Senior Capstone Projects

Spring 2017

Project A: Assembly Process Design for Aerial Camera Systems

Sponsor: Ascent Vision Technologies, LLC
Belgrade, MT 59714

Description: Ascent Vision is a technology company based in Belgrade, MT with operations in Australia. They design and manufacture gyro-stabilized gimbal camera systems that are mounted on unmanned aerial vehicles, small manned aircraft, and watercraft. The company is enjoying strong growth along with the increase in popularity of UAV's, and has reached a point where industrial and management systems engineering skill and knowledge would be useful in addressing some the challenges of their evolving business strategy.

Currently, Ascent Vision's three products are manufactured mostly in Australia, but the company is planning to move those operations to Belgrade in early 2017. In addition, a new facility is planned to house the company, including manufacturing operations. The company would like an IMSE team to design the assembly process for the new facility that will meet their projected product demand. The design should accommodate mixed model production and be scalable to several sales outcomes specified by the client. Design work will likely include layout of the production area, build plans for the different models, detailed workstation layouts, production instructions, and possibly fixture or tooling designs. The team is expected to investigate different strategies for producing the gimbal cameras, conduct engineering and economic analyses, and recommend the most effective approach given the company's objectives. The client is prepared to supply bills of materials, assembly drawings, access to existing assembly processes, time estimates (will need to be verified), production requirements and space constraints.

Project B: Redesigned Management System for Production Support Inventory

Contact: Boeing Helena
3200 Skyway Drive
Helena, MT 59602-1203

Description: Boeing's Helena facility fabricates key components for Boeing commercial aircraft. Among the most significant parts for this facility are side-of-body chords which are the main structural parts that hold the wings on the aircraft body and are thus critical to aircraft function and safety. Boeing Helena has an opportunity for a team of industrial engineering students to aid in the development of an order and

replenishment system for production and non-production support items to point-of-use locations, just in time. Items include production tooling, personal protective equipment, packaging materials, shop support items, process by-products (waste streams), and break room items. Currently several systems are used to replenish these materials, which they would like to replace with a single method or system that accommodates the range of products supporting a variety of functions with variable frequency of use and quantity requirements. The objective of the project is to decrease the amount of labor required to manage, order and replenish supplies while maintaining or improving inventory positions and service levels. Solutions must take into account a scalability factor for upcoming rate increases (variable across products) that may have impact on method/system alternatives.

Scope of project covers initial analysis of needs, generation and evaluation of ordering and replenishment methods that meet design requirements, recommendation on best alternative, and development of implementation plan w/ associated action items. The team will be expected to report out design alternatives, demonstrate functionality of design concepts and adherence to requirements, and ultimately provide recommendation for best alternative and associated implementation plan.

Note: Students will need to complete Boeing's clearance process and be able travel to Helena several times during the semester in order to acquire data from the facility.

Project C: Robotics Simulation Model for the Computer Integrated Manufacturing Laboratory

Sponsor: Joe Eldring
Dept. of Mechanical & Industrial Engineering
Montana State University

Description: The Mechanical & Industrial Engineering (M&IE) department has recently procured two new industrial robot arms using student equipment fee allocation funds. One robot is on a Certified Education Robot Trainer cart while the other is stand-alone. The robots come with state-of-the-art robot programming and simulation software. The objective of this project is to build upon the progress made over the past year to further integrate the robots into M&IE curricula and thereby enhance the education offered to students in the area of advanced manufacture. Specifically, this project will entail:

- Learning how to program the robots using teach pendant and off-line programming (the latter using state-of-the-art RoboGuide software).

- Developing a Robot Users Guide (similar to the RSLogix user guide) that can be used to efficiently teach robot programming to students and faculty, including user testing of the document.
- Creating and testing simulation model(s) of the conveyor-robot system in RoboGuide software that can be used in laboratory experiences.
- Developing a series of scaffolding laboratory exercises designed to achieve specific learning objectives in a hands-on fashion, with demonstration programs to accompany. Ideally the exercises would mirror an industrial application. (Basic exercises currently exist which can be used as a starting point.)

Project D: Pharmacy Workflow Improvement

Contact: Bozeman Health Deaconess Hospital
915 Highland Blvd.
Bozeman, MT 59715

Description: The inpatient pharmacy at Bozeman Health Deaconess Hospital supplies medications for hospital inpatients, Bozeman Health-affiliated clinics, and various departments within the hospital including the Cancer Center. As the health system has grown significantly in recent years, so has the demand for medications and pharmacy services. And yet the space occupied by inpatient pharmacy has not changed in size for the past decade. Since a new, larger space will not be available for a couple of years, pharmacy leadership and staff see a need to evaluate the current pharmacy layout in light of the necessary work flows for safety and productivity improvements.

The objective of this project is to increase patient safety within pharmacy through improved efficiency, reliability and productivity. All aspects of pharmacy operations are to be assessed, including filling of medication orders (stock, IV, and controlled medications), order verification, and stock replenishment. Based upon this analysis, alternative proposals for improvement will be evaluated. While architectural changes are out-of-scope for this project, the department is open to changes in workplace layout, flow and sequence of tasks, work allocation, inventory organization and management, and workstations and other equipment. Proposals receiving client approval will be tested through implementation or experimentation to verify potential benefits, costs and unintended consequences.

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Project E: Automated Cell Design for a Part Kitting Process

Contact: Vista Outdoor
275 Manhattan South Rd.
Manhattan, MT 59741

Description: The Manhattan, MT facility of Vista Outdoor manufactures accessories for sportsman, military, police and security personnel. Their production operations include 30 plastic injection molding machines plus assembly operations that produce products and components for the Blackhawk! brand as well as other Vista Outdoor companies and partners.

In the current operation, they use manually operated bagger machines to kit subassemblies that go into the final product package. As the company continues to see product demand increase along with new product introductions, the manufacturing team is looking at the potential for automated or semi-automated solutions to meet the growing demand, and free operators from highly repetitive tasks for more value-adding activities. Given the complex geometry of the parts to be kitted, and the differences across the products, the engineering team believes that using a robot with machine vision to pick up parts and drop them into the kit might be the best solution. But questions remain as to exactly what equipment would be most suitable and have the necessary capability and speed for the job, and how that equipment can best be integrated with existing operations and shop floor environment.

Thus the objective of the project is to provide a detailed work cell design to kit six different subassemblies, along with a financial analysis of the return-on-investment of the project. The detailed design would include specifications for the recommended equipment along with analysis showing that production requirements can be met. (At present, production requirements exceed 1M parts per year.) Students on this project should have taken EIND 371, and will have the opportunity to learn robot simulation software as part of the project.

Project F: Value Stream Improvement of Laser System Production

Contact: Quantel USA
601 Haggerty Lane
Bozeman, MT 59715

Description: Quantel designs and manufactures solid-state laser systems for

scientific, industrial, medical and military applications. Their US office is located in Bozeman, Montana which has engineering, manufacturing, and testing capability. Their existing facility no longer meets their needs, so they are in the process of building a new facility west of Bozeman. The move date is currently planned for late February.

Quantel USA is a low volume, high mix producer. While they produce a handful of base models, they offer many variants to those base models in order to customize their products for their customers. Being a laser company, the manufacturing operations include mechanical, electromechanical, and electrical assembly of components, some of which are highly sensitive optical parts, along with various testing apparatus and stations. Most of the work is manual assembly of vendor-provided parts.

Company leadership has identified a target to cut production leadtime in half in order to increase the company's competitive position in the market. However, this goal must be accomplished without adding personnel. They also recognize that simply transferring existing operations to a new building is unlikely to produce efficiencies sufficient to attain this goal. Thus the goals for this project are to conduct a value stream assessment of the current operations as they exist in the current building, from receiving dock to shipping, for the company's major laser product families; to identify areas for cycle time reduction and envision a future state of operations that can be implemented in the new facility; and to prepare detailed proposals for 1-3 targeted areas of improvement. The team's work should enable Quantel USA to reduce their lead-time by 50% within 6 months, and be economically justifiable.

Project G1: MSU Emergency Management Plan for Prolonged Electrical Outage

Contact: University Services
Montana State University

Description: This project is intended to develop an annex to MSU's Emergency Response Plan to address the risk and mitigation of, and response to, a significant and prolonged electrical outage. MSU's operations are intrinsically tied to the reliable supply of electricity to campus. In the event of a prolonged outage, planning is required to prepare for the initial response to the incident, stabilization of the situation, and the eventual recovery to normal operations. Throughout the emergency, maintaining continuity of prioritized institutional operations is critical. MSU's role in the larger community during an expanded event should also be considered. This effort should produce a comprehensive review of the following areas:

Institutional Operations (IO) -- The goal of this annex is to keep MSU operational through the stabilization of key institutional processes. This step identifies the relevant IP that this annex should address.

Vulnerability Assessment (VA) -- VA shall include, at a minimum, identifying modes of failure or events that can cause extended electrical outage. For the purposes of this VA, extended outage shall be defined as more than three hours. These modes of failure should be categorized so mitigation and response plans can be developed in a method that identifies common approaches or other planning and implementation synergies. Once the modes of failure are identified, the likelihood and impact of each should be evaluated. An outcome of the VA should be the prioritized modes of failure based on their likelihood and impact.

Mitigation Plan (MP) -- MP shall include analysis of methods to reduce the likelihood and impact of prioritized modes of failure. Analysis may include gaps in technology, policy, personnel/support and concepts to address each. Costs and/or obstacles to implementing mitigation strategies should be included.

Emergency Response Plan (ERP) -- ERP shall provide plans for the initial response and stabilization of a prolonged electrical outage. This plan should address both general and mode-specific plans. Plans should include strategy as well as prioritized tactics to achieve specific objectives. MSU's Emergency Management System follows a standard NIMS Incident Command System approach. ERP should be developed with ICS structure in mind.

Recovery Plan (RP) -- After the initial response and stabilization of an incident, the RP provides a roadmap to retire campus to normal operations.

Project G2: Energy Management Key Performance Indicators

Contact: University Services
Montana State University

Description: Montana State University's Bozeman campus is comprised of roughly 285 buildings totaling five million gross square feet of building area. These facilities are widely diverse in function, condition, and operational efficiency. This project would identify key performance indicators for MSU's building inventory to compare buildings' performance and prioritize the allocation of a limited maintenance budget. The development of KPI's should inform facilities managers of building's operation efficiency, level of deferred maintenance, and other extenuating factors to be considered in short, mid, and long term facilities planning.

Specific goals of the project may include:

- Development of Key Performance Indicates. KPI's may include energy, operation, and maintenance consumption and expense data. The amount of deferred maintenance for each facilities should also be quantified
- Review the long range campus development plan and external comparators to inform prioritization of campus maintenance budgets.
- Prioritize MSU's facilities maintenance budgets and propose a short and midterm capital investment plan.
- Assess the adequacy of present maintenance funding levels

Project H: Production Process Research and Design for Novel Flexible Body Armor Technology

Contact: MilTech
2310 University Way, Bldg. 2-2
Bozeman, MT 59715

Description: MilTech is an Office of Technology Transition Partnership Intermediary that provides assistance to the transition of innovative technology to deployment within the US military. MilTech provides technical assistance in all areas related to design, development and manufacture of new products.

Recently, MilTech program management has learned of a new project within the Air Force Research Laboratory to develop a new type of body armor that is flexible (in contrast to the hard body armor in widespread use currently). Product development is still ongoing, but is promising. One of the near-term needs for this project to reach fruition and begin protecting military personnel is to figure out how to manufacture it in a highly repeatable fashion with DoD-level quality, and make it scalable to desired production levels.

Thus, this project entails researching alternative production methods for this novel (recently patented) body armor technology, developing multiple options for production process, and providing cost and time estimates for each option. Since product development will be running concurrently, potential exists for the manufacturing research to inform product design.

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Project I: Tasting Room Start-up

Contact:
Cam Holt
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holtcam@gmail.com

Description: The potential business start-up will be a sustainable, combined brewery, winery and cider house and tasting room. To cater to a larger percent of alcohol drinkers the business will be a tasting room that serves made-in-house beer, wine and cider. With the increase of consumer demand for environmentally friendly products, this can set us apart from other similar businesses.

The project focus is to develop a sustainable brewing process with lean manufacturing practices employed. Optimization of the brewing process to create the best tasting beer, wine and cider will be included in the scope. Also a financial business case for the start up will be developed to validate the model for the stakeholder(s). The objective is to create a business case and facility plan for a combined brewery, winery and cider house tasting room, with the potential to serve food as well. The operation goal is to be self-sustaining and carbon neutral. These objectives will be achieved by the following deliverables:

- Value stream map of common brewing process and future state value stream map with proposed process
- Optimized brewing recipes and processes
- Detailed facility layout with optimal location
- Environmental impact report of processes
- Company name, values, mission, etc.
- Market research
- Detailed payback period on start-up with cash flow diagrams