

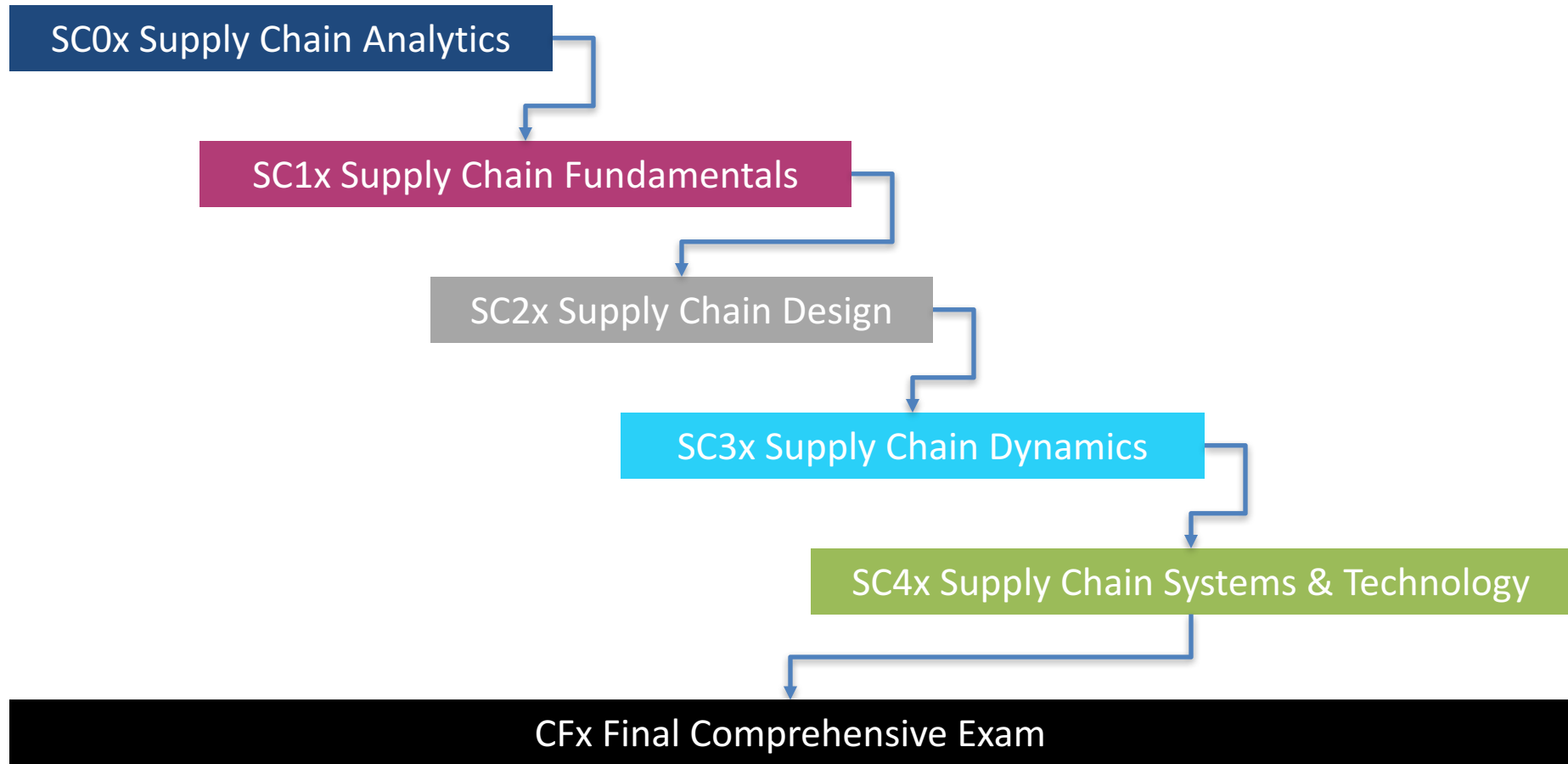
# Technology Trends & Potential Impact



**MIT** Center for  
Transportation & Logistics

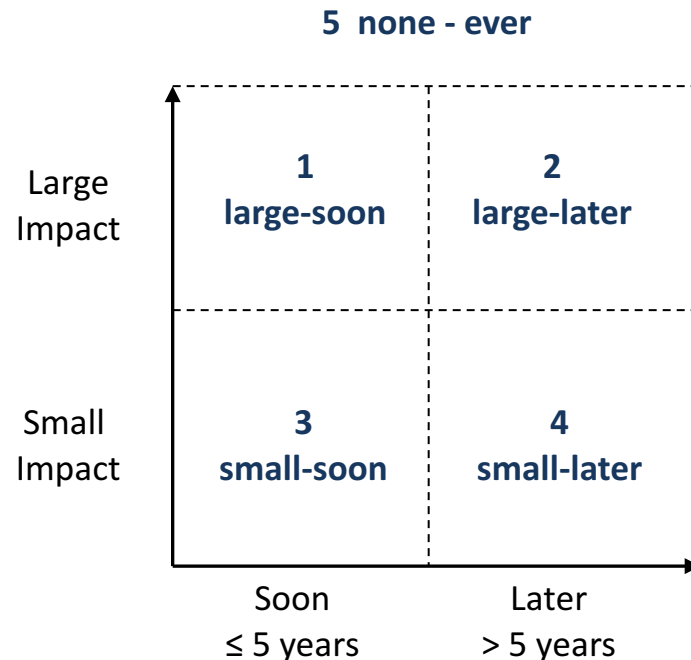
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# Technology Trends & Impact

- Game Plan for Lesson
  - Introduce and Provide Background
  - Quick Poll (Impact vs. Timing)
  - Discussion of Direct & Indirect Effects



# Autonomous Trucks

# Trend: Autonomous Trucks & Vehicles

- What is it?
  - Trucks and other vehicles that can operate with minimal (or no) human interaction.
  - Established Levels of Automation
    - No Automation (Level 0)
    - Function-Specific Automation (Level 1)
    - Combined-Function Automation (Level 2)
    - Limited Self-Driving Automation (Level 3)
    - Full Self-Driving Automation (Level 4)
- What is status today?
  - Autonomous Delivery Already Happened
    - First paid autonomous delivery occurred in Colorado in October 2016.
    - Otto delivered full TL of beer
  - Major investments in technology
    - Uber acquired Otto in 2016 for \$680M
    - Intel acquired Mobileye in 2017 for \$15B



- Where can it be used?
  - Linehaul Corridors
  - Local delivery
  - Intra-Yard

# Trend: Autonomous Trucks

## ■ Direct Impact:

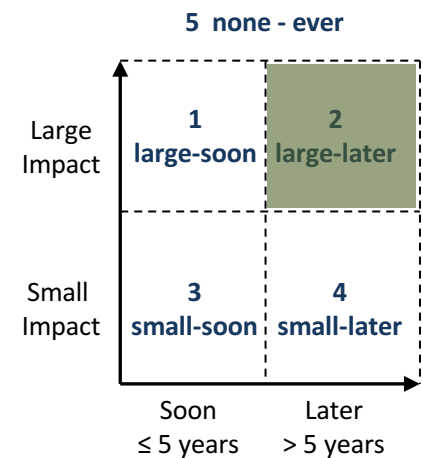
- Single day range of trucks could double (~1000 miles)
- Lower fuel costs due to lower speeds
- Ubiquity of truckload is combined with low cost of intermodal (truck-rail)

## ■ Analysis Approach

- Network modeling with new transport characteristics
- Trucking industry strategy (Porters 5 Forces Model)

## ■ Potential Longer Term Indirect Impacts

- Reduction in number of distribution centers and thus lower overall inventory levels
- Concentrated corridor traffic with terminals for local driving for last mile
- Dissolution of TL carriers to independent driving entities
- Large job loss in long-haul trucking



# Delivery Drones

# Trend: Delivery Drones

- What is it?
  - An unmanned aircraft that can navigate autonomously, without direct human control or is guided remotely.
  - Initially used in military operations in 2000
  - Commercial use now common in filming, disaster management, search & rescue, geographic mapping, precision agriculture, wildlife monitoring, etc.
- What is status today?
  - Drone Deliveries Have Already Happened
    - On Dec. 7 2016, Amazon Prime delivered an Amazon Fire TV and a bag of popcorn by drone to a man near Cambridge, UK.
    - Flirtey and 7-Eleven delivered a chicken sandwich, donuts, candy, Slurpees and hot coffee via drone in July 2016 in Reno NV.
  - Countries have varied restrictions



December 2016 Connect Robotics delivered food for an old men in the mountains of Portugal.

- Commercial Drones
  - Market size ~\$550M in 2014 and forecast to \$1B in 5 years
  - Sales grew >200% last 2 years with > 2.5M in use in US



# Trend: Delivery Drones

## ■ Direct Impact:

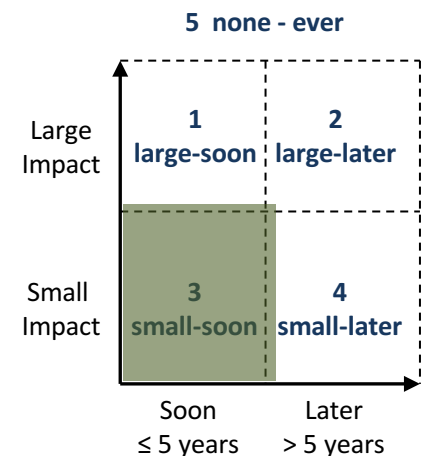
- Able to send small loads to remote locations quickly
- Expands delivery capabilities using “open air” without using existing infrastructure
- Essentially a new transportation mode for very fast replenishment of very small shipment size over a close distance.

## ■ Analysis Approach

- Network modeling with new transport characteristics
- Demand planning – new service offering

## ■ Potential Longer Term Indirect Impacts

- Amazon was awarded a patent for an "airborne fulfillment center" which essentially is blimp with a fleet of drones for delivery.
- Will complement (but not replace) existing last mile delivery techniques – will find a niche with most delivery companies
- Provide ultra-fast replenishment for high end items

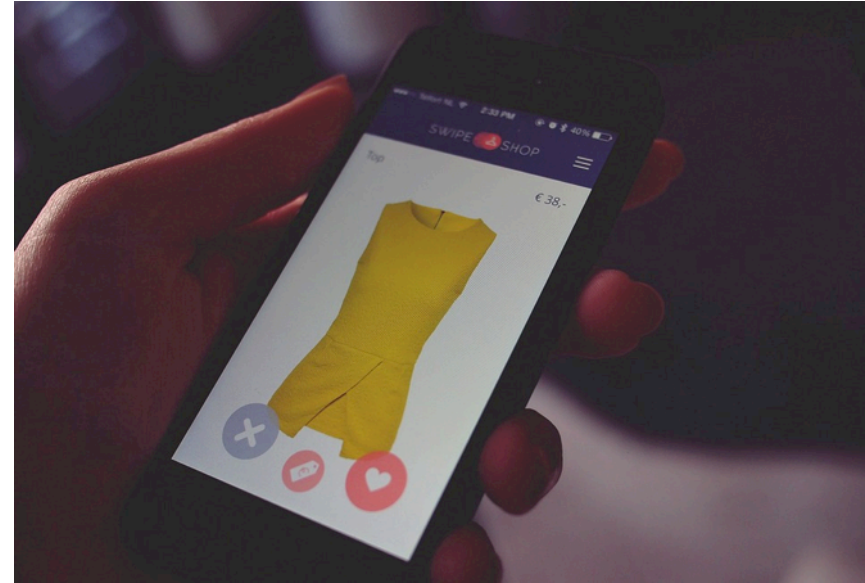


# Mobile Computing

# Trend: Mobile Computing

- What is it?

- Technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.



- What is status today (2016)?

- Mobile data traffic has grown 18-fold over the past 5 years
- 8 billion mobile devices (325 million wearable devices) currently in use
- Average smartphone usage grew 38% in 2016 with the Middle East and Africa showing 65% CAGR in mobile data traffic growth (most anywhere!)
- Smartphones are used as phones less than 3% of the time
- Online shopping behavior differs by platform: laptops & tablets vs. smartphones

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<http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html>

# Trend: Mobile Computing

## ■ Direct Impact:

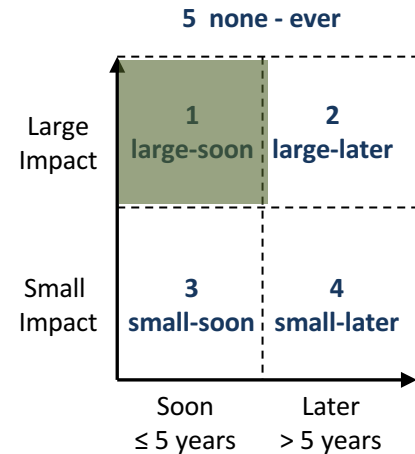
- Able to access data and systems from anywhere
- Enables new paradigms of shopping and thus retail supply chains (omnichannel)

## ■ Analysis Approach

- Demand planning models – impact of location and signals for better forecasting
- Inventory modeling – changing stocking points and functions
- Transportation modeling – delivery for more diverse locations
- Warehousing – changing the function of facilities

## ■ Potential Longer Term Indirect Impacts

- Transformation of retail shopping industry and experience
- Complete shift to Cloud computing for enterprise and other applications
- Decentralize operations for many processes



# Additive Manufacturing

# Trend: Additive Manufacturing

- What is it?
  - The process of making a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession.
- What is status today (2016)?
  - Additive manufacturing industry grew 26% CAGR in 2016 to \$5.16B
  - Many different methods and materials
    - Material Extrusion, Material Jetting, Binder Jetting, Vat Photopolymerization, Sheet Lamination, Power Bed Fusion, Directed Energy Deposition
    - Polymers, Composites, Metals, Ceramics, Sand Molds & Cores, Paper
  - Expanded beyond hobby and prototyping uses
  - GE acquired Sweden-based Arcam and Germany-based SLM Solutions (leaders in metal 3D printing) for \$1.4B in 2016



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# Trend: Additive Manufacturing

## ■ Direct Impact:

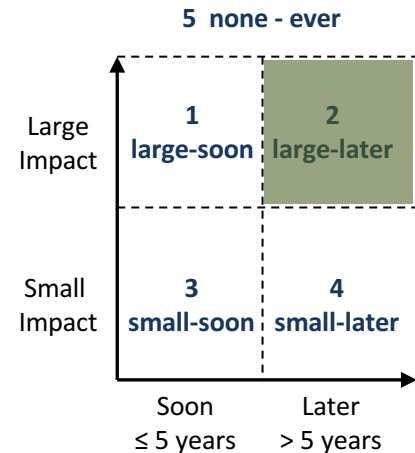
- Can create unique or customized runs of one
- Complement existing manufacturing processes
- Able to manufacture 24x7

## ■ Analysis Approach

- Sourcing – shifting in supplier base and size
- Manufacturing and Production Planning
- New product planning – faster introductions

## ■ Potential Longer Term Indirect Impacts

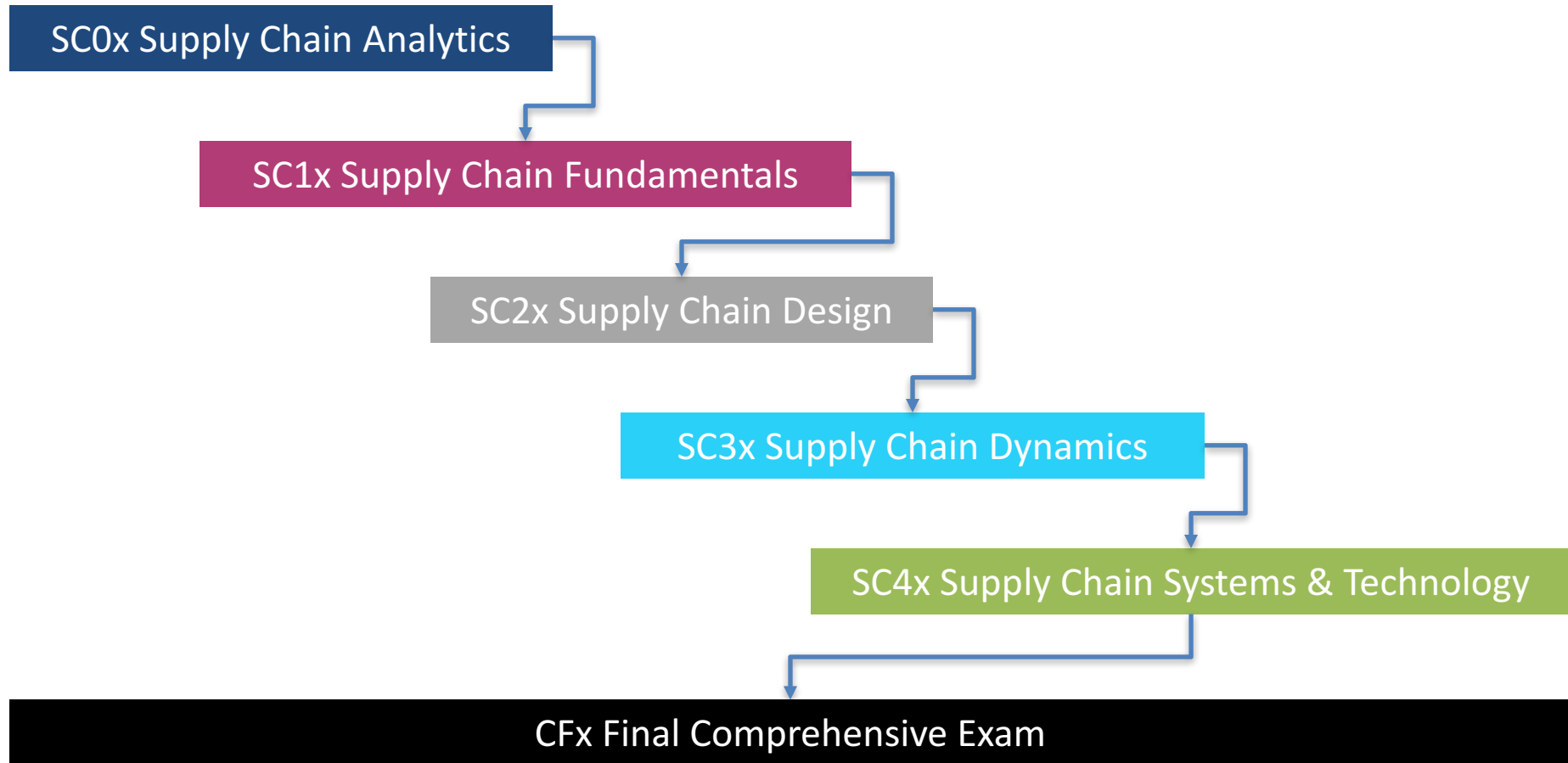
- Replacing manufacturing of individual components of a complex system to manufacturing the system whole
- Reduce number of component suppliers to OEMs to raw materials
- Shorten the supply chain by removing component manufacturing
- Transformation of technical machining skill workforce



# Final Course Note



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# Questions, Comments, Suggestions?

## Use the Discussion Forum!



“Dexter – showing his excitement over you finishing the entire five SCx courses!”



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