IBE505 Industrial digital transformation
13.05.2022
Candidate # 19

1) UPS supply chain management company – fast delivery and real-time tracking

a) Solution to improve customer/stakeholder experience and operational efficiency:

In the curriculum book "Industrial Digital Transformation" (Nath, Dunkin, Chowdhary, Patel, pg. 69), it is stated that UPS already employs a solution using digital technologies like IoT and AI called On-Road Integrated Optimization Navigation which is a routing software system that cuts down on driving time and distance – resulting in faster deliveries, less resource usage and pollution. It can then be assumed that UPS already has a solution to optimize delivery routing that accounts for available roads and traffic patterns, so we should look elsewhere for a new proposal.

We can add Global Navigation Satellite System (GNSS) cellular-based sensor gateways (alternatively GPS) on UPS vehicles that can track vehicle/cargo location, in addition to IoT sensors to measure fuel consumption and vehicle component condition for predictive or condition-based vehicle maintenance. RFID tags can be added to passages, and scanners added to UPS vehicles' back access so that the status of individual packages are updated to an online database the moment they are loaded to the vehicle, cutting down on time spent manually scanning barcodes for each package as they are loaded to the vehicle.
A more ambitious proposal is to add more automation and robotics to the UPS loading facilities, with conveyor belts and loader arms automatically loading packages onto self-driving vessels, dimensions and weight scanned by camera/distance sensors and weights to adjust loading arms accordingly. Camera sensors, gas sensors and heat sensors can also recognize tags, stickers and indicator patterns for chemical/biological, volatile/fragile and/or magnetic material to be separate for manual processing.
By employing big data and machine learning, routes and distribution of packages per driver/vehicle can be dynamically determined based on vehicle capacity and traffic patterns, producing plan alternatives to be approved by a facility supervisor. The order packages are loaded onto each vehicle would be inverse with the route order, making the next package easily available to the driver for delivery.

b) Emerging technology to implement this solution:

To implement these proposals, we would need emerging technologies like GPS, IoT (technologies connecting elements through a distributed network architecture, collecting data through sensors acting like digitized five senses, and processing/analyzing said data), automation, robotics (material handling, palletizing, AMRs to move pieces between transfer points), big data and analytics (analyzing and extracting usable information from large datasets, predictive analysis), machine learning (detecting, classifying, decision making based on training data).

c) Role as Chief Innovation Officer within UPS:

A Chief Innovation Officer is tasked with identifying new opportunities within their organization to deliver digital services to their community and/or customer base, and will usually report directly to upper level staff.
It should not be confused with a Chief Information Officer, which is generally the initiator and leader of most digital transformation efforts. The innovation officer will often take on projects outside the information officer's portfolio.

d) How to bridge skill gaps within business to implement transformation solution:

Skill gaps can be bridged by finding future requirements and educating staff in accordance with these, crowd-sourcing and hackathon teams can be formed to build prototypes using new technologies, often by pairing IT and business employees. Develop a culture of learning from failure, taking calculated risks, and being less risk-averse.

The business should form and fund in-house training classes (languages and libraries, methodologies and frameworks), cross-training between long-term and new employees, off-site training (certifications), and degree programs (investing in existing staff on-campus and online).

e) Sustainable Development Goals that would be positively impacted and how:

Goal 8 – Decent work and economic growth (more efficient schedule for employed drivers, better working conditions for distributors, new work positions to develop and maintain digitized solutions, competitive advantage, lesser use of resources)
Goal 9 – Industry, innovation and infrastructure (Prototypes and MVPs for proposed solution built in specific locations for customer and worker feedback, promoting innovation and improved infrastructure)
Goal 11-13 – Sustainable cities and communities (more environmentally friendly, can work in collaboration with smart city design and systems)

2) COVID-19 pandemic – remote learning, limited lab access, suspicious activity

a) Digital solution proposal for collaborative lab experiences from home:

AR/VR software systems running on a server would allow students to collaborate on lab experiments in a virtual environment, working and interacting with seemingly physical objects in a virtual space. Alternatively, a digital twin of physical objects on campus labs could have its settings modified in real-time by students working at home, or for a more ambitious technical proposal, CAD model schematics could be provided to students to shape a physical object by 3D printing for further work outside of school campus. Labs could also be equipped with cameras and robotics systems that students can gain authorized access to by logging into the system with student credentials and manipulate the robotics system through software installed at home.

b) Solution proposal for monitoring home exam activity with real-time feedback:

This seems like a difficult issue to provide a solution to, provided the regulatory framework educational institutions must follow and the students' rights to privacy. One solution could be that students can only access the home exam platform through a private VPN that limits access to communication services and unauthorized websites. Sensors/software tracking movement, nearby communication devices, web browsing history, open applications, keyboard/mouse loggers all seem to be violations of privacy that could not be realistically proposed as a solution.

c) Emerging technologies to implement these solutions:

Based on the proposed solutions above, we would develop AR/VR software with a library of objects, environments and user interactions with server connection that would allow educators to design a diverse set of lab experiments that can be distributed and experienced by student groups collaboratively. Digital twins of physical objects or digital representations of physical systems can also be developed to be manipulated and controlled in real-time by students.

If the school has already developed a remote connection system for computers running on the campus network, this could be engineered through server-client software to develop a private network for home exams to be performed and worked on by students within a specific time frame and with limited access to other resources. While this does not specifically require to be executed by an emerging technology, this could be designed by cloud computing or the connectivity side of IoT.

d) Challenges that could impact online learning:

Students not having access to equipment like cameras and microphones will make communication between students and educators more difficult, ending up in clarifying questions not being asked during class. There are unique challenges to designing course labs for a digital environment, as there are limited means of communication and collaboration for groups of students. Courses will most likely not schedule practical excursions to businesses for more practical examples of theoretical frameworks explained in previous classes.
If the educator/teacher has chosen an agile framework for designing teaching methods and classes, they may find it more difficult to gather student feedback to develop and improve the MVP solution further to meet the needs and wants of students.

e) Sustainable Development Goals that would be positively impacted and how:

Goal 4 – Quality education (improved methods for teaching students and giving them venues for practical experience off-campus)
Goal 9 – Industry, innovation and infrastructure (development of innovative solutions within educational discipline, could be distributed to other institutions)
Goal 10 – Reduced inequality (more accessible teaching methods for students with disabilities or chronic health conditions)
Goal 16 – Peace and justice; strong institutions (More equality in execution of home final exams, attempts to prevent cheating)

3) Healthcare providers – evaluate patient needs, staffing shortages in hospitals

a) Digital transformation strategy to lower operating costs and enhance services:

Drones and unmanned vessels can deliver medical supplies, laboratory specimens and patient data to specified rooms and patients. Specifically designed robotics can assist in complex operations, improving the success rate of surgeries. A combination of sensory equipment (medical imaging) and machine learning can build precise medical images of patients and monitor changes over time. Building a digital twin of patients can help with preventative care, cure occurring diseases and monitor healing of fractures and wounds. Tracking distance walked, hours worked and heartrate/blood pressure in staff can help prevent overworking, fatigue, stress and medical leave. Remote medical consulting with patients can be done online through image and sound sensors, requesting the patient to measure body temperature and heartrate from their home.

b) Emerging technologies to accelerate transformation:

To accelerate this proposed transformation strategy, hospitals should invest In emerging technologies like drones/robotics as delivery mechanisms and support equipment, in additions to IoT communication networks/software and sensor equipment to build digital twins of patients and hold remote consulting hours.

c) Advantages and disadvantages of implementing the solution on the cloud:

By implementing this solution on the cloud, patient information and records can be made available to doctors and nurses on many client interfaces – a limited version of this could also be made available to the patient for ease of access. Storing sensory data over a period of time will allow hospital staff to track changes and larger deviances in biological systems within the patient to predict future symptoms so that preventative care can be performed. However, this should (or must) be implemented on a private or hybrid cloud model, so that hospitals and the health care service is in control of data servers and can be responsible for keeping sensitive data secure. However, there is still a risk that an unwanted third party could gain access to sensitive patient data stored on the cloud by cybercriminal methods like phishing, malware and ransomware.

The four different cloud models are:

- Public cloud (access to hardware and software through internet, server infrastructure managed by cloud service provider, all customers share a common infrastructure)
- Private cloud (network operated exclusively for specific business, either managed internally or externally, often hosted on company location for improved security and data control)
- Hybrid cloud (integration of private and public, allowing an employee's workload to move between the two as needed/preferred, f.ex. storing sensitive information at own premises)
- Multicloud (uses cloud services from several providers, ensures maximum flexibility)

d) How to accelerate and complete this solution for non-profit/public organizations:

Non-profit and public organizations can accelerate transformation solutions by slowly influencing government culture to be accepting of riskful change and innovation, hire staff with technical expertise and education, then provide bridges across skill gaps through methods like reverse teaching and seminars.

The most fruitful method for public organizations may be private/public partnerships where the health care provider builds a long-term relationship with a private sector organization to collaborate on a solution to provide expected services to the public on time. The private business will often provide initial funding and develop a solution through innovative technologies based on public needs and expectations, allowing the health care provider to implement these technologies sooner and at a reduced cost. In return, the private business gains a new revenue stream through the partnership and developed solution.

e) Sustainable Development Goals that would be positively impacted and how:

Goal 3 – Good health and well-being (digital twin of patients, remote health consulting)
Goal 8-9 – Decent work and economic growth (better working conditions for hospital staff, systems in place to prevent fatigue and medical leave)
Goal 10 – Reduced inequality (Remote health consulting more accommodating to patients with disabilities and chronic illnesses, patients living far away from hospital)

4) Industrial digital transformation

a) Defensive strategies in the commercial sector protect the business from competitors and disrupters.
Offensive strategies in the commercial sector disrupt the industry by differentiating the product with new features and by providing new services.

b) How crises speed up adoption of digital technologies and promotes transformation:

In the example of the COVID-19 pandemic, opportunities for industrial digital transformation were identified like using smartphone Bluetooth technology to track infection, 3D printing masks and ventilators, remote monitoring and management of ventilators through IoT for reduced exposure, blockchain for tracking ventilator integrity, IoT-based remote patient data monitoring, use of drones to spray disinfectant and deliver medicines.

c) Technical debt (design/code debt) is the implied cost of additional time and effort caused by choosing a short-term solution that solves current problems instead of employing a more long-term approach that would induce higher short-term costs with more long-term benefits. When a business accumulates technical debt, it will make it much harder to implement grander changes in operations and business model.

d) Leading indicators of failure in industrial digital transformation:

Failure occurs when transformational projects do not achieve the expected gains in efficiency and cost reductions, or never get completed in the first place.
Critical indicators of transformation failure is having no industrial digital transformation strategy, not having enough top-down support from the board, being too focused and narrow minded rather than looking at industry trends and understanding the customers, a mismatch of plans and actions, focusing too heavily on technology rather than a cultural shift – often related to misaligned visions, economic and technological factors.

e) Lights-out manufacturing refers to a system where the entire production line is fully automated, and people's role is to maintain and repair systems. This can only be executed with a heavy portion of standardization (dimensions, size, material), material handling can be automated and scheduled, and machine learning can adapt to real-time changes in the factory to make decisions. Related to this, automated manufacturing can also allow for more cost-efficient solutions that cannot be managed by people ergonomically.

How industrial digital transformation drives lights-out transformation:

The key drivers and enablers that drives lights-out transformation is the forming of consortia to define industry standards for different products that allows for greater economies of scale and design of specialized equipment within production facilities, automated material handling and control systems by automation technologies, and development of machine learning / deep reinforcement learning for decision making and scheduling. The focus on digitization, process monitoring through digital twins, anomaly detection in IoT sensor data, predictive maintenance, product inspection of defects – all is a result of how companies undertaking an industrial digital transformation has gained more flexibility, control and efficiency in their manufacturing and delivery processes.