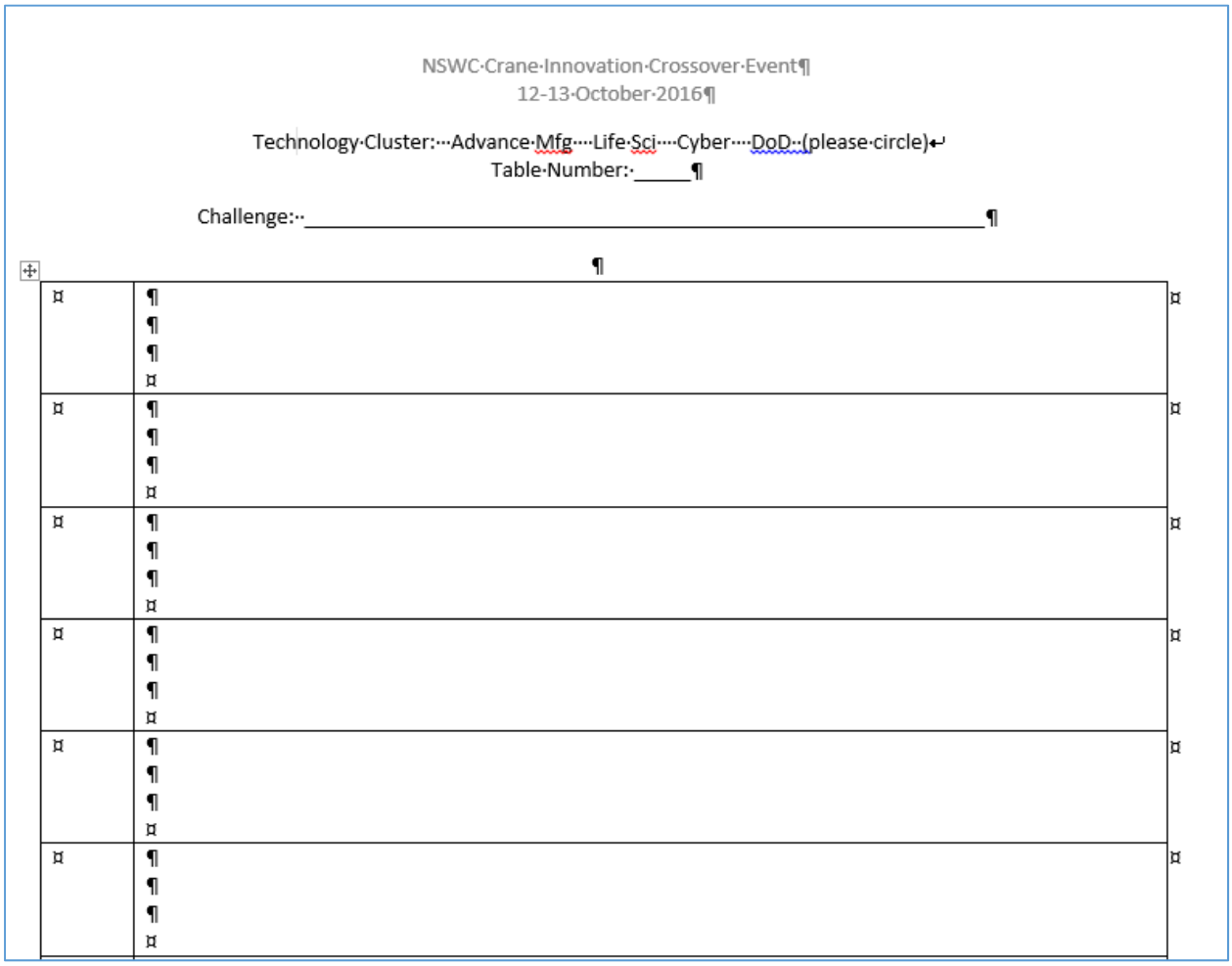
Day 1	Cyber/IT	DoD Technologies	Advanced Manufacturing	Life Sciences/Bio-medical
12:30-2:00p	Framing the Challenges (Facilitated)	Framing the Challenges (Facilitated)	Framing the Challenges (Facilitated)	Framing the Challenges (Facilitated)
2:00-2:15p	Break			
2:15-3:30p	Relevant University Research			
3:30-3:45p	Break			
3:45-4:45p	Intro to Ideation Session & Function (Facilitated)	Intro to Ideation Session & Function (Facilitated)	Intro to Ideation Session & Function (Facilitated)	Intro to Ideation Session & Function (Facilitated)

Day 2	Cyber/IT	DoD Technologies	Advanced Manufacturing	Life Sciences/Bio Medical
8:00-8:40a	Key Note Dr. Walter Jones, ONR-(Confirmed)			
8:40-9:00a	Key Note Mr. Ian Steff, ARI-(Confirmed)			
9:00-9:15a	Break			
9:15-11:15a	Idea Generation and Capture (Diverge)	Idea Generation and Capture (Diverge)	Idea Generation and Capture (Diverge)	Idea Generation and Capture (Diverge)
11:15-12:00p	Lunch			
12:00-1:15p	University Panel Dr. Bennett (USI)-Confirmed Dan Hasler (Purdue)-Confirmed Dr. Brad Wheeler (IU)-Confirmed			

Day 2	IT/Cyber	Defense Technologies	Advanced Manufacturing	Life Sciences/Bio-Medical
1:15-1:30p	Break			
1:30-2:30p	Converge To Most Promising Ideas/ Partnerships	Converge To Most Promising Ideas/ Partnerships	Converge To Most Promising Ideas/ Partnerships	Converge To Most Promising Ideas/ Partnerships
2:30-3:00p	Frame Ideasto Challenges For Presentation Follow Up On Actions and Collaborative Partnerships	Frame Ideasto Challenges For Presentation Follow Up On Actions and Collaborative Partnerships	Frame Ideasto Challenges For Presentation Follow Up On Actions and Collaborative Partnerships	Frame Ideasto Challenges For Presentation Follow Up On Actions and Collaborative Partnerships
3:00-3:15p	Break			
3:15-3:45p	Cross Pollination of Ideas	Cross Pollination of Ideas	Cross Pollination of Ideas	Cross Pollination of Ideas
3:45-4:45p	Crosswalk Ideas and Amalgamation in Joint Session			

Appendix 3 – OVO Templates

Brainwriting Template



NSWC·Crane·Innovation·Crossover·Event¶
12-13·October·2016¶

Technology·Cluster:···Advance·Mfg····Life·Sci····Cyber····DoD··(please·circle)↵
Table·Number:·_____¶

Challenge:··_____¶

¶

¤	¶ ¶ ¶ ¤	¤
¤	¶ ¶ ¶ ¤	¤
¤	¶ ¶ ¶ ¤	¤
¤	¶ ¶ ¶ ¤	¤
¤	¶ ¶ ¶ ¤	¤
¤	¶ ¶ ¶ ¤	¤

Concept Template

NSWC Innovation Crossover Event

Technology Cluster: Advanced Mfg / Life Sci / Cyber / DoD

Enter a sketch, flow chart, process map, action plan or other depiction of your concept

Concept Title/Description

Key Features

-
-
-

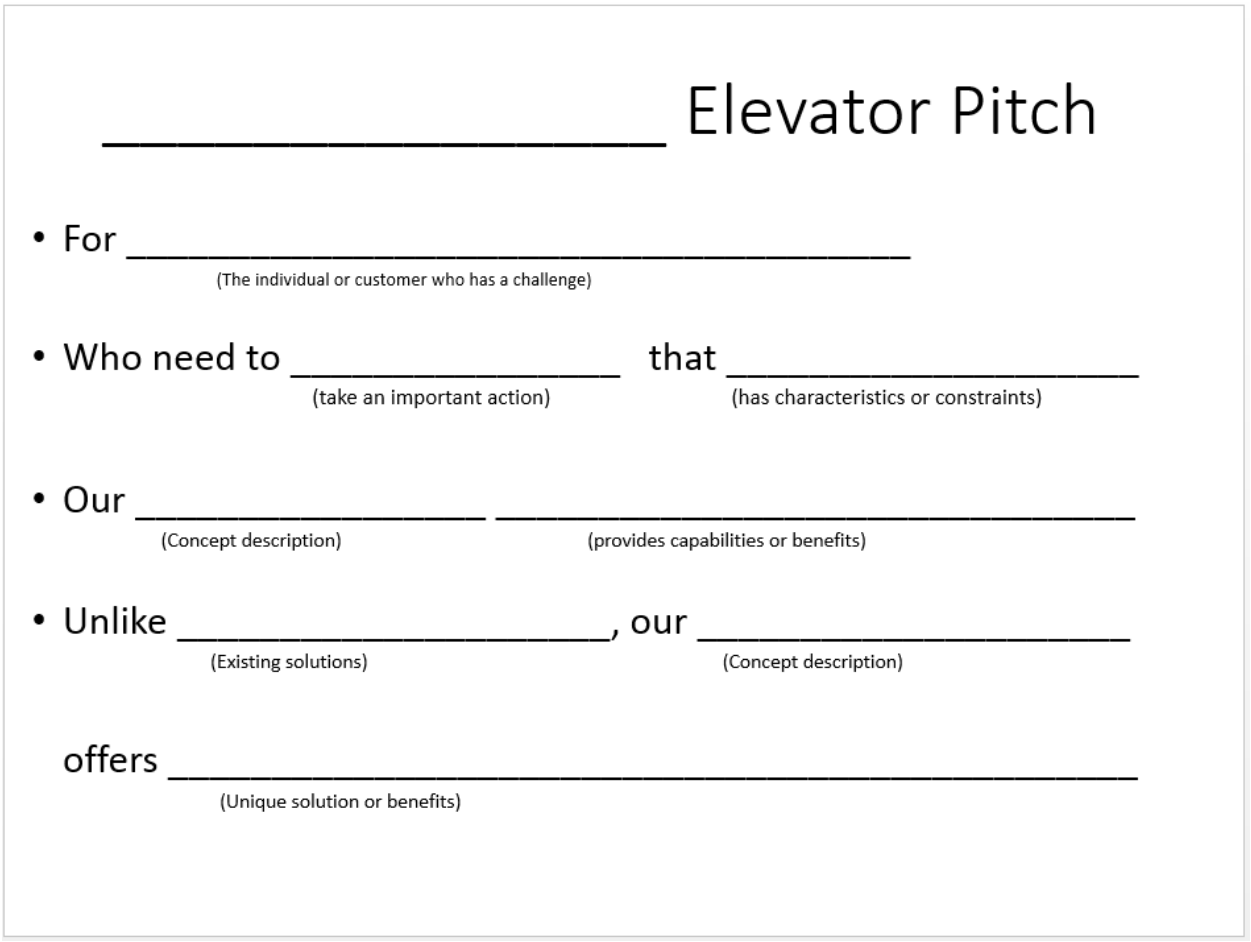
Key Challenges

-
-
-

Research needs / Potential Partners

-
-
-

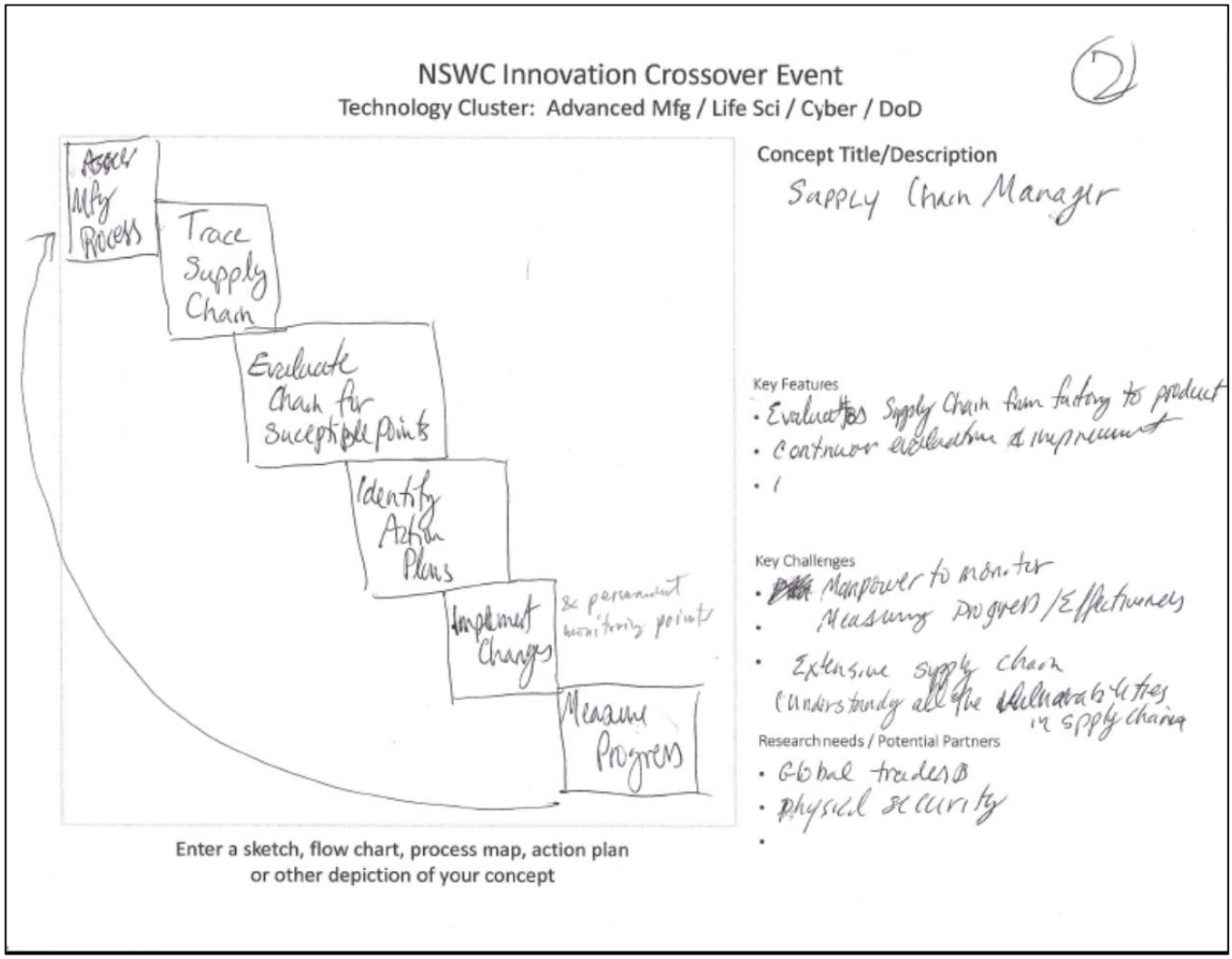
Elevator Pitch



Appendix 4 – Top Concepts by Cluster

DoD Cluster

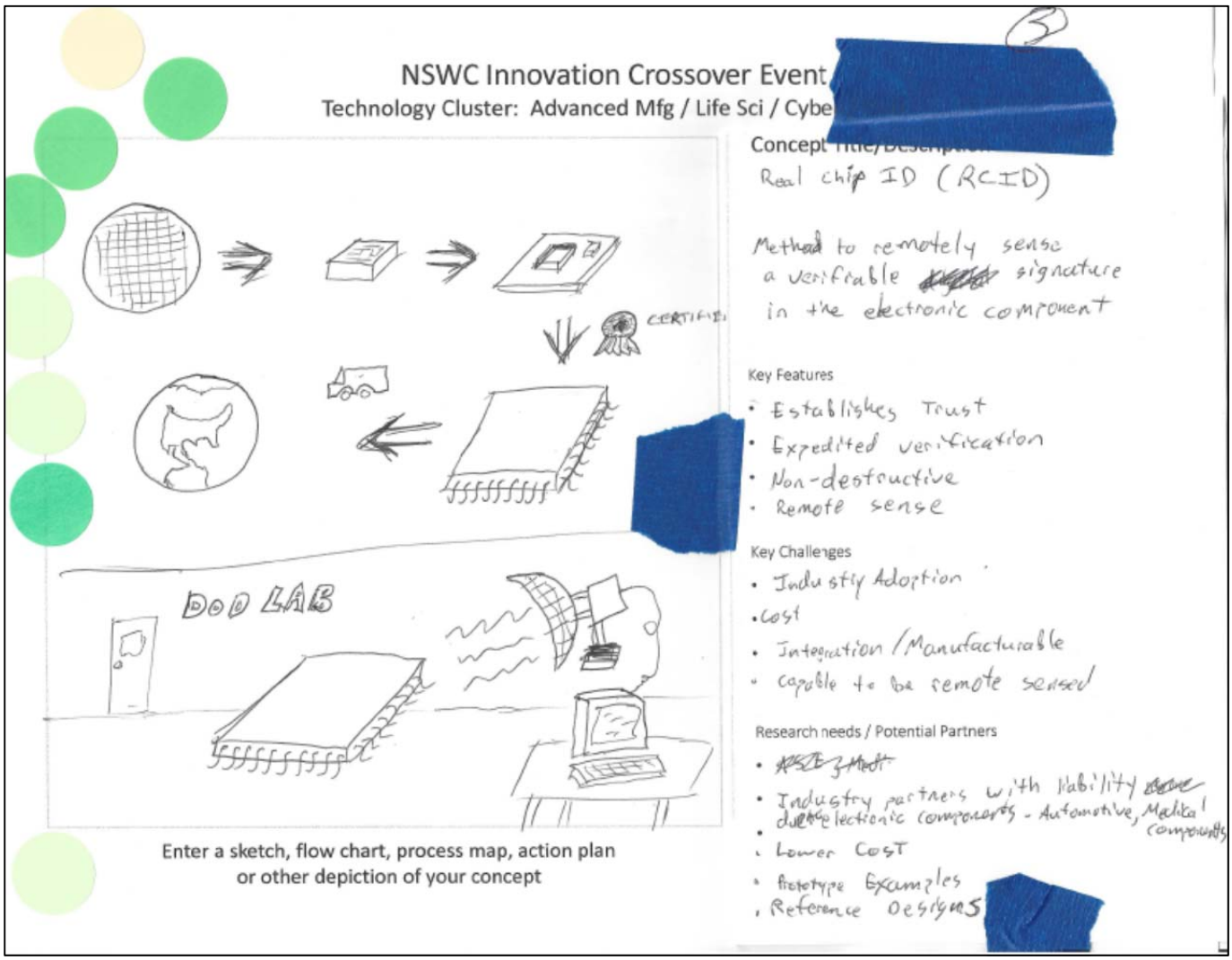
Trusted Electronics: Supply Chain Manager



Elevator Pitch

For critical electronics buyers who need to identify ICs that are not authentic our supply chain manager ensures receipt of authentic ICs. Unlike free market, unchecked supply chain our supply chain manager offers certified authentic ICs that meet all functional characteristics.

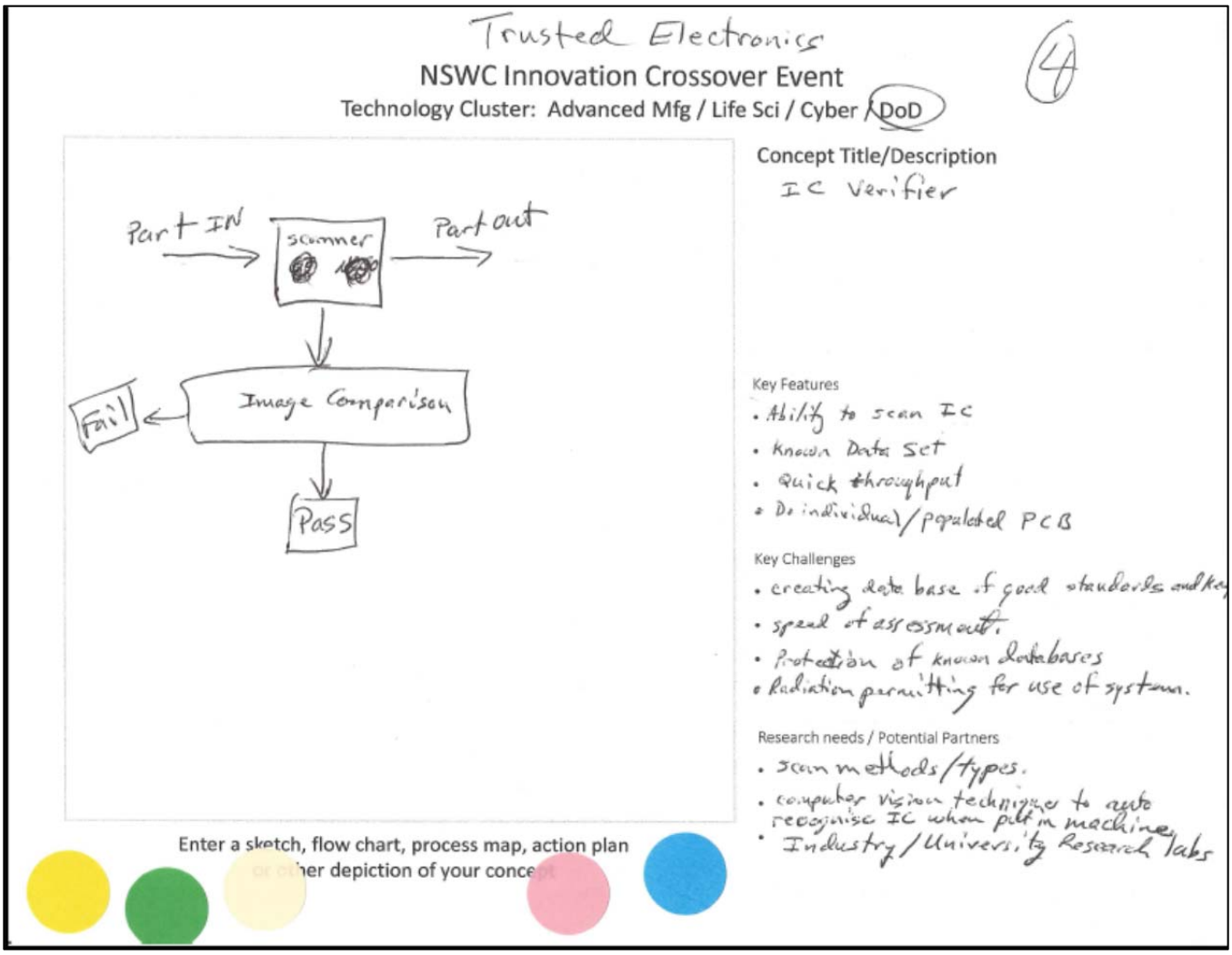
Trusted Electronics: Real Chip ID (RCID)



Elevator Pitch

For industries that have high liability and safety concerns who need to ensure that microelectronics are authentic our RCID provides remote sensing to ensure microchip authenticity. Unlike current anti-counterfeiting solutions our RCID offers protections and verification throughout the supply chain.

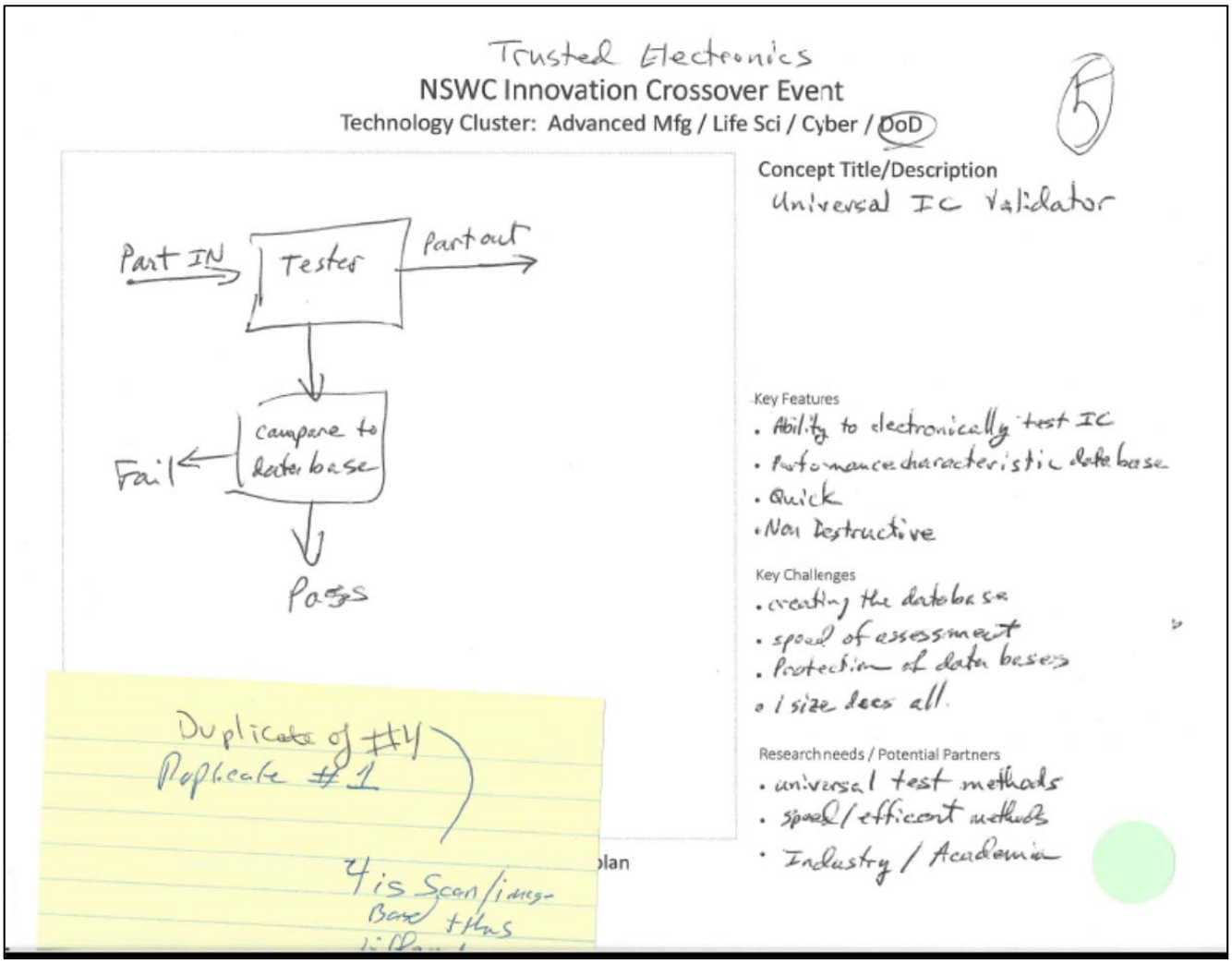
Trusted Electronics: IC (integrated circuit) Verifier



Elevator Pitch

For DoD users and supply agencies who need to verify that ICs are trusted our IC verifier validates components/circuit cards are trusted. Unlike visual verification methods our IC verifier offers automated circuit verification through optical processes.

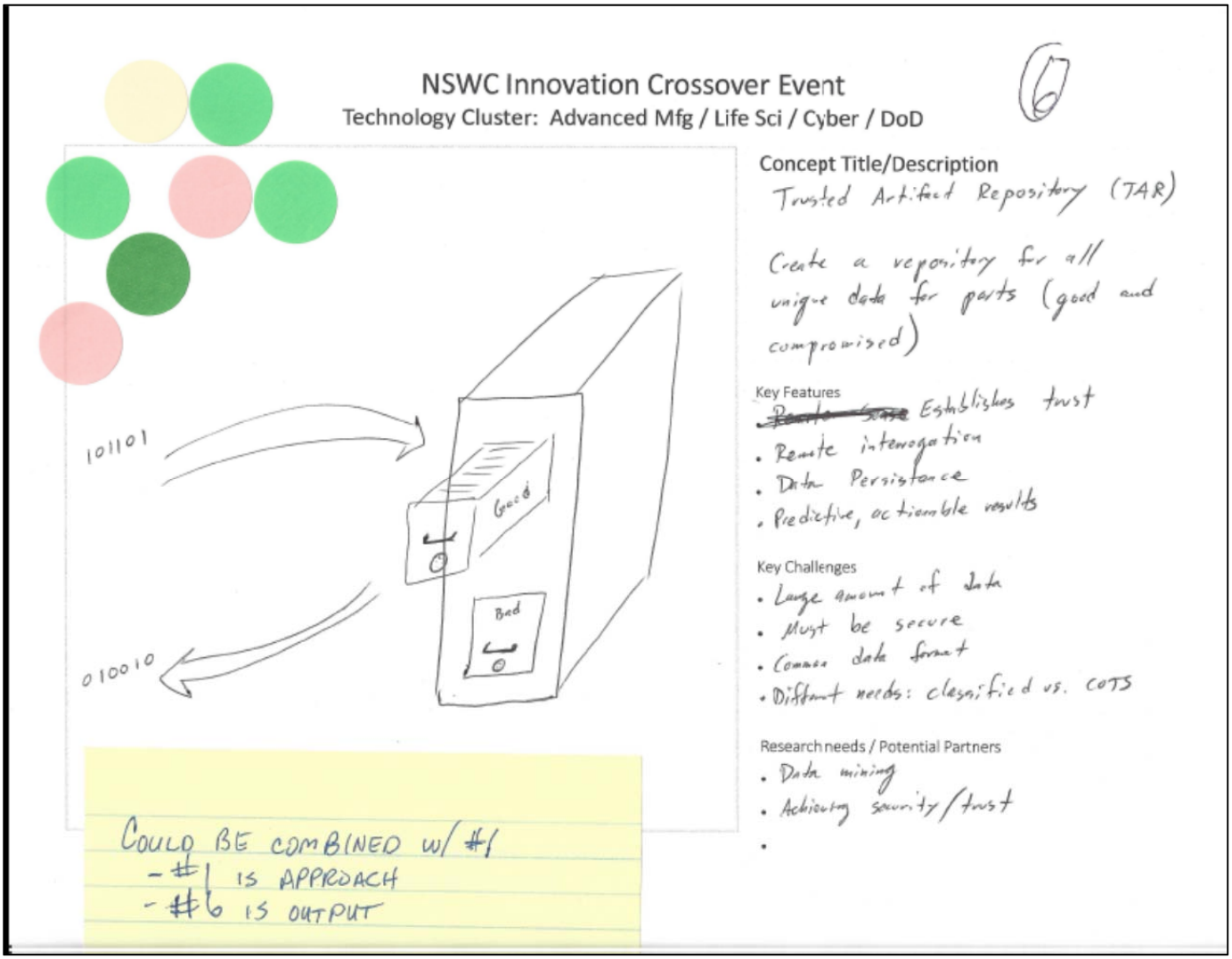
Trusted Electronics: Universal IC (integrated circuit) Validator



Elevator Pitch:

For Department of Defense (DOD) users and suppliers, agencies who need to validate that ICs are trusted and work properly our validator ensures IC are trusted and work quickly. Unlike visual verification methods our Universal IC validator offers the ability to verify the functionality (electrical) of IC.

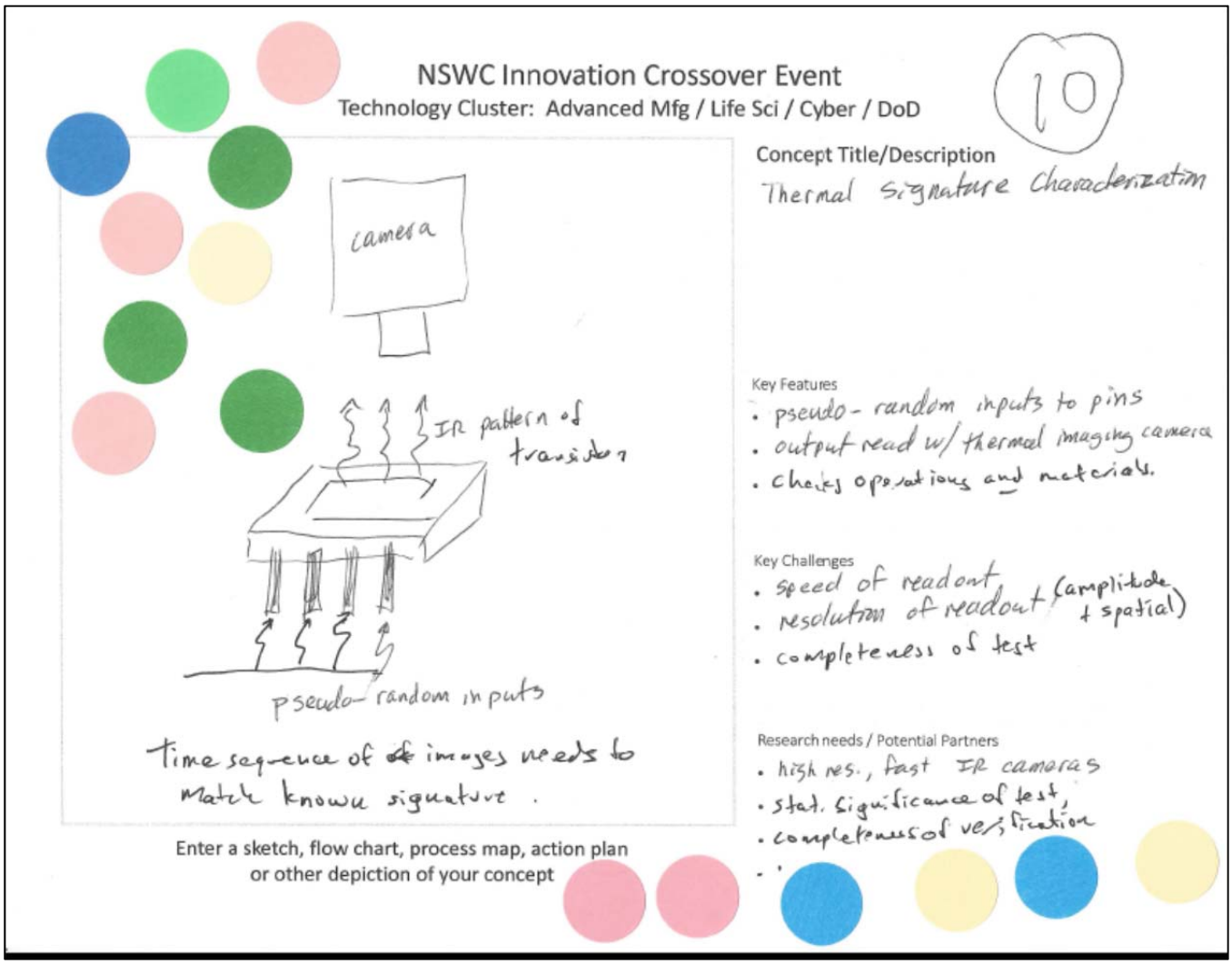
Trusted Electronics: Trusted Artifact Repository (TAR)



Elevator Pitch (also called Parts Google)

For industries which require high reliability and safety who need to ensure that micro-electronics are authentic our TAR provides the ability to verify part characteristics from a trusted data repository. Unlike previous vendor/program unique solutions our standardized process to access validation data to ensure trust offers the ability to “data mine” data to identify trends impacting parts integrity.

Trusted Electronics: Thermal Signature Characterization

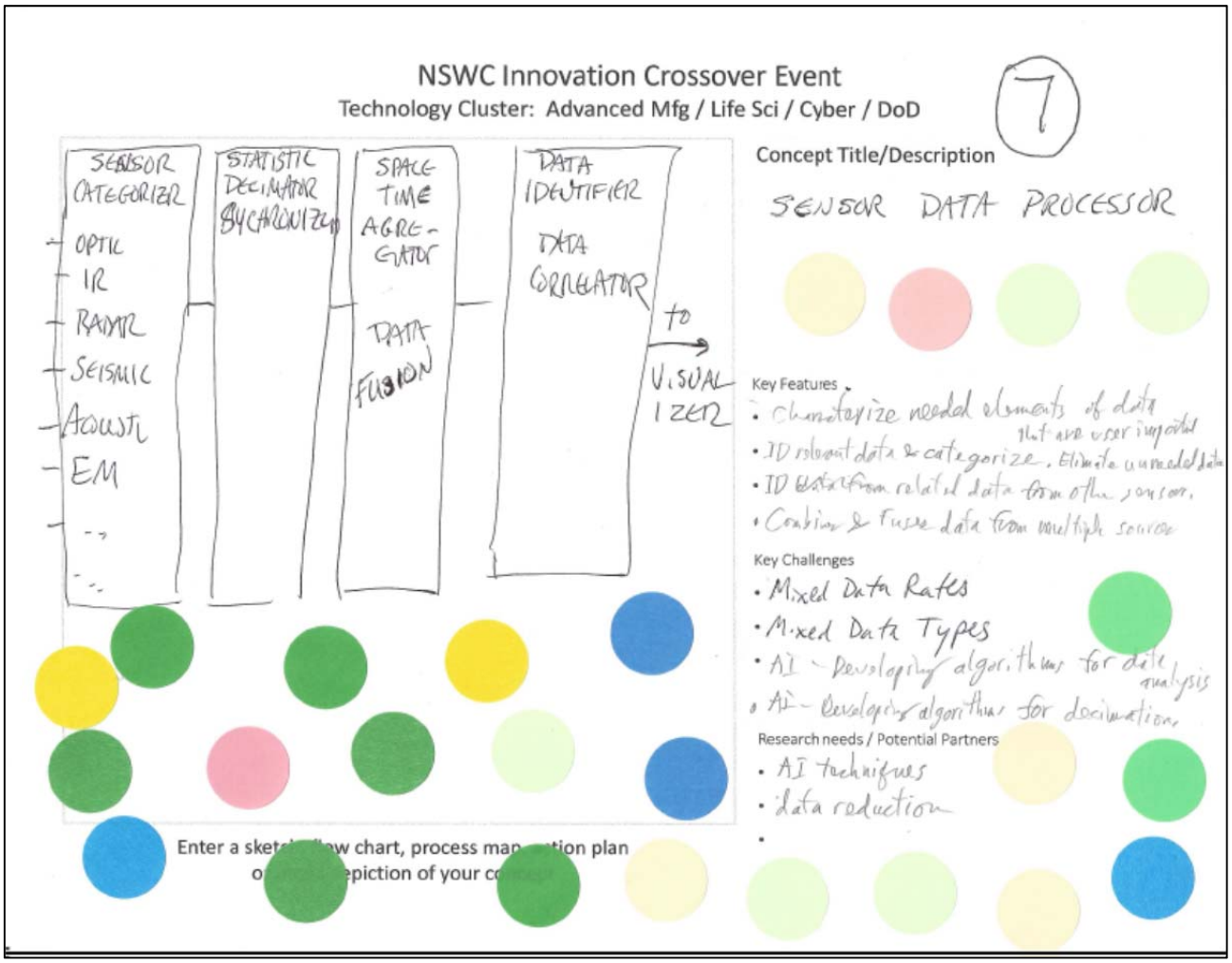


Elevator Pitch

For Chip customers with a concern about counterfeiting who need to check the correct operations of chips that are prone to counterfeiting our Thermal Signature Characterization method provides pseudo-random inputs to pins in order to rapidly sample parts. Unlike current test methods our technique offers an output read with a thermal imaging camera that is easy to implement.

Sensor Data Fusion: The concept documented in the body of the report was unique in that it was the only concept focused on display of the data. Several of the remaining concepts were focused on how the data was processed. They are noted below with a parenthetical statement (a processing solution) after the title.

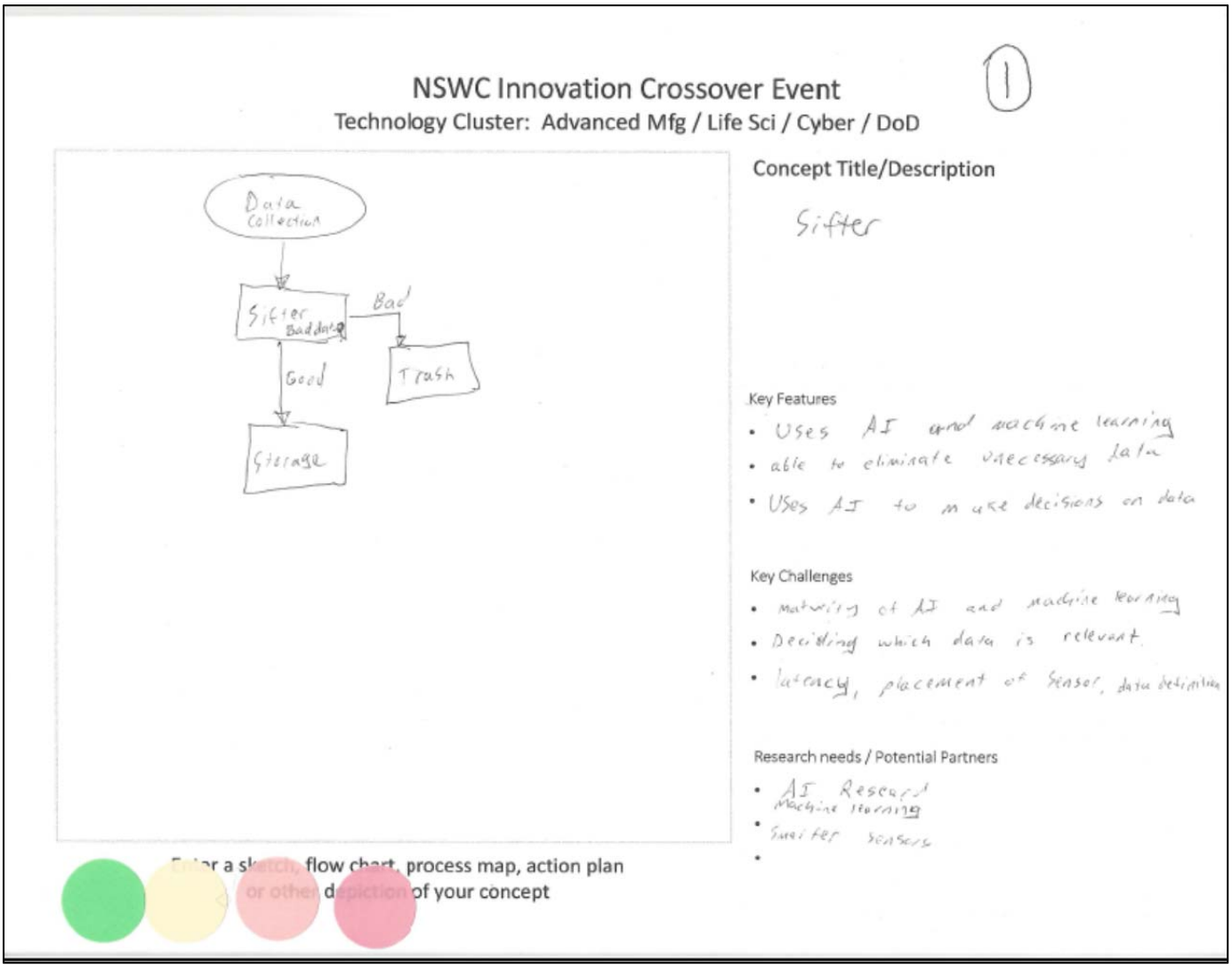
Sensor Data Fusion: Sensor Data Processor (a processing solution)



Elevator Pitch:

For observers who need to sort and process data that represents threats from multiple sensors our Sensor Data Processor dynamically simplifies, aggregates, fuses and synchronizes the sensor data stream. Unlike current, non-combined point solutions, our sensor data processor offers normalized fused data.

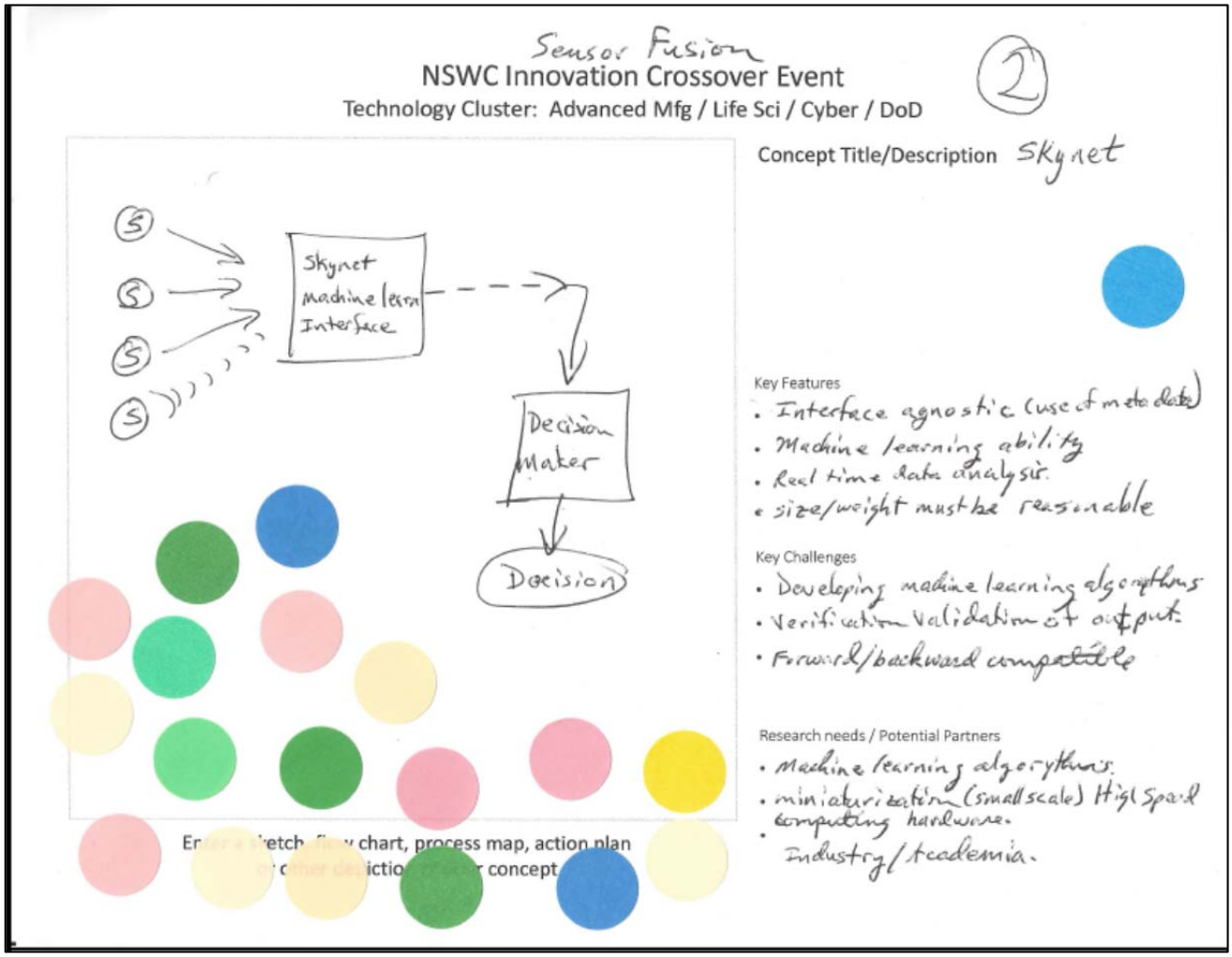
Sensor Data Fusion: Data Sifter



Elevator pitch

For DoD systems who need to fuse data that sensors have captured, our AI machine learning sifter provides the ability to assist in data decision making. Unlike unfused multisensory data our sifter offers the ability to throw out bad data.

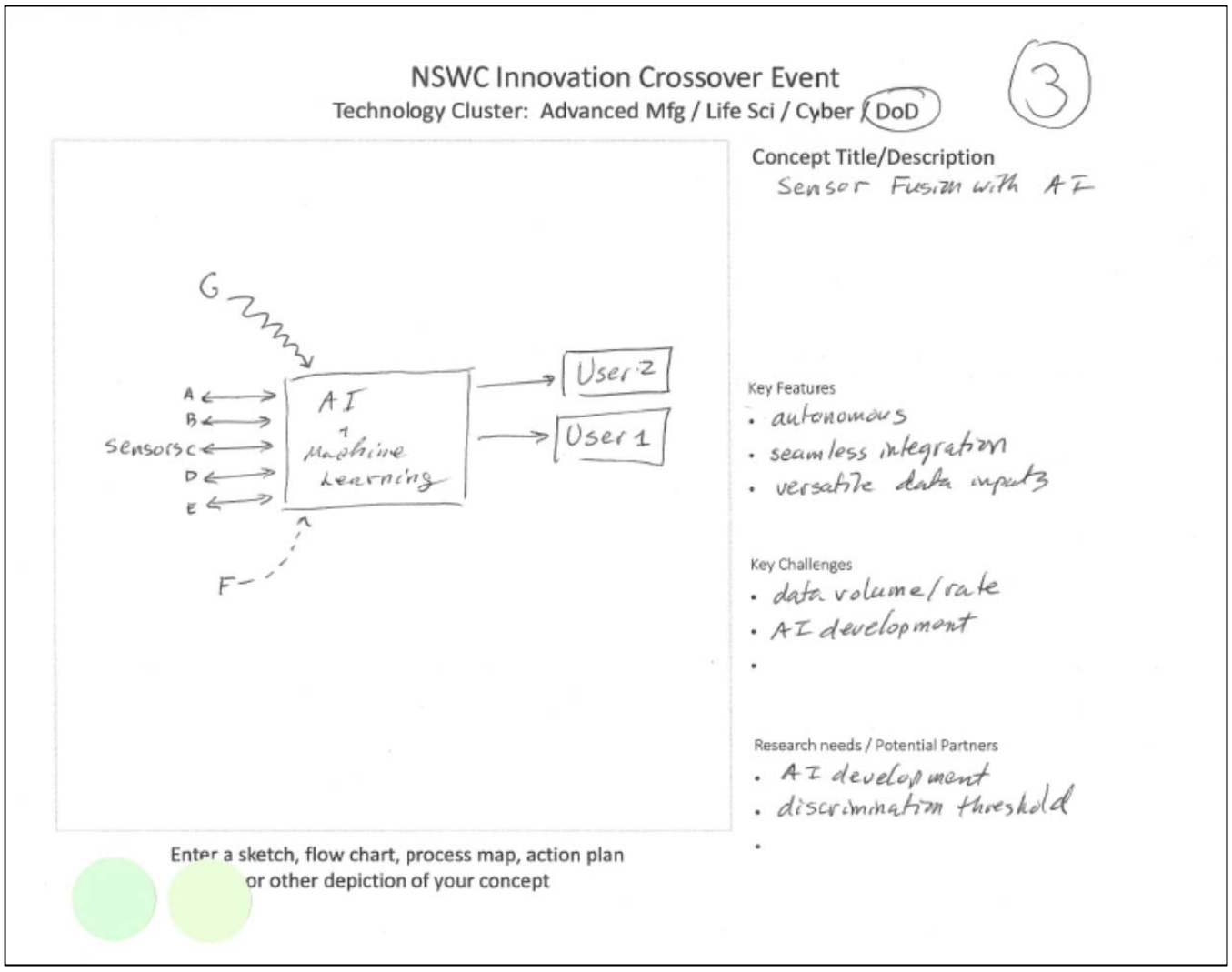
Sensor Data Fusion: Skynet (a processing solution)



Elevator Pitch

For decision makers who need to make critical decisions that use data from multiple sensors our Skynet collects disparate data types and converts to a common data stream that can be used to make decisions. Unlike current methods, our Skynet offers a way to manipulate data into a common usable data set.

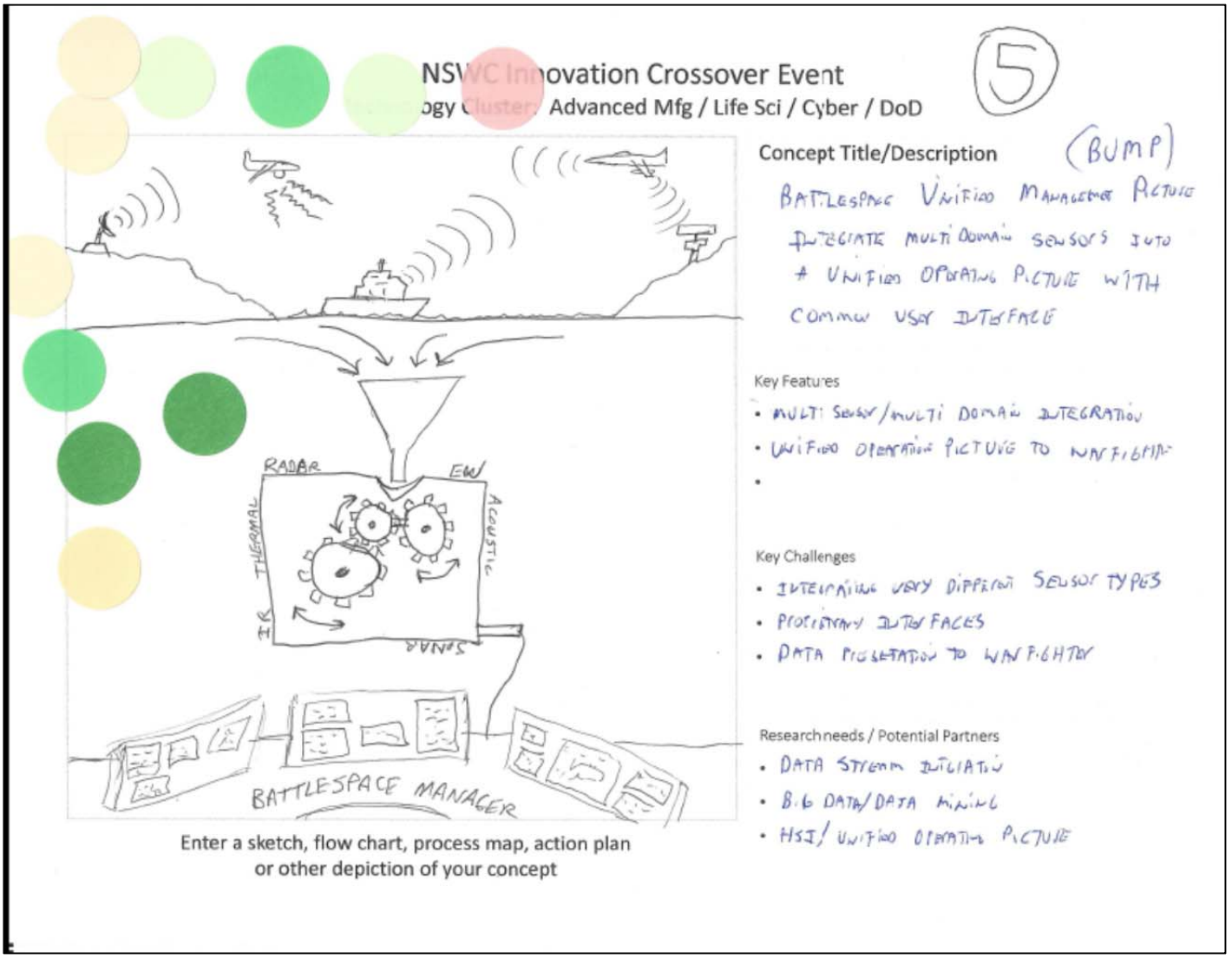
Sensor Data Fusion: Sensor Fusion with AI



Elevator Pitch:

For diverse users of complex systems who need to digest diverse forms of data that originate from disparate sensors our AI sensor fusion concept provides efficient data reduction and sensor integration. Unlike constrained systems our AI sensor fusion concept offers flexible, autonomous fusion of complex data streams.

Sensor Data Fusion: Battlespace Unified Management Picture (a processing solution)

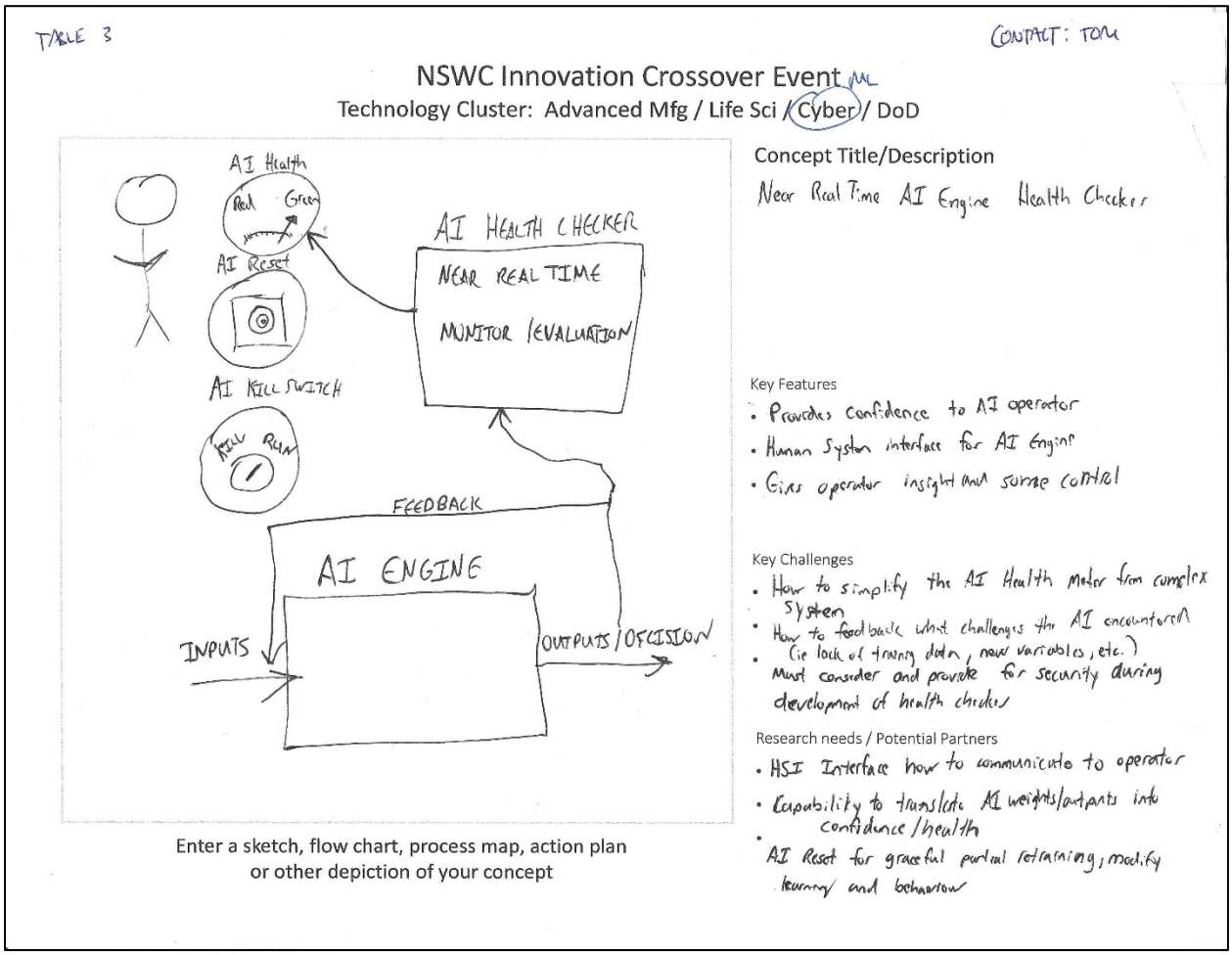


Elevator Pitch

For battlespace managers who need to make timely decisions that are critical in a rapidly changing adversarial environment our multi-domain sensors integrate data across sensors and platforms. Unlike HSI solutions our integrated multi-domain sensors offer actionable intelligence significantly reducing response time.

IT/Cyber Cluster

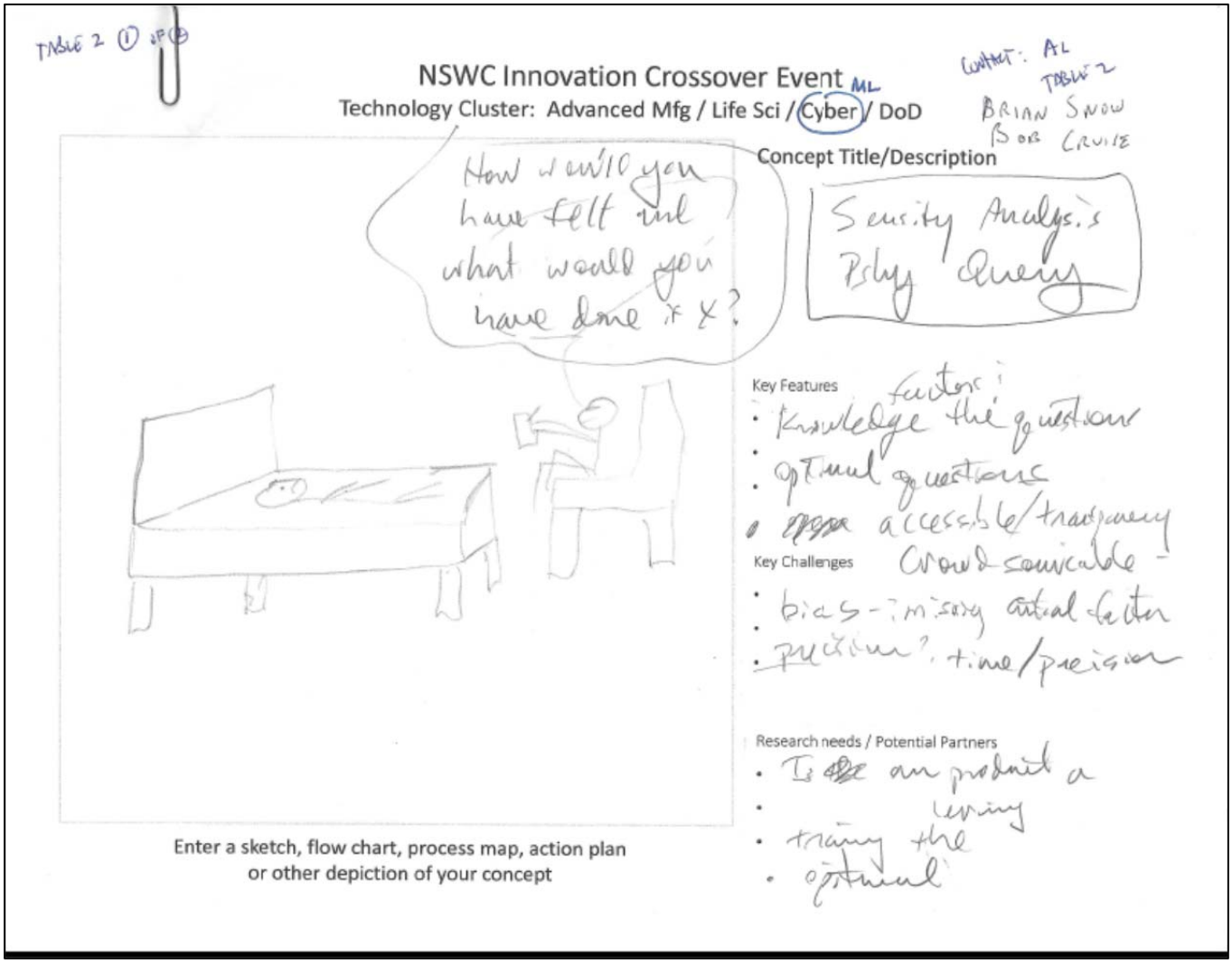
Machine Learning: Near real time AI engine health checker



Elevator Pitch

For anyone using an AI (artificial intelligence)/ML (machine learning) decision making autonomous system who needs to explain how an AI decision was made, our independent, parallel running box translates the ever-changing AI weights into human centered understandable language; plus an identifier of where/when in the decision tree process the final decision became definite. Unlike current or slow case by case reverse engineering, our AI Healthchecker offers secure feedback on each and every AI made decision in a timely manner while not adding decision making time latency.

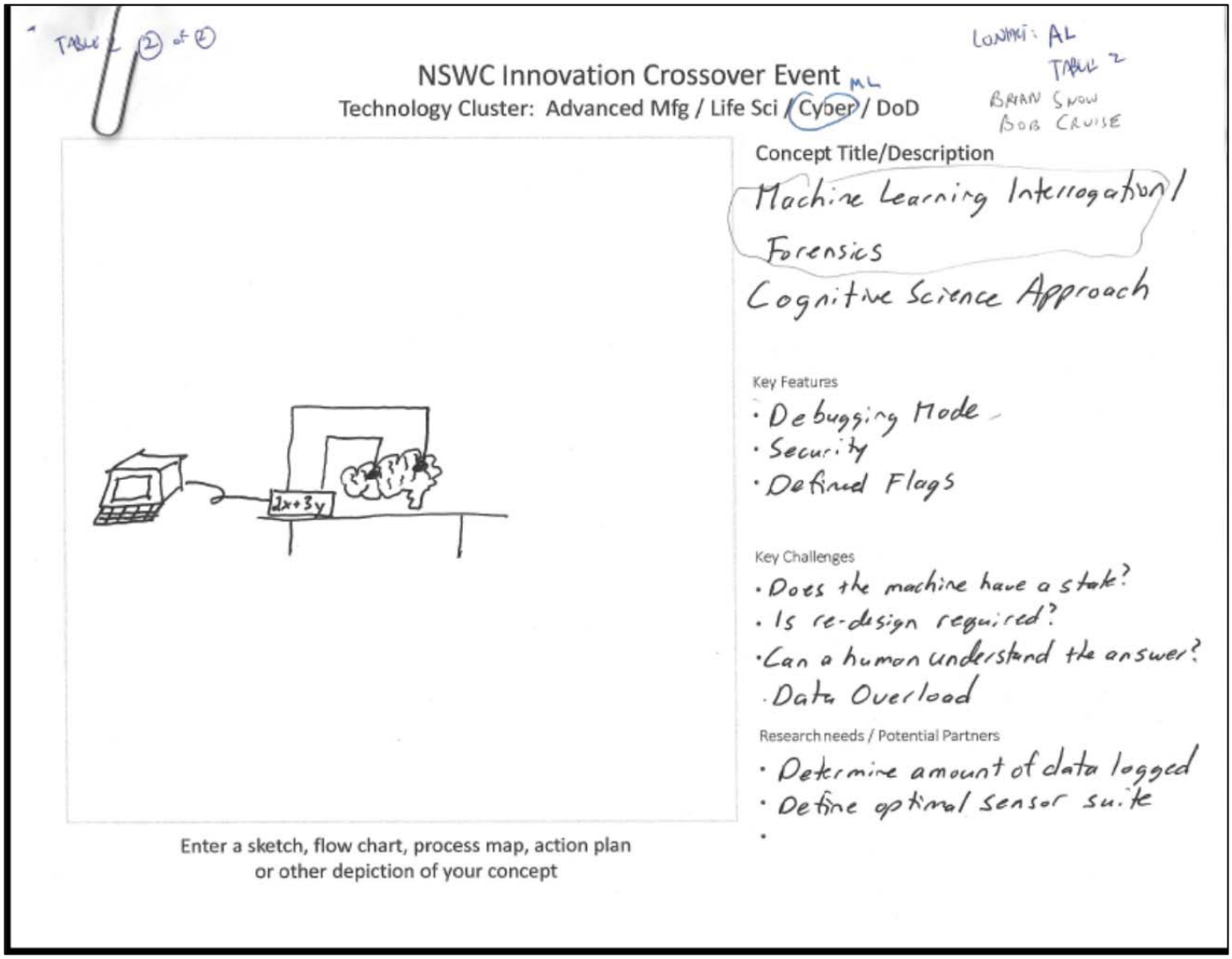
Machine Learning: Sensitivity Analysis Psych Query



Elevator Pitch

For the operator of a learning machine who needs to understand why the learning machine made a particular decision that gives the operator confidence in the decision our sensitivity analysis/psych query provides how inputs affect outputs and identifies critical factors of the learning machine. Unlike intrusive solutions to the internal workings of the machine, our sensitivity analysis/psych query offers an approach that doesn't require modification of the learning machine and provides accessibility and transparency to the user/operator.

Machine Learning: Machine learning Interrogation Forensics



Elevator Pitch

Anyone interested in forensics of learning machine decisions who needs to respond to questions about the machine's decision, our Machine Learning Interrogation/Forensics sensor provides the ability to record real time machine decisions. Unlike manual analysis our Forensic sensor (can't interpret the handwriting) offers automated solutions to machine decisions forensics not interfering, secure with everything needed to document decisions.

Cybersecurity: Cy-Phy Emulation Tool (this is distinct from the Cy-Phy concept in the main body)

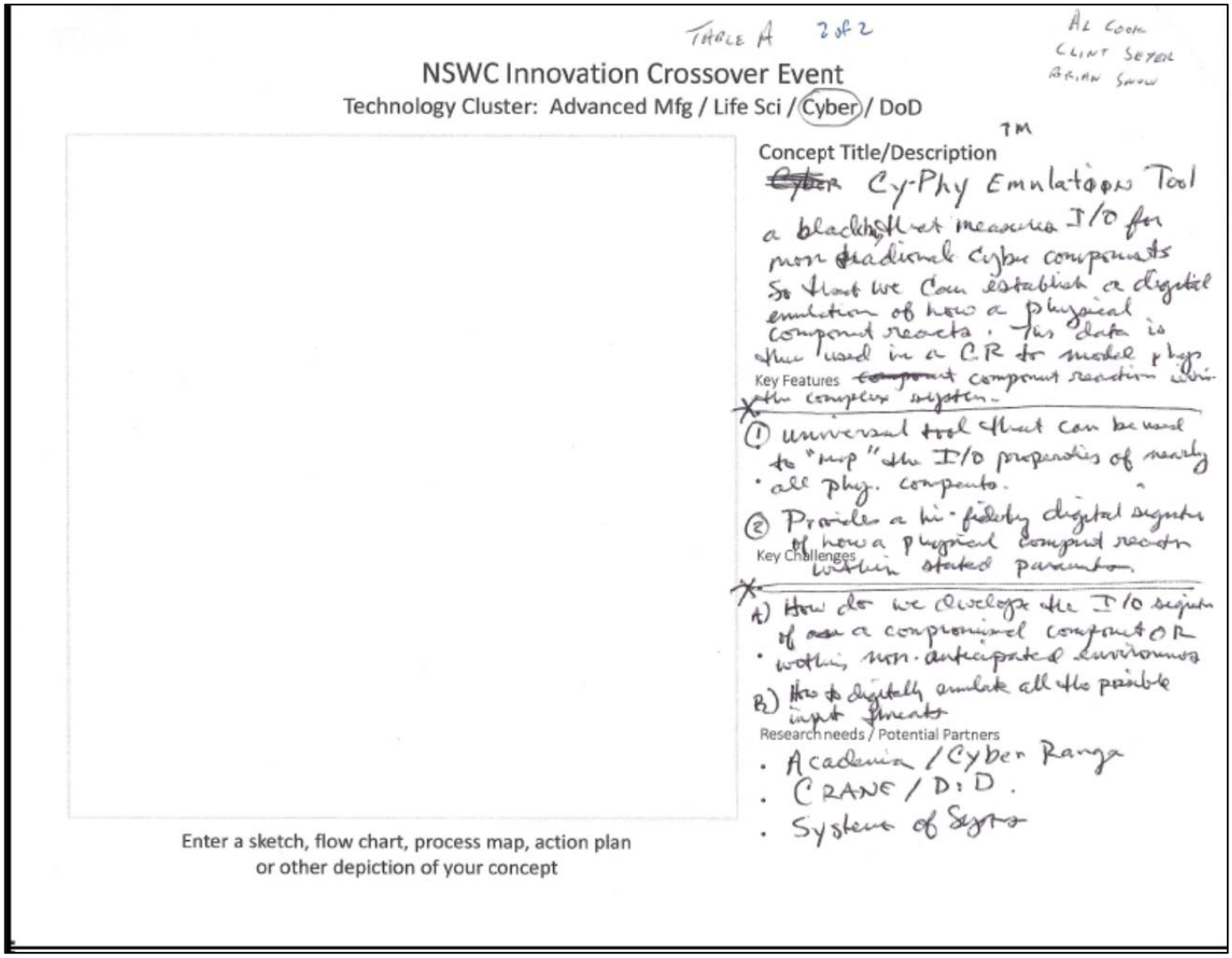


TABLE A 2 of 2

AL COOK
CLINT SEXTON
BRIAN SNOW

NSWC Innovation Crossover Event

Technology Cluster: Advanced Mfg / Life Sci / (Cyber) / DoD

TM

Concept Title/Description

~~Cyber~~ Cy-Phy Emulation Tool

a blackbox test measuring I/O for non traditional cyber components so that we can establish a digital emulation of how a physical component reacts. This data is then used in a C.R for model phys of the complex system.

Key Features

① universal tool that can be used to "map" the I/O properties of nearly all phy. components.

② Provides a hi-fidelity digital signature of how a physical component reacts within stated parameters.

Key Challenges

A) How do we develope the I/O signature of a compromised component OR within non-anticipated environments

B) How to digitally emulate all the possible input threats

Research needs / Potential Partners

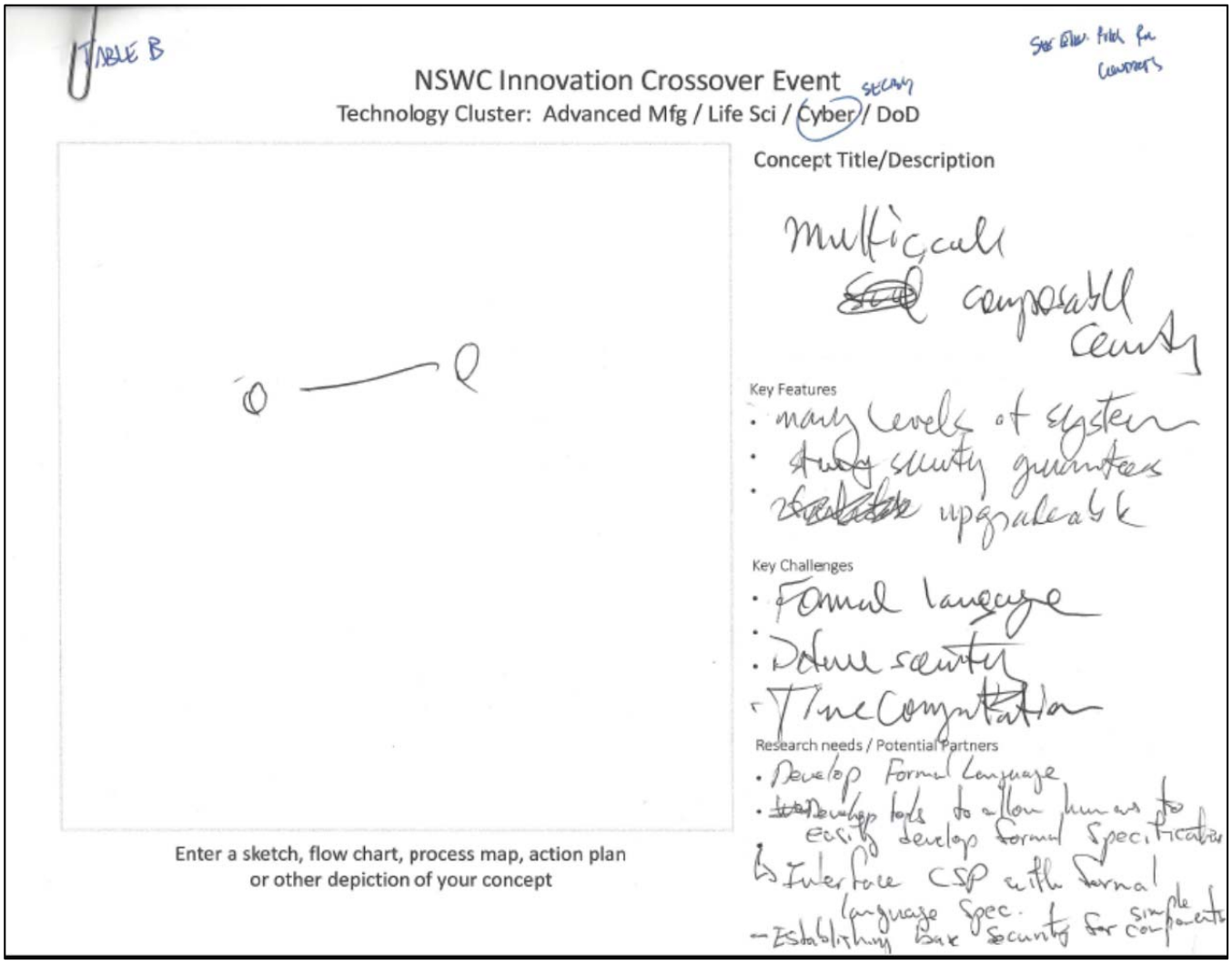
- Academia / Cyber Ranges
- CRANE / DoD.
- Systems of Systems

Enter a sketch, flow chart, process map, action plan or other depiction of your concept

Elevator Pitch

For the DoD who need to securely integrate systems that may be individually secure but not when integrated together our Cy-Phy emulation tool provides a universally scalable tool for digital emulation of physical components. Unlike current systems that are only tested at a component level, our Cy-Phy Emulation tool offers a universal tool that can map properties of all physical components

Cybersecurity: Multi-scale component security

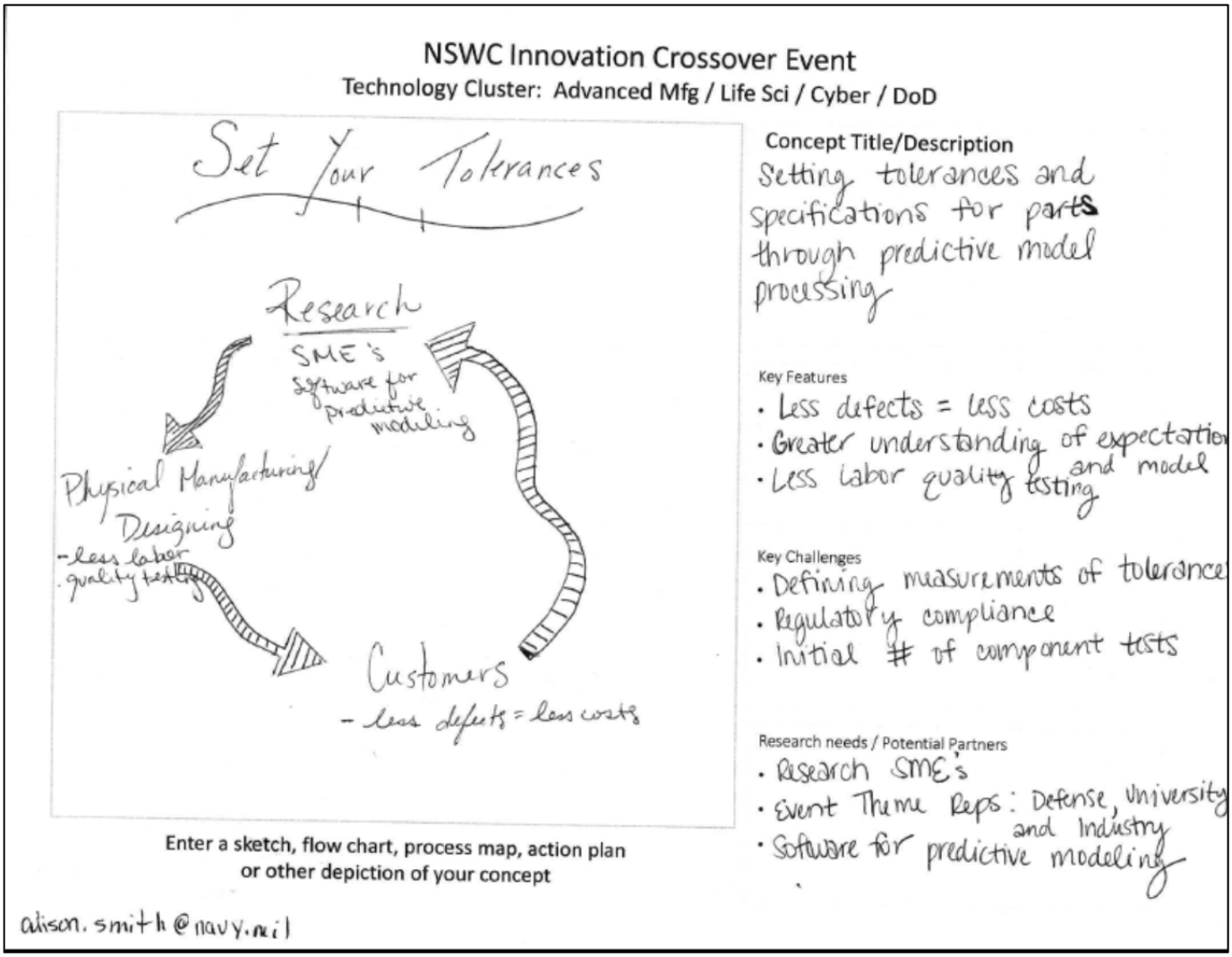


Elevator Pitch

For high assurance well defined secure system (can't read) who need to prove system security compliance our Multi-Scale component security system and methodology provides strong and quantifiable security. Unlike (past?) security and testing solutions that have failed us for the last 30 years our solution and approach offers clear understanding of security properties and high assurance they can be achieved.

Advanced Manufacturing Concepts

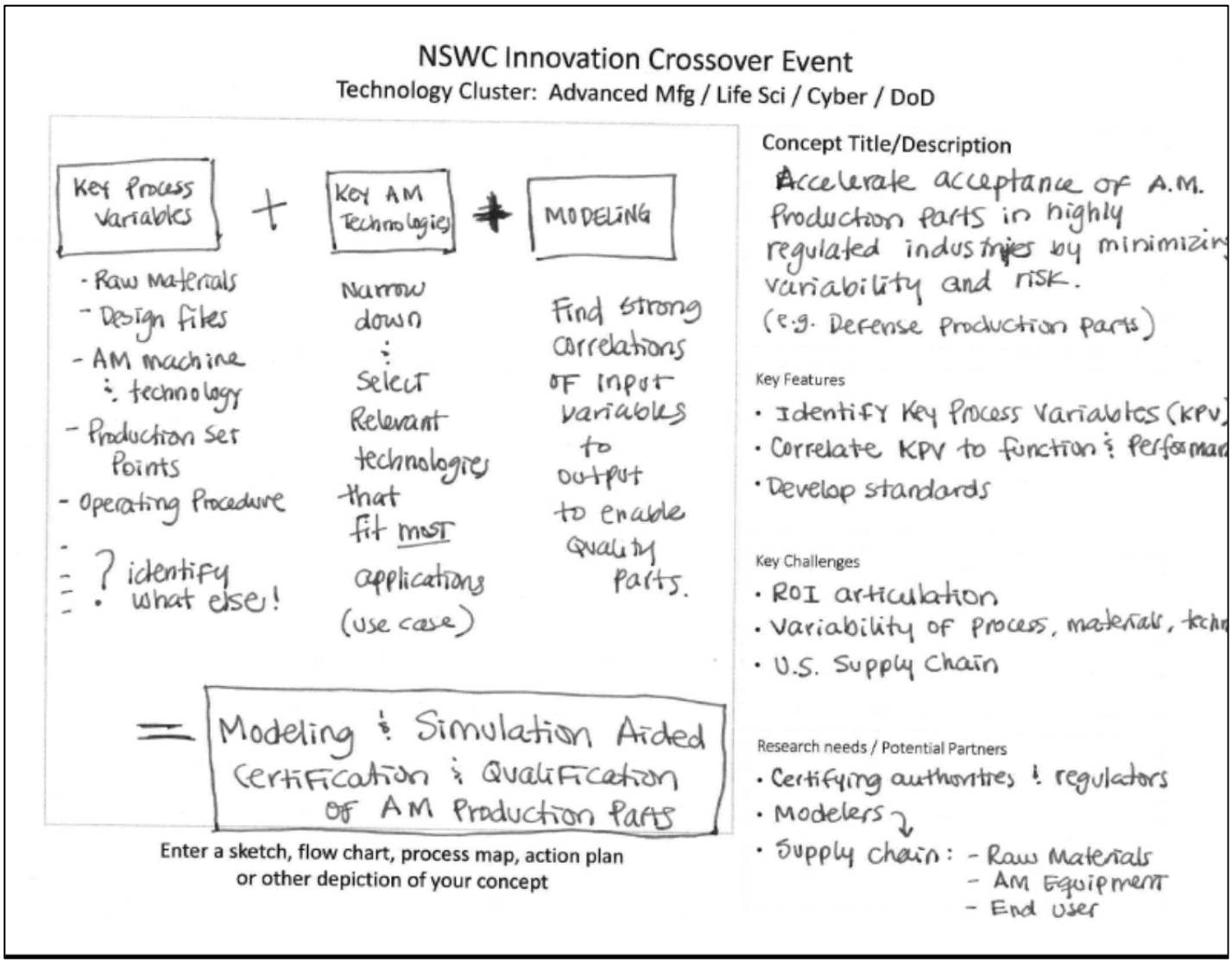
Additive: Set your Tolerances



Elevator Pitch

For Additive manufacturers who need to establish standards that define tolerances and specs within predictive model processing our “set your tolerances” gives a greater expectation of product expectation. Unlike current processes our set your tolerances approach offers less product defects and less cost.

Additive: Minimize variability and risk



Elevator Pitch

For highly regulated industries such as Aerospace, Defense, Medical, etc who need to reduce time to product that increases design freedom at higher speed and less cost and increased performance our modelling and simulation aided solution offers accelerated adoption of AM certified production parts.

MPO (Manufacturing process automation): Digitally enabled life cycle logistics

NSWC Innovation Crossover Event

Technology Cluster: Advanced Mfg / Life Sci / Cyber / DoD

Concept Title/Description

Digitally Enabled life cycle logistics

Key Features

1. Industry standard, open sourced to collect and track life cycle data across vendors
2. Component tag and tracking to match physical
   - Part to digital twin to connect predictive with actual performance
3. Life cycle predictive modeling (e.g. ICME

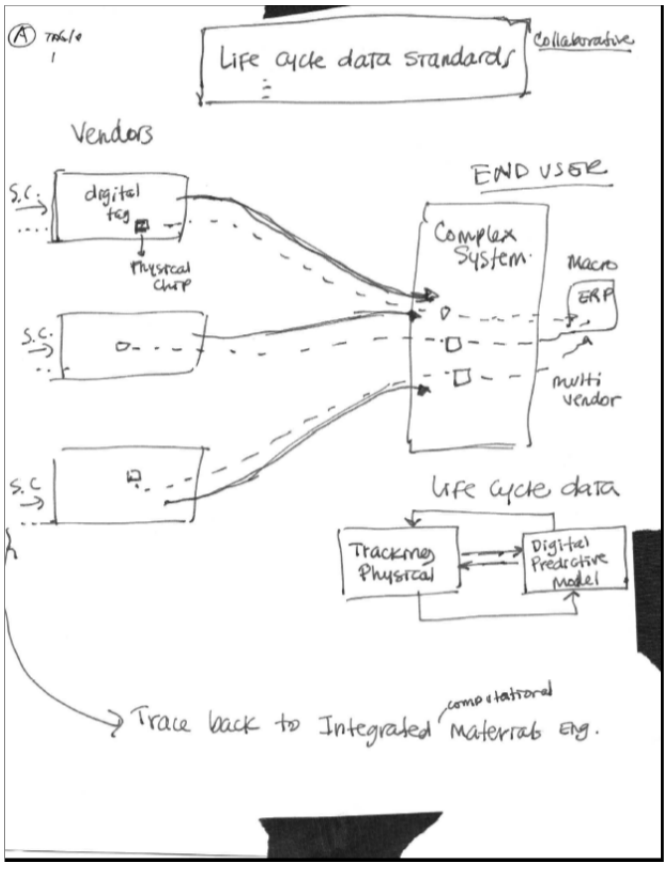
Key Challenges

- IP, Firewalls
- Cyber security
- Collaboration / Culture shift

Research needs / Potential Partners

- DMDII Commons / MBX
- Demonstrate with additive
-

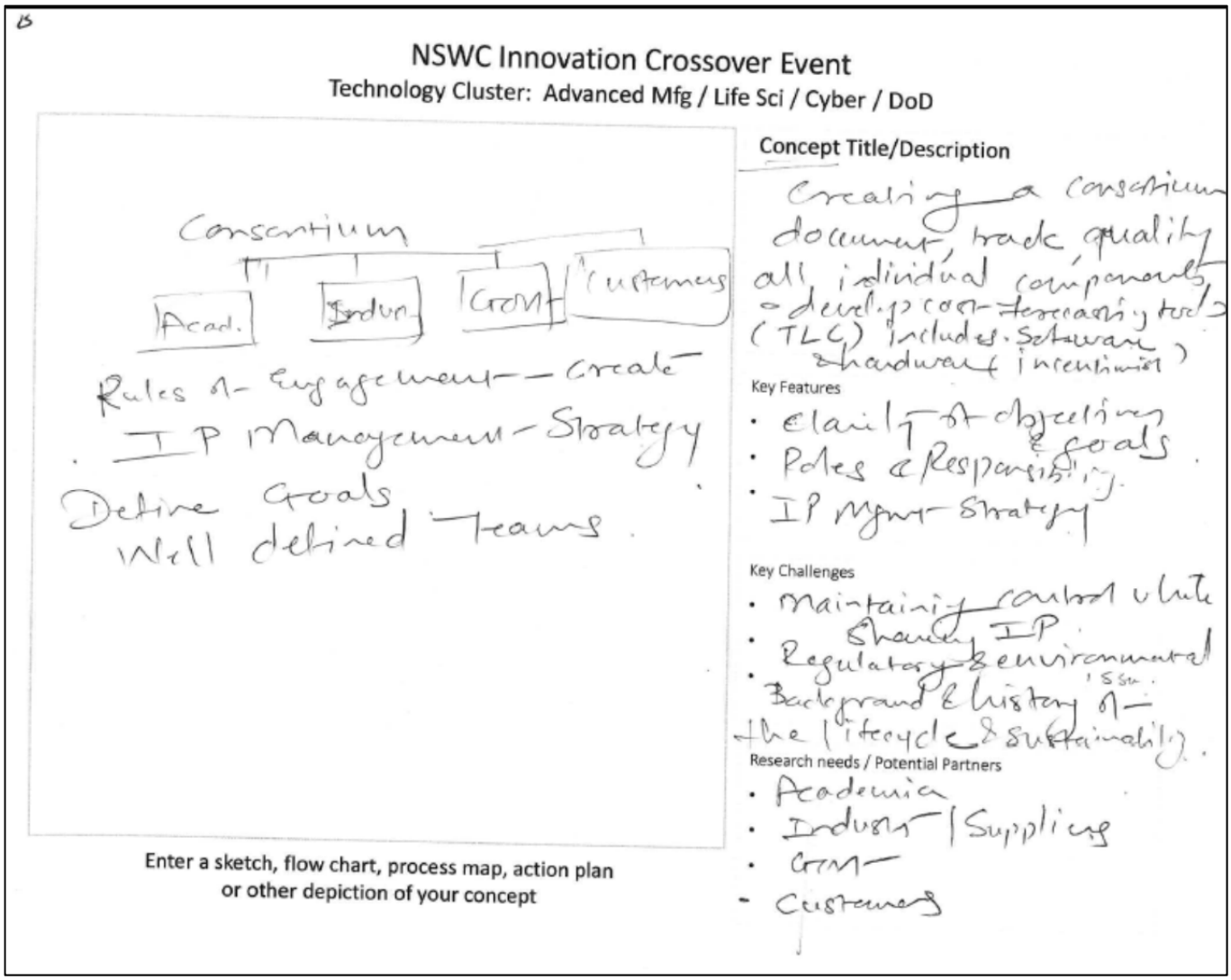
Enter a sketch, flow chart, process map, action plan or other depiction of your concept



Elevator Pitch

For complex manufacturing systems that need to manage LC costs our digitally enhanced life cycle logistics creates an industry standard that collects and tracks life cycle data for long term optimal performance at lower cost. Unlike historically stove piped environments and project teams, our digitally enhanced life cycle logistics (DELCL) offerings matching digital tags of individual components in complex systems to physical/real performance for real time LC management across vendors and predictive modeling validation

MPO: V^2C (verification, validation, certification) Consortium

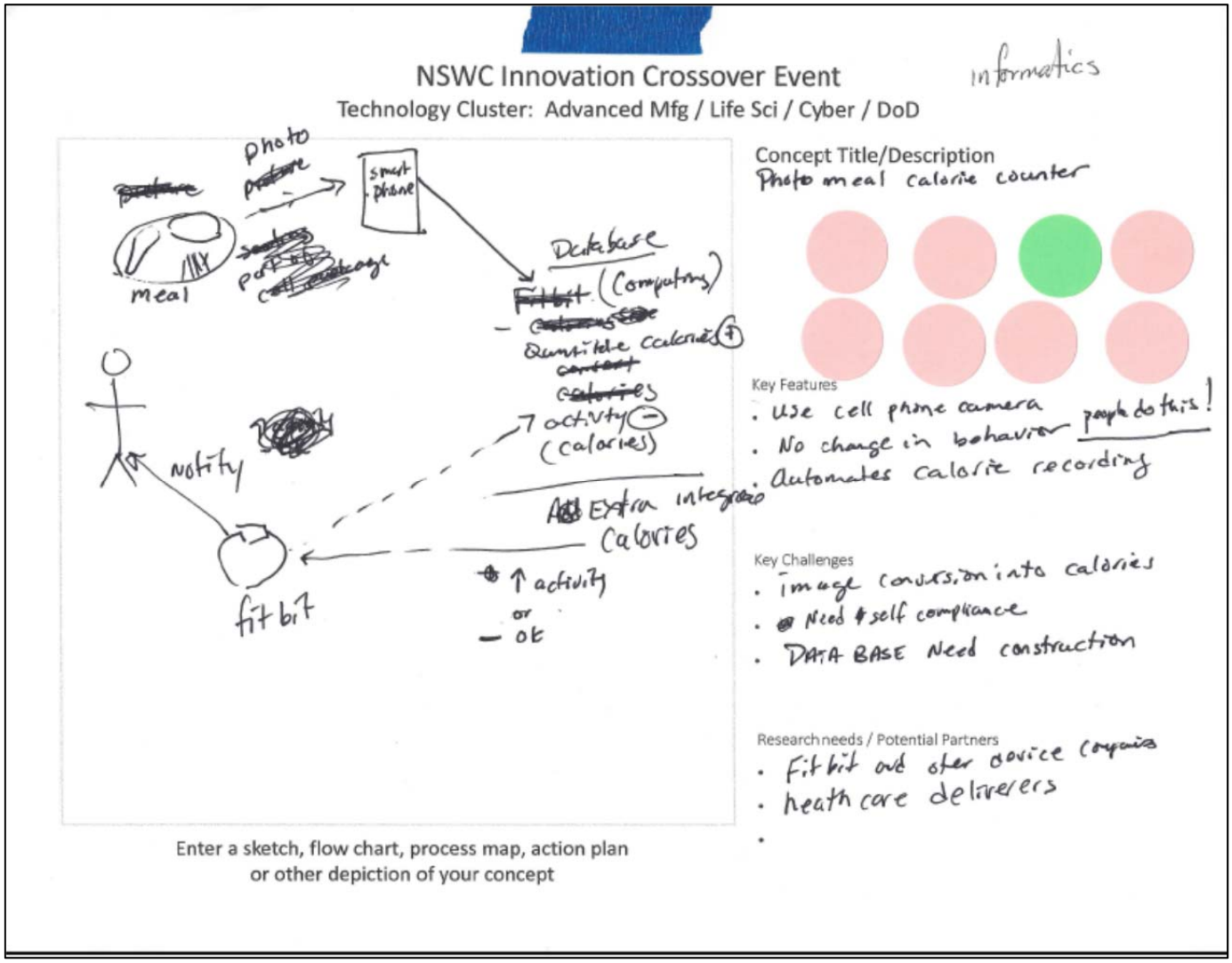


Elevator Pitch

For end users in the manufacturing industry who need to identify lifecycle costs of products in highly regulated industries our consortium will provide verification, validation and certification. Unlike fragmented data/knowledge our consortium offers an agreed set of standards.

Life Sciences Cluster

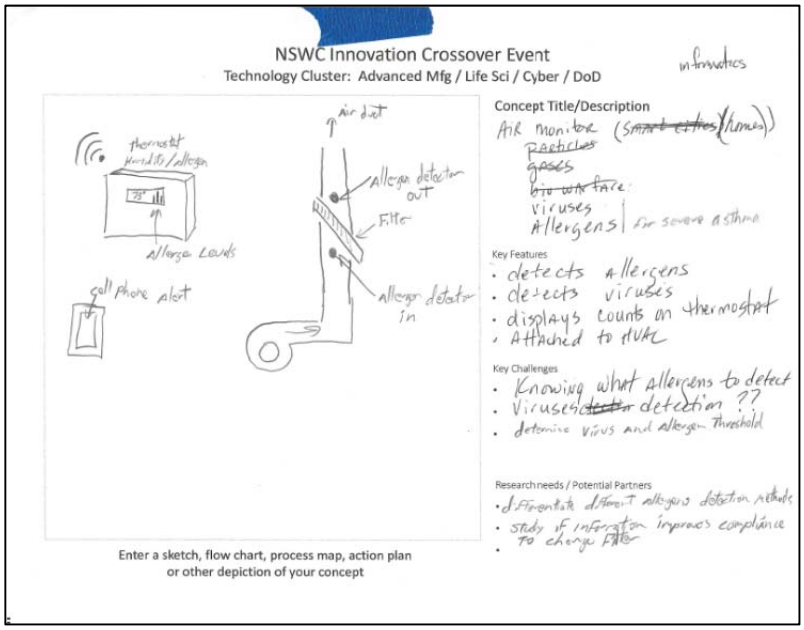
Informatics: Photo Meal Calorie Counter

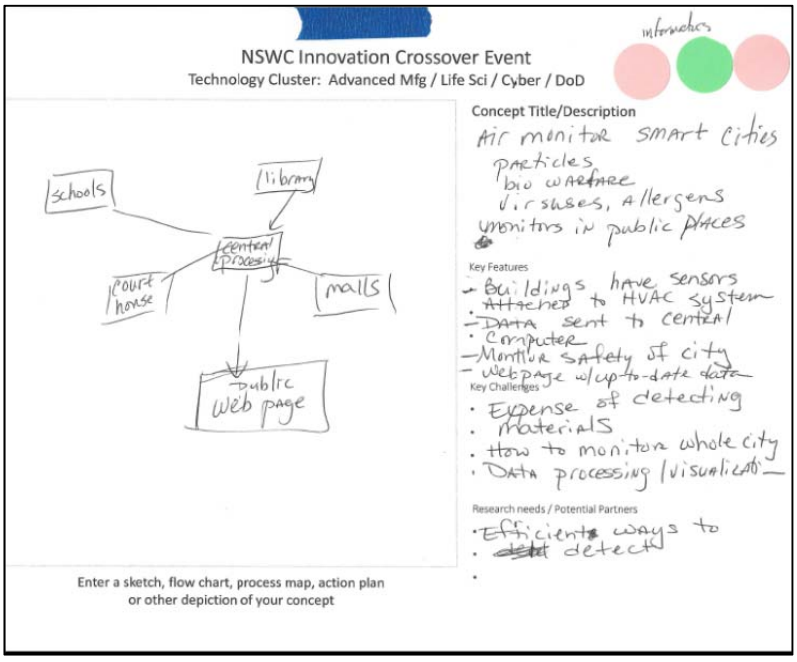


Elevator Pitch

For the health conscious individual who needs to control weight with activity our calorie counter automates food intake recording. Unlike manual input systems, our photo calorie counter offers automatic integration with activity monitors.

Informatics: Air Monitors

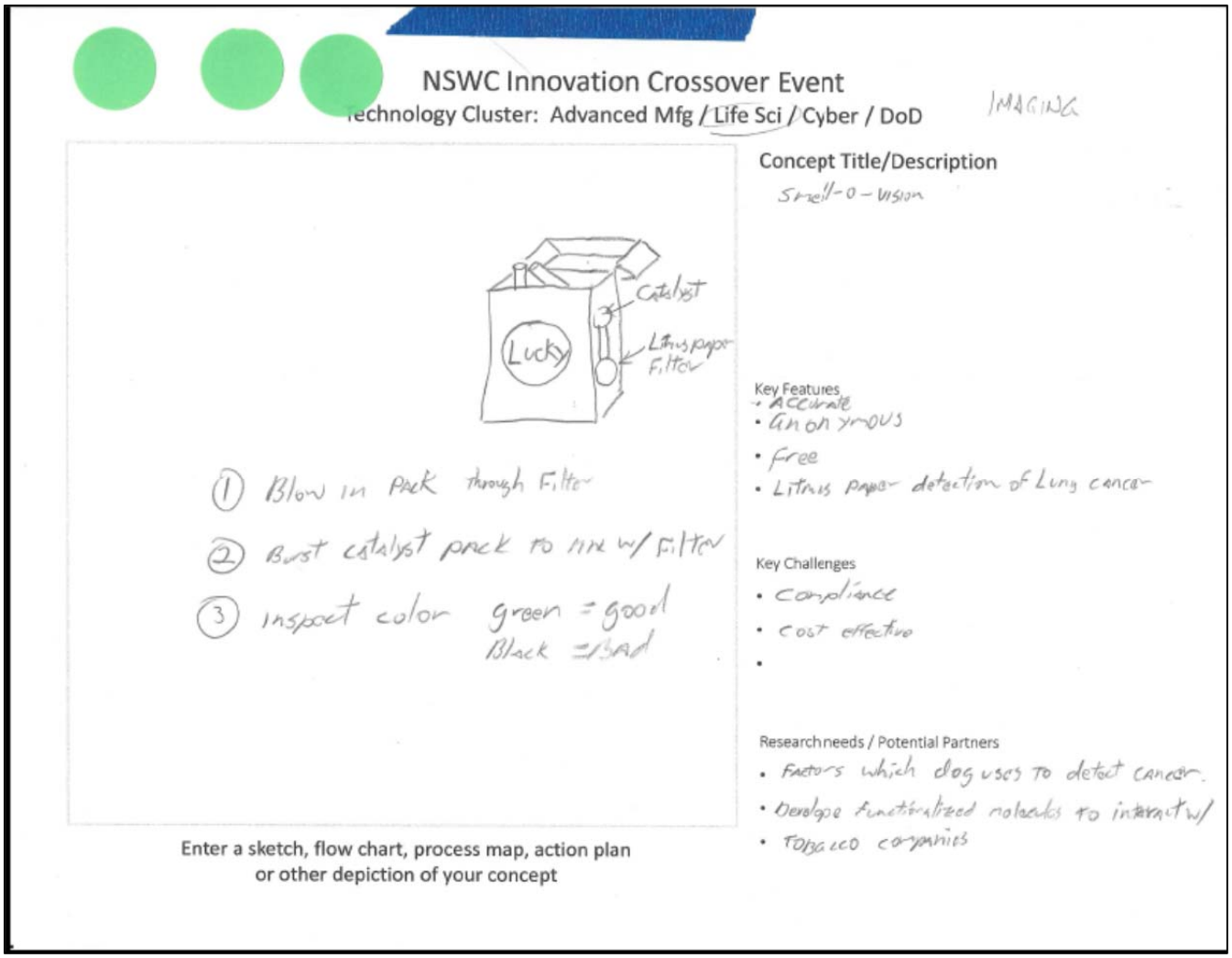




Elevator Pitch

For homes or cities which need to address asthma or protect from contagious diseases that can impact health our Air monitor system provides real time information about air quality. Unlike particle counters our air monitor offers detailed breakdown of the types of particles in the air.

Imaging: Smell-o-Vision



Elevator Pitch

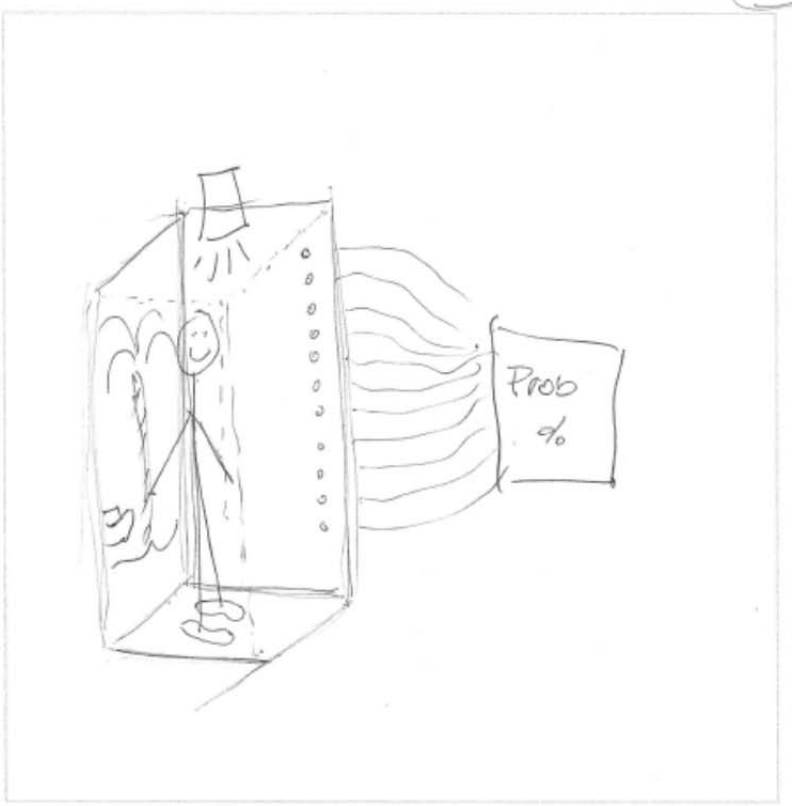
For early cancer detection for smokers who need to monitor lung health our Litmus breath detection as a part of cigarette packs. Unlike x-ray imaging our breath litmus chemical analysis offers quick, confidential detection for lung cancer.

Imaging: Multi-sensor scanner

NSWC Innovation Crossover Event

Technology Cluster: Advanced Mfg / Life Sci / Cyber / DoD

IMAGING



Enter a sketch, flow chart, process map, action plan or other depiction of your concept

Concept Title/Description

Multi-sensor imaging scanning scanner

Key Features

- Patient steps in
- Sensor array makes reading
- Returns prob for range of cancer.
- Can be designed to be user friendly for patient

Key Challenges

- Size
- Cost
- Portability

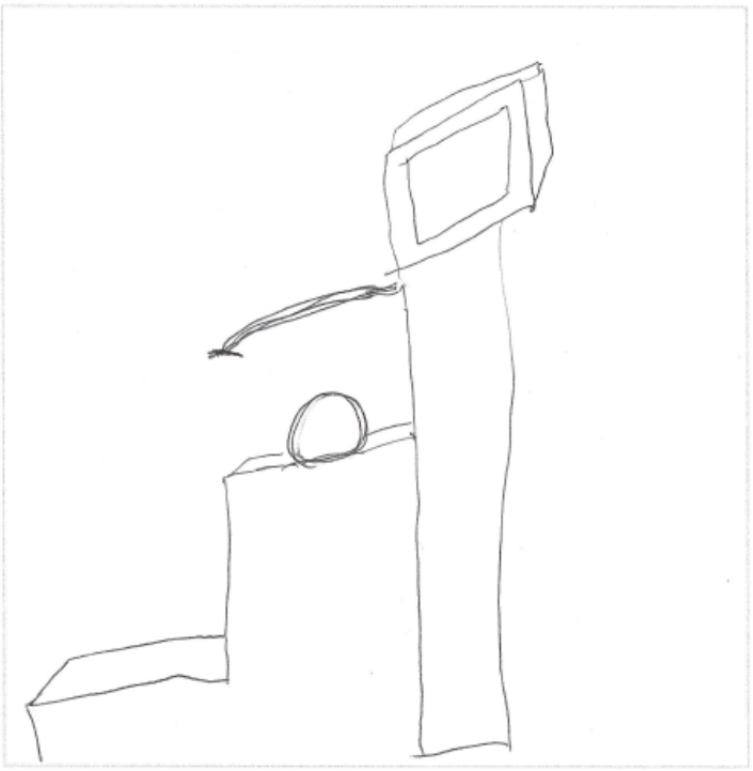
Research needs / Potential Partners

-
-
-

Imaging: Screening Kiosk

NSWC Innovation Crossover Event

Technology Cluster: Advanced Mfg / Life Sci / Cyber / DoD



Enter a sketch, flow chart, process map, action plan or other depiction of your concept

Concept Title/Description

Screening kiosk

Key Features

- Kiosk calculates risk for lung, leukemia & brain cancers
- Available to core population
- Takes 5 min for full screen

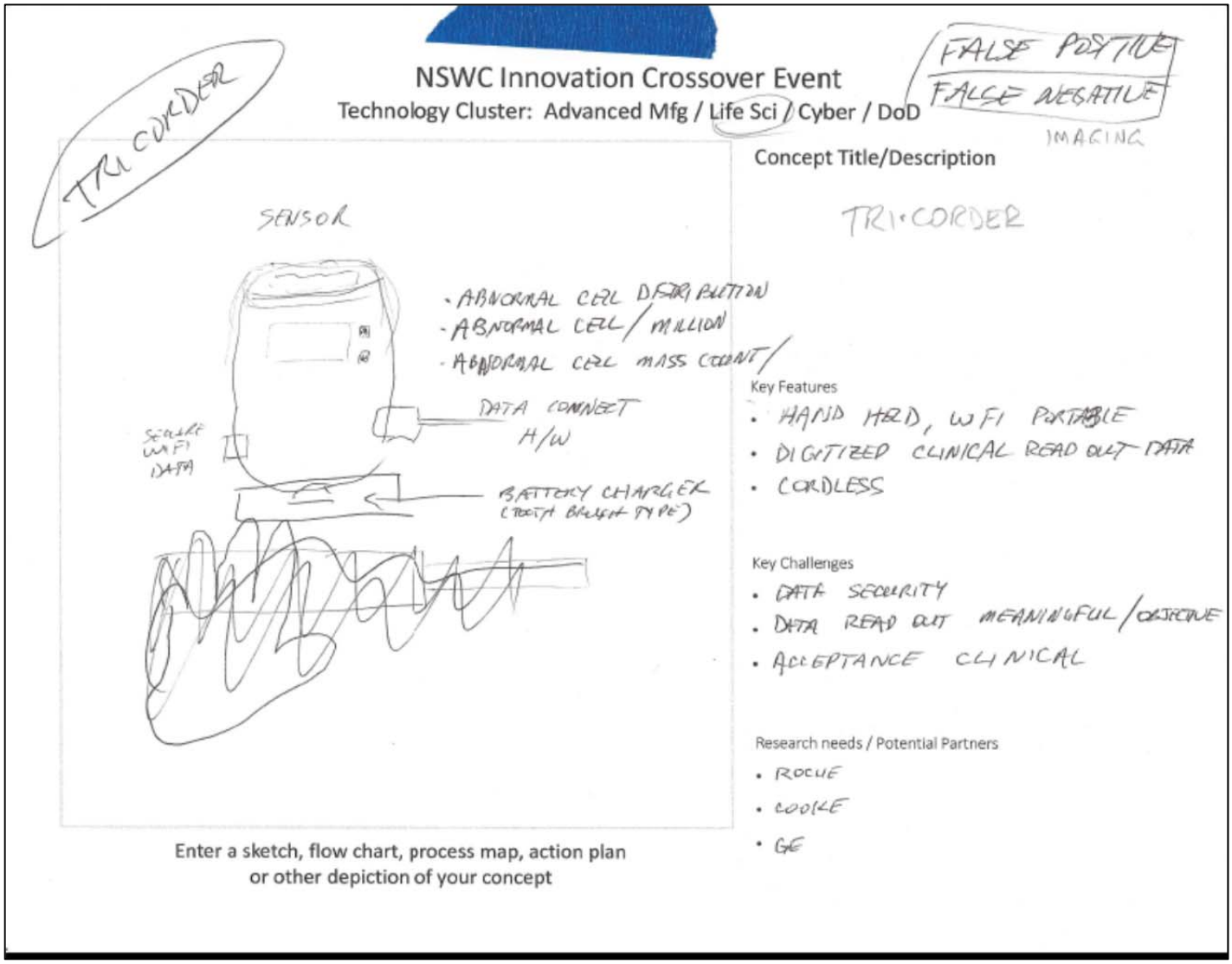
Key Challenges

- Get public to take test
- Send diagnostic info to physician
- Signed consent

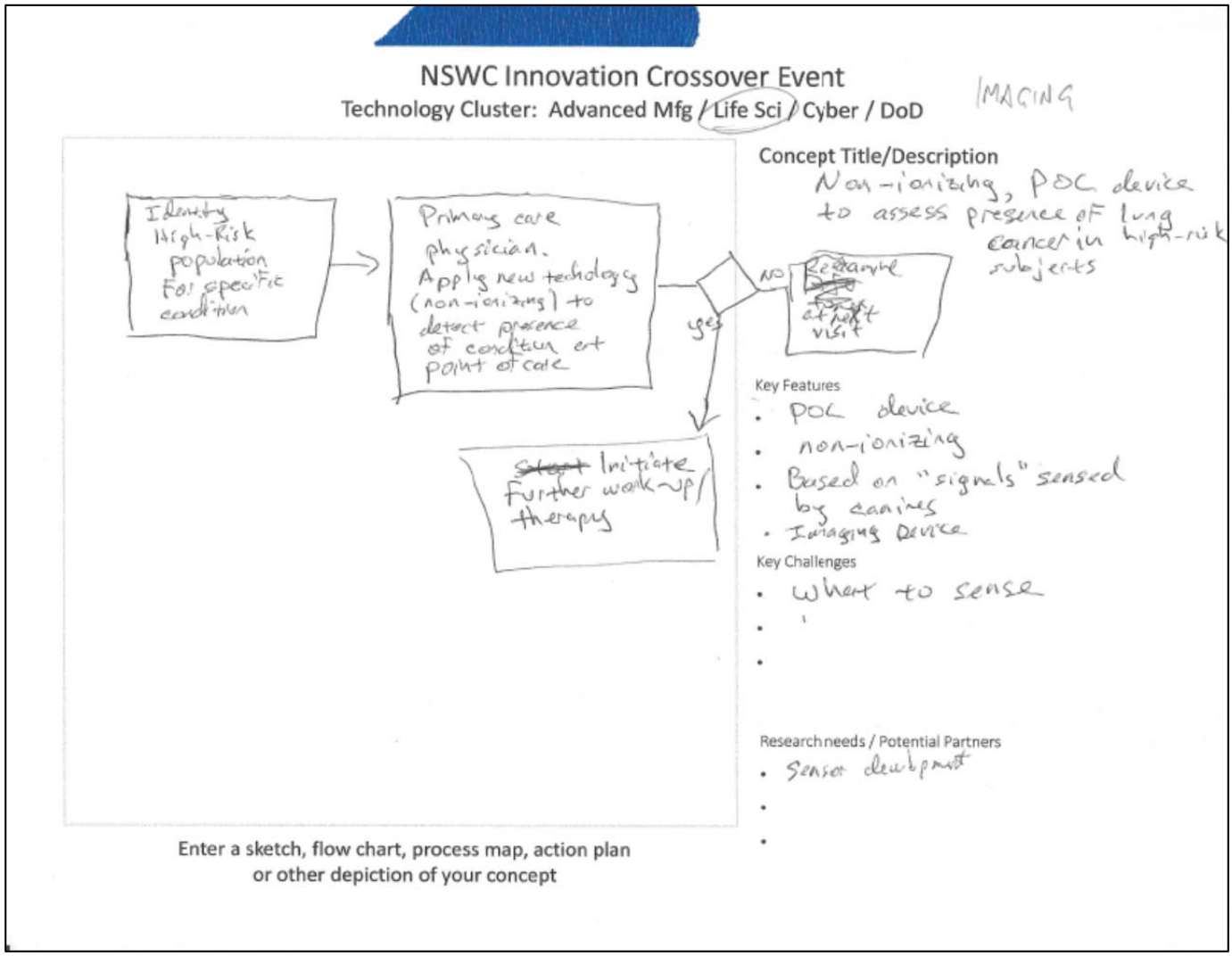
Research needs / Potential Partners

- Insurance companies
- Local hospital groups
-

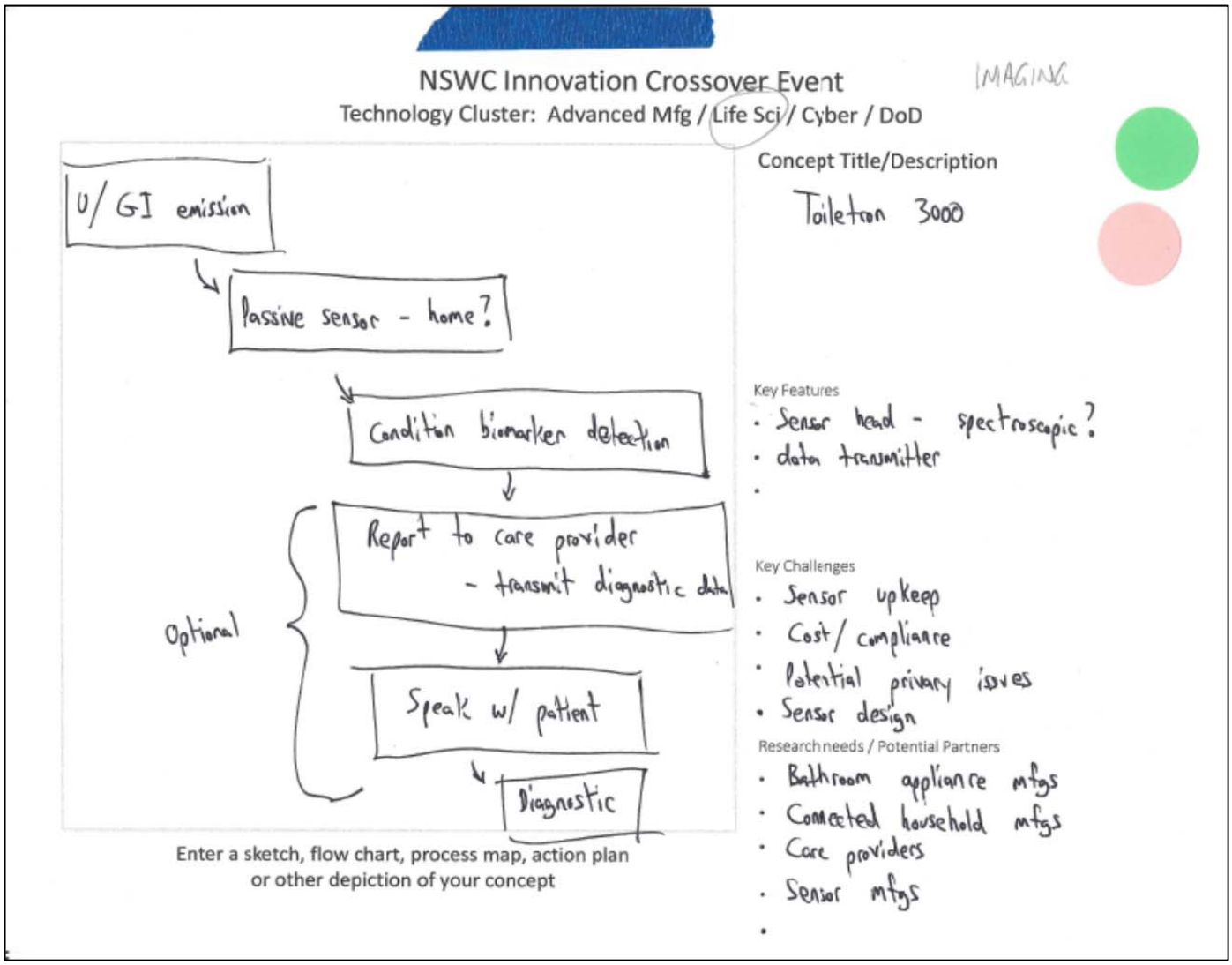
Imaging: Tricoder



Imaging: Non-ionizing point of care device to detect lung cancer



Imaging: Toiletron 3000



Appendix 5 – Innovation Crossover Press Release

Collaboration Leads to Promising Innovative Ideas from NSWC Crane Conference

Bloomington, Ind. (October 12, 2016) -- Naval Surface Warfare Center, Crane Division (NSWC Crane) hosted close to 300 professionals from defense, industry and academia for the "Innovation Crossover: The Shape of Things to Come" conference on Wednesday and Thursday at the Bloomington Convention Center.

Through collaboration and open and honest conversation, the attendees walked away from the event with innovative ideas to both combat mutual technological challenges and foster regional economic growth.

"We're very pleased with the level of support and enthusiasm around the technology clusters," said Kyle Werner, NSWC Crane Applied Science Department Director. "The level of ideation and engaged participation is a clear indicator that the region has real potential for crossover innovation across the technology clusters."

Participants heard prominent keynote speeches from Dr. Chris Fall, White House Office of Science and Technology Policy, Dr. Walter Jones, Office of Naval Research (ONR), and Ian Steff, Applied Research Institute.

“I had no idea of the gem that exists in this part of the United States,” Dr. Jones said of Indiana. “I had a blast. The best part was talking to all of these bright people. They are working on problems that are real and interesting. You seem to be having a great time at Crane, so keep up the good work.”

Dr. Jones said ONR recognizes the importance of collaboration with industry and university, so much so that ONR decides what to focus on based on the needs of others.

“I like to joke that we don’t do anything at ONR, we enable other people to do things,” Dr. Jones said. “Each side has to bend a little bit. What’s worked is a place that brings those sides together. If you have Crane as one of your partners, there won’t be an issue with keeping the government involved. It’s just a matter of bringing together the people and understanding each other’s needs. There are no secret ingredients.”

Dr. Fall centered his speech on the challenges of continued innovation in the areas of technology and economic growth, and how those challenges can be addressed through the collaboration of defense, industry and academia.

“I’m a policy guy. I think it’s important that we take small steps forward in understanding the policy and how it affects us,” Dr. Fall said. “Great on Crane for tech transfer. I think we could look at Crane as the model for tech transfer. You guys are way ahead in trying to tie this together. I think you have a great plan.”

Steff, the Chief Innovation Officer for the state of Indiana, applauded NSWC Crane for its focus on innovation and collaboration, calling the event "a significant milestone".

"This was perfectly timed to serve as another catalyst in the formation of the Applied Research Institute," Steff said. "It serves as a further linkage between ARI and NSWC Crane's Innovation Ecosystem, and it highlights Crane's use of progressive partnerships to develop and deliver innovative solutions.

“We are huge fans of NSWC Crane. I can’t tell you how proud we are to have them here. I couldn’t speak more highly of their leaders. It’s a great privilege to work with them.”

Participants also had the opportunity to both listen to and interact with two panels of experts, one from the industrial sector and one from the academic sector. Wednesday's panel featured Dr. Matt Waninger, Cook Medical, Mr. Eric Matteson, General Electric (GE), and Dr. John Matlik, Rolls Royce.

Thursday's academic panel featured Dr. Linda Bennett, President of the University of Southern Indiana, Mr. Dan Hasler, President of the Purdue Research Foundation, and Dr. Brad Wheeler, Indiana Unversity's vice president of IT and chief information officer.

“There aren’t too many states where people from three different universities can collaborate and work together,” Dr. Bennett said.

Dr. Bennett admitted that USI isn't a research institution, and isn't trying to be. Instead, the university takes a more pragmatic, hands-on approach, with the help of NSWC Crane.

“We’re a fairly new school, and we were created with economic development in mind,” she said. “To do that, we have to work across boundaries, bring people together across fields, and be able to reimagine the work you do every day. That can be challenging, but I think it was our partnership with Crane that helped us reimagine that.”

The event was designed to foster collaboration on mutual technology challenges and regional economic growth, as well as to spark a wave of entrepreneurialism and innovative companies across the region, and create tech-based economic development.

The regional strategy is aimed at fostering new growth and capitalizing on existing assets for the industry clusters in southern Indiana with the greatest potential for growth and advancement, including Department of Defense Technologies, Advanced Manufacturing, IT/Cyber and Life Sciences/Biomedical.

Those goals were accomplished at the Innovation Crossover event not only through the keynote speeches and industry panels, but also through breakout sessions focused on coming up with specific ideas for innovation in their respective clusters.

Werner said he plans to have a report on some of those ideas sometime in the near future. Werner also said there will be a discussion about having similar events periodically in the future.

NSWC Crane worked with Indiana University, Purdue University, University of Southern Indiana, Cook Medical, Indiana Office of Defense Development and Radius Indiana to put on the event.

Planning for the collaborative event began in 2014 after a report funded by Eli Lilly Endowment Inc. and the Battelle Technology Partnership Practice that identified four different technology clusters that could be explored and improved upon.

NSWC Crane is a naval laboratory and a field activity of Naval Sea Systems Command (NAVSEA) with focus areas in Expeditionary Warfare, Strategic Missions and Electronic Warfare. The warfare center is responsible for multi-domain, multi-spectral, full life cycle support of technologies and systems enhancing capability, all which provide a decisive advantage for our warfighters.

Appendix 6 – Innovation Crossover Event Blog

Innovation Crossover: Day One Blog

BLOOMINGTON, Ind. — NSWC Crane News is live from the inaugural "Innovation Crossover: The Shape of Things to Come" conference at the Bloomington Conference Center. Throughout the two-day event, there will be a number of experts in their respective fields as keynote speakers, and we will provide periodic updates on this page on the key issues discussed.

If you're attending the event or want to participate in the conversation on Twitter, use the hashtag #Innoxover2016 and follow @NAVSEACrane.

Dr. Chris Fall:

Wednesday's Innovation Crossover event began with a key note speech from Dr. Chris Fall, White House Office of Science and Technology Policy.

Dr. Fall centered his speech on the challenges of continued innovation in the areas of technology and economic growth, and how those challenges can be addressed through the collaboration of defense, industry and academia.

"I'm a policy guy. I think it's important that we take small steps forward in understanding the policy and how it affects us," Fall said. "Great on Crane for tech transfer. I think we could look at Crane as the model for tech transfer. You guys are way ahead in trying to tie this together. I think you have a great plan."

Dr. Chris Fall, White House Office of Science and Technology Policy, addresses the audience at the Innovation Crossover conference. (Oct. 11, 2016)

Highlights from SPARC Panel:

In a fast-moving, 75-minute session, the Innovation Crossover conference audience heard from a number of experts in a variety of fields from a variety of institutions.

Here are a couple of the highlights from those talks:

- **Dr. Ben Conley** of NSWC Crane gave an interesting speech about the development of new efficient lighting technology that helps Warfighters see significantly better in the dark.

The lights can not only be attached to the helmets of the fighters, but weapons and binoculars as well. Conley said the lights can last for a full 24 hours on a single AA battery, and they feature an extremely fast frame rate.

"It allows for our fighters to see when the adversaries cannot," Conley said. "We always want to have the upper hand. They're high speed. We can put these on Warfighters that are doing extremely fast tasks."

- **Dr. Jonathan Poggie** of Purdue University introduced the audience to the concept of hypersonic flight and argued its importance to the United States. Essentially, hypersonic flight uses an air-breathing engine through a concept Poggie called "Payload Fraction", which would significantly increase the efficiency of flight.

Poggie used a rocket ship as an example of an inefficient form of flight, and he said using an air-breathing engine could double the payload.

"Hypersonic testing is an extremely expensive endeavor, and by doing some of that work on a computer, we can speed up that process," Poggie said.

Poggie said Purdue is currently working on developing a new wind tunnel to test hypersonic flight and find a way to combat the extreme heating associated with flying so fast in the atmosphere.

- **Dr. Matt Gadlage** of NSWC Crane focused his presentation on the concept of trusted microelectronics and the challenges that the continued evolution of such electronics present.

Gadlage pointed out the fact that advanced electronics give warfighters a distinct advantage, but also warned about their potential dangers.

Defense electronics must be both trusted and reliable, Gadlage said, meaning they must have long lifetimes and be able to function in extreme environments.

"They need to do exactly what they're supposed to do, nothing more, nothing less," Gadlage said. "Your IPhone probably won't work in 20 years, but we have to design security programs that will last that long."

Innovation Crossover: Day Two Blog

BLOOMINGTON, Ind. — NSWC Crane News is back in Bloomington for the second and final day of the inaugural "Innovation Crossover: The Shape of Things to Come" conference at the Bloomington Convention Center.

We will update this blog throughout the day, highlighting the key points from the many scheduled speakers as well as the breakout sessions in the afternoon. You can also follow along with the event on Twitter by following @NAVSEACrane. We encourage you to participate in the conversation by using the hashtag #Innoxover2016.

Today's agenda begins with two Key Note speakers, Dr. Walter Jones, Office of Naval Research, and Ian Steff, Applied Research Institute.

Highlights from Dr. Walter Jones' Key Note

Dr. Walter Jones, Office of Naval Research, had never spent time in Indiana before this week's Innovation Crossover conference. He'd flown through Indianapolis on his way to Illinois on numerous occasions, but this two-day event opened his eyes to all that Indiana has to offer.

"I had no idea of the gem that exists in this part of the United States," Dr. Jones said. "I had a blast. The best part is talking to all of these bright people. They are working on problems that are real and interesting. You seem to be having a great time at Crane, so keep up the good work."

Dr. Walter Jones, Office of Naval Research, delivers his Key Note speech at the Innovation Crossover event. (October 12, 2016)

Dr. Jones' presentation gave the audience an in-depth look at exactly what the ONR does and how they spend their $2.1 billion each year. The majority of that money is delegated to research and trying to figure out what ideas are feasible and ready to move forward, and which ones are not.

"If you don't spend the time on the research, then the rest of it just doesn't happen," Dr. Jones said. "We don't just do research for the fun of it … though it is fun."

Dr. Jones said the ONR uses both basic and applied research to cast seeds far and wide to consider as many possible ideas and solutions as possible.

"If you don't do that, you'll be short-sided and won't have much of a future in science and technology," Dr. Jones said.

The ONR doesn't take a lot of risks in the initial research stage, but it has something it calls "Technology Pull" which is much riskier but also has the potential for a much higher payoff. Examples of such projects include railguns and lasers, which are especially innovative and intriguing to those in the industrial world.

Dr. Jones said the ONR recognizes the significance of collaboration with industry and university, so much so that the ONR decides what to focus on based on the needs of others.

At ONR, it's all about a process they call High Velocity Learning. The steps are simple: Experiment — Learn — Adjust — Deploy.

"I like to joke that we don't do anything at ONR, we enable other people to do things," Dr. Jones said. "Each side has to bend a little bit. What's worked is a place that brings those sides together. If you have Crane as one of your partners, there won't be an issue with keeping the government involved. It's just a

matter of bringing together the people and understanding each other's needs. There are no secret ingredients."

The growth of ideas — and the process of innovation — is accelerated at the ONR, Dr. Jones said, because he and his colleagues report directly to the Secretary of the Navy. He also encouraged the audience to attend the latest Naval Institute conference in Washington D.C. next July because all six program officers will be at the event and will be accessible to those in attendance.

"We have direct access to high-level people," Dr. Jones said. "It enables us to do more because we sit in the staff meetings every week. We can get your questions answered and your ideas heard.

The fun thing about working with places like Crane and universities is we get to dabble in all of it."

NSWC Crane's Kyle Werner (right) presents Dr. Walter Jones with an Indiana state plaque following his Key Note speech.

Highlights from Ian Steff's Key Note:

Dr. Jones was certainly a hard act to follow, but **Mr. Ian Steff** captured the audience's attention with his speech on the importance of the Innovative Crossover event and how it could help shape the next 10 years.

Steff, the Chief Innovation Officer for the state of Indiana, used the state's bicentennial celebration to look toward the future, asking the audience, "What might the next 100 years look like?"

Steff mentioned the progression of driverless cars and virtual reality, and the role Indiana can play in helping to lead that future innovation.

"Is Indiana going to lead that revolution that is offered to us? I think we will," Steff said. "In fact, I know we will because we have for the last 200 years. This [event] is a significant milestone. It highlights Crane's use of progressive partnerships. The development of the ideas and research ideas generated here will become focus areas in the future."

Like the other speakers from the event, Steff highlighted that working together is not only a good idea — it's essential for future prosperity.

"You really have to make these things relevant to industry," Steff said. "Ask them, 'Where do they want to go over the next 10 years?' If we're not focused on the challenges being addressed by industry, we will not be talking about the ARI (Applied Research Institute) in 10 years because it will become irrelevant.

"There's so much convergence in our industries. If we don't take advantage of that, we will have lost something in a big way. But fortunately, we are having those discussions."

Steff is an Indiana transplant, but he couldn't say enough good things about the state and the people that inhabit it.

"It is an exciting time to be here in Indiana. The research and talent that came from Indiana was second to none," Steff said. "That's what led to our global connection partnerships.

"We are huge fans of NSWC Crane. I can't tell you how proud we are to have them here. I couldn't speak more highly of their leaders. It's a great privilege to work with them."

Steff also took time to thank the Lilly Endowment, which provided the funding for this event and the research and development associated with it.

University Panel: IU, Purdue, and USI working together

It isn't often that you can get officials from Indiana University, Purdue University and the University of Southern Indiana together on one stage, but that's exactly what happened Thursday afternoon at the Innovation Crossover event.

Dr. Linda Bennett, USI President, **Mr. Dan Hasler**, President of the Purdue Research Foundation, and **Dr. Brad Wheeler**, IU's Vice President of IT, served on a 75-minute panel and had a productive and interesting conversation about innovation from the perspective of the academic world.

"There aren't too many states where people from three different universities can collaborate and work together," Dr. Bennett said.

On Wednesday, the audience heard from a panel of three experts from the industrial field, and both days of the conference featured keynote speeches from government officials.

The overarching goal of the event was to bring together those three worlds — government, industry, and academia — to find ways to work together and create new and innovative ideas, and turn those ideas into results.

Thursday's panel of university representatives tied that initiative together nicely. All three panelists were open and honest about the challenges their respective institutions have faced, and proposed ways to solve some of those challenges.

- Dr. Bennett (USI) pointed out the fact that every university across the country uses the word "innovation" somewhere in its mission statement.

"But how are you going to actually innovate, how are you going to make it real?," Dr. Bennett asked.

She wasn't just asking questions, though. Dr. Bennett provided her own answers. She admitted that USI isn't a research institution, and isn't trying to be. Instead, USI takes more of a pragmatic, hands-on approach, Dr. Bennett said.

"We're a fairly new school, and we were created with economic development in mind," she said. "To do that, we have to work across boundaries, bring people together across fields, and be able to reimagine the work you do every day. That can be challenging, but I think it was our partnership with Crane that helped us reimagine that."

- Mr. Hasler (Purdue) opened his presentation by laying out the step-by-step process by which things are invented. That is:

Money Comes In -> Research -> Invention -> Protection -> Actualization -> Social Impact -> Reward

Sounds simple enough, right? Well, no. In order for that process to flow quickly and productively, there has to be cooperation and collaboration with both the government and industrial sectors. Hasler believes that the more innovative minds collide, the more progress there will be. But he also pointed out that such collision is much more difficult in a place like Indiana than, say, Silicon Valley.

“It’s about creating that collision. It’s about just being there,” Hasler said. “It’s about artificially creating these opportunities for collisions to happen.

“I plead that this not be a one-time, feel-good thing. I want to come back here and do this for years to come.”

- Dr. Wheeler of Indiana University focused his presentation on CyberSecurity and the importance of educating the industrial sector on the issue. He noted that IU has five different collaborations with Crane, and most recently a collaboration on CyberSecurity.

“Stuff will happen,” Dr. Wheeler said simply, warning about the dangers of the cyber world.

Dr. Wheeler said too many people believe that collaboration is a difficult to accomplish and dread the thought of it. But collaboration really isn’t hard at all, he said.

“Personal connections are the beginning of collaboration,” Dr. Wheeler said. “We’ve got to get beyond the conversation of, ‘How do we go from first to second gear?’ We should be asking ourselves, ‘Why aren’t we in fourth gear? What’s holding us back?'”

Dr. Wheeler concluded the panel by discussing the significance of keeping students that attend college in Indiana in the state once they graduate. The panel agreed that too many talented graduates are departing for jobs elsewhere.

“We have to compete for them,” Dr. Wheeler said. “We are not disadvantaged to these other places, other than perception. We have to change that.”