

Breakout Session E-1: Resilience

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Lead issues (from questionnaire)

- Stress tests for resilient supply chain designs
- Post-COVID supply chains and supply chain resiliency
- Digital twins for resilient supply chain designs

Teaching Discussion

The group agreed that students need to gain the following skills:

- Define and measure resiliency,
- Consider resiliency in both design and operations,
- Evaluate alternative options for ensuring resiliency,
- Consider trade-offs when ensuring resiliency and evaluate the effects on important KPIs.

The ABET requirements for civil engineering now include resiliency: “The curriculum must include ... Application of ... principles of sustainability, risk, resilience, diversity, equity, and inclusion to civil engineering problems; support the inclusion of resiliency.”

Simulation is an effective tool for teaching resiliency.

Fabio and others have positive experiences with using AnyLogistix for teaching about supply chains and risk management:

AnyLogistix is provided by same company as AnyLogic.

Dimitry Ivanov has a very helpful text with examples. The text covers an introduction to AnyLogistix and provides examples on supply chains and resilience.

<https://www.anylogistix.com/%2Fresources%2Fbooks%2Falx-textbook%2Findex.php>

The group also discussed the difference in finding an optimal solution (a math perspective) versus a robust solution (an engineering perspective). They noted that the latter is quite often far more important in real situations and understanding the differences is an important concept for students to learn.

Research Discussion

The following types of research questions were discussed:

- When designing material handling and logistics solutions, how can we ensure both efficiency and resilience?

- Currently, we seem to only think about resiliency/sustainability in terms of trade-offs – cost-effective vs. resilient, efficient vs. resilient, etc. Can we change the entire premise from vs. to and.
 - When designing material handling and logistics solutions, how can we ensure both efficiency and resilience?
 - Similarly, how can we jointly evaluate cost, service level, time, and resiliency?
- How can digital twins (DTs) and simulation models support supply chain resiliency:
 - DTs and simulation models allow us to evaluate the effects of disruptions,
 - Designers and operators can learn from disruptions and evaluate extreme scenarios,
 - DTs and simulation models are useful for attracting students to the field of simulation and ISE and SCM.
- How can material be effectively tracked and traced through the supply chain? This is still an active area of research.
- What did we learn from COVID that can be applied moving forward?
- How can micro-supply chains be used for resiliency?
 - Micro supply chains are finite, decentralized, resilient, agile 'mini operating models', with flexible supplier contracts and relationships, and manufacturing closer to the point of purchase [KPMG definition]
- How can the use of additive manufacturing serve as a potential contributor for resiliency in SCs.

The discussion of optimal versus robust re-emerged in the research discussion as well.

Kash Barker has published interesting work on “Introduction to Resilience Analytics for Cyber-Physical-Social Networks.”

Ensuring an agile supply chain requires communication, information, and visibility to support coordination.

Important supply chain network decisions cross different organizations/entities, which often have different goals, rendering the supply chain network optimization problem extremely difficult.

Around the Room – What you heard, what you liked, what we missed?

Importance of integrating design thinking at the UG level; simulation and scenario-based teaching can contribute.

Importance of teaching cloud technologies and app development for UG.

I plan to use ideas from this session when teaching warehouse design SC management. I will integrate the software that Fabio mentioned.

The overall perspective of resilience is important for students (awareness).

I will strive to integrate resilience into our Introduction to ISE course.

Efficiency versus resilience – how can we ensure both in warehouse and SC design?

The sociotechnical system (STS) is important to consider when designing and when evaluating risk.

Is there a roadmap this community could develop for integrating resiliency in the curriculum, such that students advance from becoming aware, to explaining, to applying?

The connection between simulation models and evaluating resilience is tangible and attractive.

Complexity increases with human involvement and decentralized nature of supply chains. How do we design, evaluate, and operate them under the conditions?

We often discuss disruption in negative terms, but disruptions can be negative or an opportunity.

In an UG systems engineering course, important design concepts and design characteristics (such as resilience, sustainability, economical, etc.) can be integrated.

An article was shared that noted the 10 most resilient countries according to the FM Global Resilience Index. <https://www.industryweek.com/the-economy/media-gallery/21267975/top-10-most-resilient-countries>

Potential Funding Mechanism:

NSF has a Dear Colleague Letter related to Next Generation Supply Chains

<https://new.nsf.gov/funding/opportunities/next-generation-supply-chains>