



Course Learning Outcomes for Unit III

Upon completion of this unit, students should be able to:

3. Evaluate new approaches to safety based on modern systems thinking and theory.
 - 3.1 Demonstrate an understanding of the Systems-Theoretic view of causality.
 - 3.2 Demonstrate a working knowledge of the STAMP model of accident causation.

Reading Assignment

Chapter 6: Engineering and Operating Safer Systems Using STAMP

Chapter 7: Fundamentals

Unit Lesson

In the first two units, we learned about Deming's (1986) engineering design for continuous improvement (Plan-Do-Check-Act or PDCA cycle), and we learned about our role as scholar-practitioners of safety engineering being firmly rooted as decision management scientists. Further, we were introduced to Leveson's (2011) STAMP (Systems-Theoretic Accident Model and Process) causality model, synthesized from traditional safety engineering models of accident causation, and reengineered to a systems perspective.

In this unit, we are revisiting the STAMP model while learning to apply and deploy the STAMP in various other applications related to a wide cross-section of industry sectors. One critical aspect of Leveson's (2011) STAMP model design is the careful incorporation of three major components of a cost-effective system safety process. These include the subsystems of management, development, and operations within the larger system. As such, this design effectively incorporates the most powerful design features known to optimize the decision-making process, given that the STAMP model works to align and subsequently address processes. It can then be used to identify controls with a clear, linear perspective of systems component criteria interrelationships (see Figure 6.1). This means that as scholar-practitioners of safety engineering and decision science, we must become proficient practitioners in the fields of engineering management, engineering development, and operations engineering. In order to accomplish this level of proficiency, we must learn to utilize and operate the most eloquent design tools available to industry engineers. Fortunately, Leveson (2011) has incorporated several of the most effective tools into her STAMP model for us to use as engineering and operations tools for highly sophisticated and complex work systems.

First, as Leveson (2011, p. 177) reminds us that safety starts with management, we must first closely evaluate and measure the aspects of management: leadership and commitment. Viewing management as a component of the system safety process necessarily demands that one closely consider the role of industrialization within society. Herbert Blumer (1990), a noted contemporary theorist of industrialization, sought to analyze the role of industrialization as a cause of social change. What Blumer (1990) did for our field of study was to make it clear that understanding the interaction of machines with humans (an informal summary of his definition for industrialization) was one of the most critical aspects of understanding the subsequent causal relationships among various industry activities and societal change. Further, Blumer (1990) stressed that while the industrial processes introduce situations to a traditional group life order, the actual process can neither explain nor predict how societies will act or react. This is because ultimately industry is controlled by human decisions. Consequently, it can be effectively argued that poor human

decisions at the management level can create poor societal outcomes (such as workplace hazards or environmental pollution). As such, careful analysis of the decision-making process within a system safety process must begin with executive management commitment to human and environmental safety and effective leadership in managing the system (Leveson, 2011).

After we address management aspects, developing a system safety process then becomes an academic exercise of linear thinking with applied decision-making opportunities embedded within the process system. Leveson (2011) explains that this engineering development subsystem is initiated first by defining a clear goal for the system. Next, potential hazards are identified, and then constraints and controls are designed into the system in order to mitigate potential hazards (Leveson, 2011).

This type of linear designing was first introduced to our field by Robert Cooper (1999), terming the design technique the *stage gate process*. The stage gate process affords the design engineer the opportunity to lay out the pathway from the management team's commitment to a given outcome, all the way to the organization's product (service product or manufactured product) while providing gates at critical decision points within the process. Cooper (1999) and others subsequently reported improved quality of execution, sharper focus and better prioritization, fast-paced parallel processing, and the utilization of true cross-functional teams, among the benefits of the resulting system design (Yoshimura, Izu, & Fujimi, 2003). The STAMP model (Leveson, 2011) accommodates for this type of gating within the process with gates at critical decision-making points within the process.

Finally, we consider the operations subsystem within the system safety process. Once the system is built, it must also be safely operated (Leveson, 2011). This is the point where Deming's (1986) PDCA cycle really comes into focus in our theoretical design process. We must learn to identify the planned risks during the engineering development phase of the process and do what we can to engineer around the risks with gated decisions to better alternatives to worker decisions. We must then check (measure) the effectiveness of the gate and alternative outcomes to the worker and the environment, and act upon our collected data of observations to make further improvements (better decision gate alternatives) for workers within the work system. This is systems engineering at its best! This type of prescriptive decision making is inherent in the STAMP model. Leveson (2011) provides for safety design constraints aligned against predetermined and forecasted hazards of the work system.

A quick look ahead into the Unit V Required reading at Figure 7.1 illustrates the incorporation of these design tool aspects using a train door and its related hazards.

Now take a moment to turn to the demonstration on page 500 of the same technique with a scenario of a bacterial contamination of a public water supply. The technique is the same, but more complex, given the abundance of independent variables causally related to the two system safety constraints identified for a single system hazard. Notice how the system hazard (public being exposed to bacteria) informs the system safety constraints (water quality not to be compromised; public health measures to reduce exposure to contaminated water), leading to the individual decision gates within the model. For example, before the water wells are utilized to charge the water system, the decision gate is the selection of the wells based upon some criteria (presumably mineral concentration, chlorine residual measurement, and aquifer production strength). As such, the model affords three wells to select from for a single gated decision leading to supplying the water system with water.

As we discussed at length in our last unit, our role in the comprehensive safety management of humans and the environment rests upon our ability to make decisions. Rather than trust our own decision-making abilities, we rely upon models demonstrating statistical validity and reliability, such as the STAMP model, to help us with this critical task. Get ready to dive into Leveson's (2011) work and learn to use the textbook as a template for designing safe work systems with sophisticated decision-making gates and constraints. With this unit we are moving from theory to application, looking forward to your ultimate creation of an Operations Safety Management Plan for a specific industry in Unit VIII of this course.

Let's get started engineering with the STAMP model!

References

- Blumer, H. (1990). *Industrialization as an agent of social change: A critical analysis*. New York, NY: de Gruyter.
- Cooper, R. G. (1999). *Product leadership: Creating and launching superior new products*. New York, NY: Perseus.
- Deming, W. E. (1986). *Out of crisis*. Cambridge, MA: Massachusetts Institute of Technology.
- Leveson, N. G. (2011). *Engineering a safer world: Systems thinking applied to safety*. Cambridge, MA: Massachusetts Institute of Technology.
- Yoshimura, M., Izui, K., & Fujimi, Y. (2003). Optimizing the decision-making process for larger-scale design problems according to criteria interrelationships. *International Journal of Production Research*, 41(9), 1987-2002.

Suggested Reading

- Broum, T., Kopecky, M., & Kleinova, J. (2011). Enhancement of stage-gate process by value analysis. *Annals of DAAAM & Proceedings* 22(1), 755-756.

In order to access the resource above, you must first log into the myCSU Student Portal and access the Academic Search Complete database within the CSU Online Library.

Learning Activities (Non-Graded)

Conceptual Model Development

Consider one of your own, smaller work systems (such as driving a vehicle to the local grocery store). First, map out the entire process of getting out of your home, into your car, to the grocery store, into the grocery store, and all the way back home. Do not leave out any steps. Second, identify the system hazards. Third, list the system safety constraints. Fourth, engineer in gated decision-making points with controls.

Feel free to present your conceptual model to others in the Student Break Room. If you are experiencing any issues, be sure to email your professor for guidance on the development of this model.

Conceptual Model Analysis

Browse the CSU Online Library databases for a topic that interests you. Look specifically for a scholarly article that presents work system conceptual model using stage gate analysis. Closely read the article and critically evaluate the model. Develop at least five improvements to the model, given your current understanding of the topic.

Non-graded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.