Northeastern University
College of Engineering

Weekly STEM Newsletter 8 (May 8 - May 15, 2020)

Industrial Engineering

Introduction

When you order at a fast food restaurant, contact customer service representatives, or order products to be shipped straight to your door, it is easy to forget the complexity of the systems that allow this to happen. For example, if you want to order a copy of your favorite book from an online retailer, you simply open your computer, go to the website, enter your credit card information and address, and then click “buy.” A few days later, the book shows up on your front doorstep. What seems so simple nowadays is actually an incredibly complex task with numerous working parts that must be repeated perfectly every time someone orders a product. From accepting the payment from the buyer, to locating warehouses that have the book in stock, to routing the package to its final destination on a delivery truck, a number of complex systems must be designed to ensure the buyer receives the book quickly and at a low cost. The engineers that design how systems like these work are called industrial engineers.

The Institute of Industrial and Systems Engineers (IISE) gives the following definition of Industrial engineering:

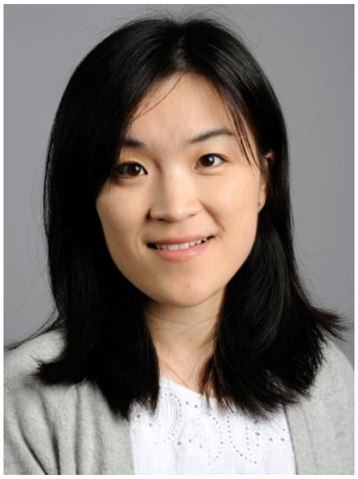
> “Industrial and systems engineering is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems.”

Essentially, industrial engineers work to design better, more efficient systems. This week’s newsletter will explore this field of engineering and introduce activities and resources related to the topic.

Watch this video to learn more about industrial engineering!

Northeastern Connections

Faculty Connection



At Northeastern, a group of mechanical and industrial engineering professors was created with the goal of researching resilient systems. Resilient systems are defined as "those which are designed to operate such that the entire system is equipped to respond effectively and recover quickly from disruptive events." In essence, resilient systems are systems that will not fail if one or more of their parts are disrupted. Professor Xiaoning Jin is a researcher affiliated with this group. Professor Jin heads the predictive informatics lab which works on creating resilience in healthcare systems and manufacturing.

Student Connection

Senior industrial engineering students at Northeastern complete an engineering capstone course before graduating. For this course, students work in teams to design and create solutions to real-world projects. In 2016, Center for STEM Education work-study and industrial engineering student Phoebe Patwell (second from right) and a group of her peers worked to optimize the Center for STEM Education's application process for its summer programs. They created an easy-to-use, efficient online application process to replace what was previously done on paper. In the end, their project worked great and helped save the Center time and money!

In addition to coursework, students can get involved in a number of student organizations related to industrial engineering. The Northeastern student chapter of the Institute of Industrial and Systems Engineers (NU IISE) promotes professional and academic development and helps students network with industry professionals. Additionally, the Northeastern chapter of Alpha Pi Mu, the national industrial engineering honor society, is an organization that recognizes industrial engineering students who have exhibited academic excellence.

Do Now

Legoman Assembly Activity

This activity requires two teams, with a minimum of 1 person per team. Each team will be assigned a specific role to complete, with teams swapping roles midway through. One team will be designated the “design team” (DT) whilst the other team will be designated the “replication team” (RT). The DT will be building a LEGO “person” [from now on, called legoman] using a pre-defined kit and the RT will need to re-build the design without seeing it. The DT will have to effectively communicate to the RT how to re-build their design, as accurately as possible, without the use of technology (such as a camera) to capture their initial design. The DT team will only be able to communicate in writing (no verbal instructions): through hand drawings and/or written instructions. The only thing the RT knows is what lego pieces the DT started with. The design team is emulating the real life challenge of building a design through the use of "engineering drawings" , "pictures", and Standard Operating Procedures (SOPs).

Instructions:

Step 1: **Pre-Defined Kit Assembly**

As a group (all teams’ members included): Build your “assembly” kit. This kit should have multiple sets of lego body parts: multiple heads, multiple torsos (including arms), multiple hands, multiple legs (see left picture). In addition, the kit should include multiple sets of accessories (see right picture): multiple head-gear, multiple neck-gear, and multiple hand-held accessories. The kit should have at least two of each part and at most five.

Step 2: DT Builds their Legoman

In this step, the design team should spend at most 5 minutes making their legoman. You may only use the pieces in the kit you assembled in Step 1 and the legoman must have at least one accessory.

Step 3: DT Makes Communications Plan

In this step, the design team should come up with and finalize their plan for how they will communicate their design to the other team (20 minutes). Remember, these are instructions for how to build the legoman and should be as detailed and as specific as possible. However, think about

LEGO instruction manuals: the instructions don't show every single piece being added: that would be very time- (and ink-) consuming. Feel free to write out instructions step by step and include hand-drawn images, but no use of digital technology (such as videotaping or sharing a camera picture).

Step 4: DT Documents their Design

When the DT has built their legoman and created communications plans, remember what the figure looks like, and if possible, take a picture of the final design, preferably from different angles (front, back, top, side). Afterwards, fully take apart your legoman and return all the pieces you used to the kit (as the RT will need them for their build). The pictures taken in this step are not to be shared with the RT - they are only to be used when comparing the RT's final design to the initial DT's design (step 6).

Step 5: RT Replicates the Initial Design

Using only the written instructions provided by the design team, the replication team has 10 minutes to build the design as accurately as possible, staying faithful to the instructions they were given. The design team may watch the process, but may not say or indicate anything related to the design or building process.

Step 6: Compare Designs

Using the pictures you took in step 4 (or based on memory if you did not take any pictures), compare the two designs (similarities and differences). How accurate was the RT's design? What misunderstandings were there? Why? How could the design team improve their instructions?

Step 7: Swap Roles

Take apart the RT's replicated design and return all pieces to the kit. Then, swap roles (i.e. the RT becomes the DT and the DT becomes the RT). Repeat steps 2-6, this time in your new roles.

Step 8: Discussion

What role did you prefer (making the design or replicating the design)? Why? What was difficult about communicating your design (and why)? What was difficult about duplicating the design (and why)?

Activity

Industrial engineering is all about optimization: making something more efficient (i.e. using less resources). Industrial engineers work in a wide variety of fields. For today's activity we will be working in the architecture field: optimizing the layout of a kitchen, i.e. re-arraigning the kitchen to minimize the distance you must move around the kitchen when baking cookies. We will be learning about and using an "Activity Relationship Diagram," which is a

tool Industrial Engineers use to visually represent the importance of relationships between the different parts of a given layout.
The activity handout can be found here. The instructions are included in the handout, but you will also need the kitchen features handout (found here). We suggest you print both handouts and do the activity by hand (as you will be drawing and re-arraigning pictures), but you can also do so online - by drawing lines on the Activity Relationship Diagram and re-arraigning the pictures within a text editor. Note: the Oven has just one "dark edge": the front. Good luck!

Discussion Questions:

1. How many steps (what total distance) were you able to reduce the kitchen layout/baking process to? What are some things you noticed during this activity regarding this optimization process?
2. What was the most difficult part of re-arriagning the kitchen layout? The steps in the baking process?
3. Come up with another example where an Activity Relationship Diagram might be useful to determine ways that process or activity can be optimized. Think about things you see or do frequently.

Share Your Results

We'd love to know how the activity and/or the "do now" turned out! What worked and what didn't work? Please share with us something you learned and/or send us pictures of your Legoman drawings or your Kitchen layouts! How many steps moved were you able to reduce the kitchen layout down to in both steps? Email us at stem@northeastern.edu.

Related links/Extensions

- In-Depth Description of Industrial Engineering
- IISE: Industrial Engineering's Professional Society
- How LEGOs are made
- Making your own digital LEGO instructions
- How Amazon Delivers on One-Day Shipping
- Behind the Scenes of a brand new McDonalds
- Video Games on Industrial Engineering:
  - Production Line
  - Big Pharma
  - Factorio
  - Capitalism Lab