ENGINEERING EXPO 2018

PROJECT ABSTRACTS BY DEPARTMENT

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING PROJECT ABSTRACTS

10.MIE.1

A Linear Programming Model for Course Project Selection Considering Student Satisfaction

Jianqi Jiang, Fan Wang, Tianyi Xiong

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Abstract

The project selection process in the Senior Design course has presented an interesting problem with regards to group selection. Students formerly signed up for projects on a 'first come first serve' principle. As a result, students considered themselves unsatisfied as they were not assigned to the project or teammates of their choices. Similarly, professors found it was a considerable effort to try to match the groups and project selections manually. Therefore, we have designed a model to satisfy the students' preferences as well as save time for professors. The model considers both the students' selection of teammates and projects, whereas many similar scheduling models consider only matching people with a certain project or schedule. In this case, when matching people within a group, we encourage pairs of both people agree to work on the same team with each other instead of just one person wants to work with another one. The method consists of 1) collecting data of group and project preferences from students via online survey; 2) importing data into the model in Python, which generates all possible combinations of groups and their respective happiness scores; 3) eliminating groups with happiness below a minimum threshold; and 4) feeding remaining group combinations into a linear programming model using the Gurobi solver. By adding necessary constraints, we may generate matching results to maximize the overall happiness within the class. The complete process is done in parallel computing on a cluster. The model can be easily modified to other scheduling problems, such as workforce scheduling and assignment of roommates in student dormitories.

14.MIE.2

A Shipping Robot on Tracks for physical Distribution of Multiple Items in Warehouses

Ze Li, Kaijian Wei, Kaiwen Xue, Chu Zhang, Jianan Zhang

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Abstract

Many shipping/receiving facilities currently have a lot of employees whose job is to pick items from the shelves and place them into boxes for shipping. This process can be automated on a small scale. This project is designed to create a shipping robot for the online retailers' warehouse to improve the efficiency by reducing the burden of employees and saving time by increased speed and accuracy. The goal of this project is to design the robot which can quickly ship items from the shelves of the warehouse to appointed containers, and also obtain multiple items from different places on the shelf in one order. This project can be divided into three different parts: moving part, control part and grabbing part. The design will also include an interface which allows people to set orders. Problems occurred when the original design was based on a four-wheel car: accuracy and efficiency were not sufficient. The moving part of this design is changed to rails so that the shipping robot can complete the assigned order in a short time period. The Arduino is used as control part, because it is a single-chip system that is much simpler than other programming software. The grabbing part consists of 2 Claw Grasping mechanism which is driven by 9 volts motor. This design is created and tested for safety by using SolidWorks, especially analyzing stress result. The final design meets all the required criteria: To design a prototype which narrowed by scale and can ship 9V batteries from shelves to appointed boxes at once including an interface where customers can choose different batteries which placed at different positions on the shelves and deliver this information to the shipping robot. The final device is prototyped using 3D printing and laser cutting and then assembled at UIC make space.

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PROJECT ABSTRACTS BY DEPARTMENT

11.MIE.3

Adjustable Column Splitter with Particulate Reduction System

Rodolfo Benitez, David Ivan Fugate, Jose Fidel Galvez, Eric George Olsen

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Andy Savenok, Royal Corinthian
Anzelmas Tursa, Royal Corinthian

Sponsor: Royal Corinthian

Abstract

Architectural stone columns have been used in structures throughout history because of their ability to handle compressive loads. They are also structural works of art, like the columns of the Parthenon, they add to the aesthetics of a structure. In the modern-day, structural columns are usually made from steel and covered with a relatively lightweight fiberglass or synthetic stone, hollow, architectural column. These columns come out of a mold in one piece and are then split open lengthwise with two cuts 180 degrees apart. Our sponsor, Royal Corinthian, needed a machine that could perform these cuts quickly, safely, and on a wide range of column sizes and shapes. Initially a study of different cutting methods was conducted until the circular saw with a diamond blade was selected. Since there were no column splitting machines commercially available, inspiration was drawn from other stone cutting machines, namely, stone cutting bench saws. A single blade machine concept was generated and divided into separate assemblies: table, saw, gantries and track system. Solidworks was used to generate CAD drawings. Static force analysis with free body diagrams kept track of how the machine managed the demands placed on it. Finite element analysis with ANSYS Workbench was performed to double check the calculations. A basic cost analysis was also performed, taking into account; total cost of the machine, operating costs, and reduction of manual labor. These factors determined the financial viability of the machine for Royal Corinthian. The goal was to provide our sponsor with technical drawings and a bill of materials that could be used to construct the machine.

26.MIE.4

AIAA Liquid Rocket Design: Injector and Nozzle Systems

Daniel L Gray, Matheus Scotti Alves Tonin Simoni, Barak Robert Stoltz, Matt Valenzeno

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Sponsor: AIAA at UIC

Abstract

A liquid bipropellant rocket is the most efficient form of delivering payloads into outer earth orbit. The development of such a system is the goal of the American Institute of Aeronautics and Astronautics (AIAA) chapter at UIC. This project is year one of a two-year process and is expected to increase the group's understanding and reach. The specific goal of this project is to develop a motor for use in competition with a vehicle apogee of 145,000 feet. Various proposed solutions are explored for the liquid fuel, as well as the liquid oxidizer. Key considerations are thrust produced, toxicity and handleability, and cost. The chosen propellants are RP-1 (Rocket Propellant-1) and 95% hydrogen peroxide. Extensive research into nozzle geometries reveals two main options: conical and bell. The conical nozzle is chosen for its machinability, simplicity, and weight. FEA simulations are completed to predict the pressure and velocity characteristics of the flow of expanding gases through the nozzle. Injector designs are also explored thoroughly, including options such as impinging doublet, impinging triplet, impinging triple swirl, and concentric injectors. The impinging triplet injector is selected primarily for its machinability, atomization, and mixing abilities. The injector system is designed as four stacked plates, and also receives thorough FEA simulation to visualize pressure and velocity profiles of the propellant flow. Also completed are outlines of the plumbing system, and a review of options for cooling systems which will be included in the final design in 2019.

14.MIE.5

ALISTARS: A Logistic Intelligent System Based on the Automatic Rotating Shelf

Jiahao Chen, Chen Lin, Hao Ling, Zhenshen Wu

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Abstract

Most working processes in shipping facilities, such as Amazon, have been completely automated by robots. However, there are still large staffs of employees whose job is to pick items from shelves and place them into boxes for shipping. This project aims to design an intelligent logistic system that can reduce the number of employees and fully automate said process. The design in this project is based on a similar scenario at the service counter of the UIC Recreation Center, which also involves pick-deliver processes. The proposed system allows students to select items and have them delivered after logging in with a student ID. Our system design has four components: 1) an automatic rotary shelf, 2) a lift with a central push rod, 3) a transporter, and 4) the control code. After the student orders, the system will receive a signal from Arduino and begin operation. First, the transporter will move to the shelf and then the shelf will rotate to align the ordered item with the push rod. Then, the push rod will elevate to the level of the ordered item and push the item into the cart of the transporter. If more than one item is selected, the system will repeat these steps until all the items are dropped into the cart of the transporter. Finally, the transporter will return so the student can retrieve the items. In addition to the prototype and design, we conduct stress analysis and experimentally test to ensure quality, stability, and high efficiency. Compared to traditional pick-and-place, this intelligent logistic system improves efficiency by reducing human error and increasing transportation speed, therefore achieving our goals of saving time and money for shipping-related facilities.

9.MIE.6

AMS Modular Flow Bench for Airflow Analysis of Performance Vehicle Engine Components

Jacobo Cabrales, Shao Chung C Chen, Ibraheem Elbadawi, Kangwei Fan

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Jonathan Moser, AMS Performance
Adam Miszta, AMS Performance

Sponsor: AMS Performance

Abstract

Automobiles and their subsequent parts have been enhanced over the years in order to achieve superior performance. It has been demonstrated that air velocity at higher rates plays an important role in producing higher overall performance for internal combustion engines. A flow bench is commonly utilized to analyze and modify individual automotive parts for desired flow rates. A flow bench has many industrial and commercial uses including the tuning of air filters, manifolds, carburetors, throttle bodies, exhaust manifolds, pipe fittings, and valves. A flow bench is an effective tool in knowing how each component is contributing to the overall engine's performance without the need of having the whole engine assembled and checked on a dynamometer. The objective of this project is to design and manufacture a versatile flow bench that will allow for individual and varying automotive parts to be tested for their performance. A flow bench utilizes a multitude of sensors and components to successfully measure and record relevant data. The fundamental metric that allows for components to be analyzed is pressure and its universal relationship to flowrate. Parts are fixed on the top plate which will be adjustable based on the cross section needed for the experiment. The test-piece will then be examined against calibrated orifice plates that are known to flow accurate flowrates at exact pressures. When the manometers read the predetermined criteria for pressure differences, the flowrate of the test-piece can be deduced. Once the flowrate is known, some modulations could be done to the test-piece until the desired design parameters are met. The unique features of this design include reversible direction of flow that provides suction and blowing using a rotatable plate, versatile interchangeable top plates each with different hole size, and versatile interchangeable orifice plates that flow unique flowrates depending on the hole diameter.

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PROJECT ABSTRACTS BY DEPARTMENT

9.MIE.7

An Air Knife Assisted Spray Nozzle for Large Droplet Diameters

Robert A Banez, Bryce A Coffey, Adam Malecki

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Kyle Bade, Spraying Systems Co.
Rudi Schick, Spraying Systems Co.

Sponsor: Spraying Systems Co.

Abstract

Spraying Systems Co. are experts in spray technology and are constantly developing and improving their products from nozzles to complete systems. Spray nozzles, in particular, allow the distribution of a liquid into a spray. This allows coverage of a larger area and also increases the surface area of the liquid. There are a variety of nozzles (full jet, spiral jet) that tend to specific needs to be more efficient. Some of these needs can be spray painting, fire suppression sprinklers, and direct injection fuel to name a few. Using various parameters in these nozzles (such as spray angle, fluid pressure, flow rate, and spray patterns) they can be adapted to suit specific needs. Spraying Systems Co. seeks a system that filters out small droplets, while keeping larger droplets within a range of 500 – 3000 micrometers. The proposed solution includes an air knife that has the air pressure necessary to filter out the small droplets and not create secondary atomization on the larger droplets. Different combinations of air and water pressures are tested to find the most efficient spray. The result is the key parameters for a spray nozzle that performs similar to rain with only droplets within a range of 500 – 3000 micrometers are being sprayed out of the system. This will also result in larger droplets than if the spray nozzle was used without the air knife.

11.MIE.8

An Anti-wrap System for Pouch Laminators

Maulik Hiteshbhai Amin, Bilal U Khaja, Hardik Girishkumar Patel, Marvin Renteria

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Aaron Melamed, ACCO Brands

Sponsor: ACCO Brands

Abstract

Laminators are common office equipments used to protect and preserve documents by enclosing them in plastic. The most common problem with laminators is jamming due to uneven pressure, glue build up on the rollers, static on the rollers, debris in pathway, curl on a document and operator error. The heated rollers are the primary part of the device and are what makes the lamination possible. In this project, designing an efficient anti-jam system is our main goal. We must meet the design criteria such that the cost is under $5, not creating any new possibility of jamming, maintaining output quality, and not creating any fire hazards. Reverse-engineering and examination of the provided CAD files of the laminator lead to brainstorming solutions of an anti-jam system. Out of the six proposed solutions, two of them were experimented with. The first was a wire wrapped around the exit tray to decrease the gap between the rollers and the exit trays. The second solution was to extend the exit tray itself and produce the same outcome as the wire. The designs were updated through the procedure based on the results of experiments. The experiment suggested that there was one case of jamming out of 10 extreme scenarios. With the extended trays, there were no cases of jamming during the experiment of same extreme scenario. By decreasing the gap, we observed that when inserting a document that was deformed to induce a jam, it did not jam.

15.MIE.9

Arduino Controlled Multi-Axial Orbital Fluids Mixer

Tanisha Danielle Beals, Babatunde Oluwatosin Famuyiwa, Jesus Miranda, Alex Orzechowski

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.

Abstract

The objective of this project is to design and fabricate a motor driven orbital mixer using Arduino control whose significant purpose is to mix low viscosity chemical solutions efficiently in a timely manner, while rotating on multiple axis. In order to attain this goal, the task is divided into three stages as shown in this research. The beginning stage requires not only the formulation of preliminary design ideas and concepts according to the design criteria, but also determining the best choice for a final model using a decision matrix to analyze their individual fishbone diagrams. The second phase shows the creation of the model and it's required parts with CAD drawings using Solidworks, and also selecting the best choice of materials for the prototype by using a cost analysis. The concluding stage of the project involves creating a working prototype, modifying it according to other additional specifications from the sponsor if any, showing adequate manufacturing information and accurate financial analysis in order to keep the cost of production as low as possible.

15.MIE.10

Arduino Controlled Robot Arm with 6 DOF

Taisong Han, Tomoki Kamitani, Bao-Duy Hoang Le, Kevin Xavier Sanchez Amay

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.

Abstract

This project includes the design and fabrication of a six degrees of freedom robotic arm with a two degrees of freedom end effector. These two fingers are attached to a wrist which rotates about the z-axis and flexes forward and backwards in the x-z and y-z planes. Each joint has a stepper and servo motors for its respective movement and the base consists of polylactic acid plate and aluminum turntable swivel capable of 360° rotation about the x-z plane. The model requires one stepper and six servo motors to drive the joints with an input of approximately 5V each. An Arduino Uno controls every motor through an Xbox controller. In order to have more motors connected to the microcontroller, more driver shields were added to it. C++ code language was used for the control algorithm. The design of the arm was done on Solidworks for 3-D printing and machining as well as optimizing the basic design specifications.

2.MIE.11

ASHRAE 2018 Student Design Competition: HVAC System Design

Alex Bashqawi, Michael C Gonzalez, Erik I Pyshnov, Skyler Wilkinson, Jingwei Wu

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. William Ryan, Ph.D., P.E., UIC MIE Dept.

Sponsor: UIC ASHRAE

Abstract

Every modern building project requires a mechanical system to ensure the indoor air quality is at a suitable level for its occupants. These systems are designed to be both efficient and sustainable during the life of the building. This project focuses on the design of the HVAC system for a 70,000 square foot building in Istanbul, Turkey. The building is four stories and contains retail spaces, office spaces, a restaurant, and a hotel. Compliance with all relevant ASHRAE standards and local codes is ensured by satisfying the energy usage and indoor air quality requirements. Specific building parameters such as occupancy, building construction, and miscellaneous loads are gathered based on assumptions that satisfy all building standards and local codes. The project deliverables include: heating and cooling load calculations, ductwork and piping layout, equipment selection and layout, and cost and energy analysis. The load calculations and energy analysis are performed using Trane Trace 700, and the financial analysis is performed via cost data from CostWorks. The selected final design is a Direct Expansion (DX) Variable Air Volume (VAV) system. A VAV system supplies air to a zone at a constant temperature and varies the amount of air supplied as needed. A DX system uses refrigerant in the cooling coil to directly cool the treated air. This system is used five times throughout the building, once for each floor and once for the restaurant. This system was chosen because of its simplicity to integrate and low cost of maintenance. The final design is slightly oversized compared to the calculated load. This is done because the selected equipment is not manufactured at exactly the size required, instead, the next largest size was chosen. This allows the final design to be more reliable and flexible and the final cost to be more realistic.

2.MIE.12

ASHRAE HVAC Design Calculation for a Four Story Building

Malek Majdi Abdelraouf, Rama Al-Ali, Nicolas Buitrago, Ahmed R Hameed

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. William Ryan, Ph.D., P.E., UIC MIE Dept.

Sponsor: UIC ASHRAE

Abstract

Turkey's green building industry has rapidly grown in the last few years. The objective of the presented research is to calculate the Variable Air Volume (VAV) and Air Handling Unit (AHU) for an HVAC system of a four-story complex unit located north of Istanbul, Turkey. South of the new international airport, this facility features retail, office spaces, restaurants, and a hotel to accommodate for the airport in its completion in 2019. The building operating hours are 7am-10pm Monday through Friday, and 8am-1pm Sunday. Since the building has two residential floors that will actively run 24 hours a day, seven days a week, and 365 days a year an intricate heating and cooling system is needed. To design the proper HVAC system to put up with these operating hours, the Owner's Project Requirement (OPR) and the international building code that follows ASHARE standards 90.1 ,62.1.55.189.1 must be considered. To calculate the specifics, a software called TRACE 700 made by Trane Inc. was exploited to render useful numerical values. A default system with similar enclosure variables is selected to run the software. To determine the best system design for the building, a decision matrix is employed. The best design is primarily chosen for its low impact on the environment and lowest cost, therefore complies with LEED specification.

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PROJECT ABSTRACTS BY DEPARTMENT

1.MIE.13

Automatic Pump System Model for Liquid Biological Medium Exchange

Joshua Montana Acocella, Jorge M Claeyssen, Ryan William Drechsel, Michael G Janikowski

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Jie Xu, Ph.D., UIC MIE Dept.

Abstract

Growing and maintaining a cell culture usually requires laborious work and may induce operating errors. A common procedure for cultivating A549 cells involves thawing the cells and medium, inserting medium into cell culture flasks, incubating for four days, removing medium manually, adding a trypsin solution to detach cells from the flask wall, and then harvesting or sub-culturing the cells. With the permission from the team sponsors, the automatic fluid aspirator was identified for project development. The cell culture system's primary function is to automatically aspirate cell growth medium from culture flasks. The development of the fluidic aspirator was chosen due to the simplicity, affordability, and realizable potential of the design. The design criteria are as follows. The cell culture flask would be portable and small enough to fit within the Xu Microfluidics Lab biosafety cabinet. It would aspirate and dispose of the used medium upon command. It would also contain a port for the cell culture flask to reside within our system. Furthermore, the cost of design, manufacture, and assembly would cost less than similar products currently on the market. In order to meet these design criteria, a Solidworks design of the device, a cost analysis of the device, and a visual aid detailing the function of the device have been both produced and provided.

14.MIE.14

Autonomous Sorting Robot

Brian Herrmann, Saman Hooshyar, Tamal K Kumar, Augustine Kofi Marfo, Alberto Olea

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.

Abstract

Automated machine oriented manufacturing has become one of the most significant improvements in modern industrialization. Improvements in automation technology combined with reliable mechanical equipment have allowed us to reach incredible production goals while minimizing human risk. The goal of this robot is to simulate a manufacturing application by sorting an object based upon the object's color. Thus the design should be able to autonomously determine what object to move and where to place it. The robot will have a maximum horizontal reach of 24 inches and a vertical reach of 16 inches. The operating conditions include the following: Being able to sort several different objects of different colors, and being able to sort within the area of a 180° rotation up to 16 inches from the base of the automated arm. The arm should be also able to perform this sorting in a time efficient manner comparable to a manually operated machine. The autonomous sorting consists of picking up the object from a random position near the base diameter, and then moving it onto a new designated storage location near the edge of the defined operating range. This process will be completed without direct user input. The only human interaction that should occur will be for basic maintenance and performance diagnostics. With the following performance criteria and a limited budget, the final design will enter a competition that will determine the most robust, and effective robotic manipulator. The design was checked for its robustness and structural safety through ANSYS simulations and the results indicate the design is suitable under its current operating conditions despite concerns of design malfunctioning due to joint failures. This autonomous object manipulator will help further the viability and practicality of automated production in industry.

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PROJECT ABSTRACTS BY DEPARTMENT

12.MIE.15

CNC Mini Mill Retrofit for Society of Automotive Engineers at UIC

Emanuel Borrero, Michelle N McClary, Sara Nolan, Robert Matthew Ridgway, Dulce Maria Varela

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Sponsor: UIC Society of Automotive Engineers

Abstract

In-house manufacturing capabilities are important in reducing the cost of production and manufacturing times. The Society of Automotive Engineers (SAE) at the University of Illinois at Chicago (UIC) have access to a variety of machining operations including, turning, drilling, and milling. The mill available to SAE requires manual operation, which limits manufacturing to polygonal shapes with little to no curvature due to an increase in manufacturing difficulties. The conversion of a mini mill into a Computer Numerical Control (CNC) mill is desired to increase manufacturing capabilities. Parameters for milling operations were considered when designing for the retrofit of mini mill to ensure optimal functionality. Constraints on the design included: a desired tolerance of .005", ability to mill aluminum, and a budget of $1000. Compatibility of the motors, drivers, controller, and ball screws were taken into consideration as well manufacturer specifications, such as strength, and power requirements, on selected parts. The motor selection was constrained by calculated torque requirements: 5.32 lb-in and 7.09 lb-in for the spindle and stepper motors respectively. The selected motors dictated the amperage and voltage requirements of the power supplies. A TinyG board was selected as the motion controller due to its embedded Gcode language and cost effectiveness. In addition to purchasing decisions, various components were manufactured. The design for these components was tested using Finite Element Analysis (FEA) software to ensure the safety of the parts, as well as deformation effects on the tolerances. The resulting CNC mill is assembled and tested for accuracy and safety.

9.MIE.16

Computational Fluid Dynamics Program for Wind Turbine Performance Analysis

Matthew Lee Burks, Devin Jimenez, Brandon L Judkins, Hung Quoc Ngo, Bartlomiej Jan Szczech

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.

Sponsor: Jevon Plog

Abstract

This project analyzes wind turbine performance with the use of computational fluid dynamics (CFD) software. CFD results are compared to wind tunnel data recorded using a scaled, geometrically similar turbine. The sponsor of this project grew up in the farmlands west of Chicago and has witnessed the proliferation of wind farms. During the growth of this industry a common question that came to mind so often was “why are they not rotating?” The ubiquitous three-blade design is seen around the world, on shore and off shore. Through analysis of various turbine design parameters, a secondary goal is to identify an optimal design for residential use, where lower wind speeds with inconsistent wind flow dominate. The CFD analysis utilizes ANSYS Fluent and uses a moving mesh analysis method. This project aims to show the following results: 1) Three-blade designs do not perform as advertised and, as such, are not worth the investment 2) A turbine with more than three blades will produce more power and be more efficient.

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PROJECT ABSTRACTS BY DEPARTMENT

10.MIE.17

Cost and Energy Analysis of an Industrial Facility

Naman Bindra, Savon S Clark, Shivam N Patel, Stephen N Piller, Kevin K Tang

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Lin Li, Ph.D., UIC MIE Dept.

Sponsor: UIC Industrial Assessment Center

Abstract

The overall goal for this project is to perform energy audits for a wastewater treatment plant followed by recommendations for energy efficiency, cost reduction, and sustainable operational practices. Wastewater treatment plants remove as much solids and waste from the water before it is discharged back into the environment. However, wastewater treatment plants can use up a lot of electricity and gas to operate on a daily basis. Therefore, the utility bills will be analyzed and annual energy consumption and cost will be determined. Additionally, equipment will be audited and the equipment energy consumption will be calculated. After all the information is studied and processed, a post-assessment analysis will be completed that contains all of the studies and research done over that time, along with the recommendations made detailing an estimated amount that the company can increase their energy efficiency, reduce costs, and increase their productivity by. Following the post-assessment analysis, the company can choose to implement some, none, or all of these changes at their discretion. The assessments were conducted through The University of Illinois at Chicago Industrial Assessment Center (IC-IAC), which provides free energy, productivity, and waste assessments for industrial facilities through funding provided by the US Department of Energy.

6.MIE.18

Design and Fabrication of a Prototype Exhaust Hood for Residential/Commercial Use

Andreas Mastoracos, Patrick Maziarz, Matthew K Sas, Michael P Wietecha

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Connor Quiros, Triangle Metals

Sponsor: Triangle Metals

Abstract

Kitchen exhaust hoods play a vital role in households by providing a clean and safe environment for cooking. It is essential to remove the smoke, steam, and grease produced while cooking because it can cause dangerous side effects if inhaled. Additionally, by removing this toxic air, the presence of carbon monoxide and the growth of bacteria and mold is reduced. For these reasons, it is important to choose the correct exhaust hood to properly ventilate your kitchen. However, this can be a challenging task when trying to match the right size and efficiency for any kitchen. This project focuses on eliminating this problem by creating a parametric exhaust hood model in Inventor. Using Inventor, the exterior shell of the exhaust hood is designed out of stainless steel sheet metal which houses an exhaust hood insert. The insert provides all the functionality needed for an exhaust hood while the dimensions of the exterior shell is adjustable. This allows a customer to specify their own desired dimensions to obtain an exhaust hood. As a result, this hood fits in areas that a standard size hood would not and provides the proper amount of ventilation for their kitchen. The minimum amount of ventilation required is determined by the 2015 International Mechanical Code found in section 403.3.2.3. The air flow of all insert sizes exceeds this regulation which ensures that the harmful fumes are removed from the kitchen. Thus, an exhaust hood can be fabricated in a variety of sizes while guaranteeing customer safety.

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PROJECT ABSTRACTS BY DEPARTMENT

12.MIE.19

Design of a Desktop Laminator Pouch Feeder Attachment

Alex Bazdor, Marcin Maksimowicz, Daniel Walter Raymond, Mae Janine C Viado

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Aaron Melamed, ACCO Brands

Sponsor: ACCO Brands

Abstract

Laminating materials have great benefits to a user who would like to preserve important documents. The history of the laminator design is comparable to that of the printer, as desktop printers are commonplace in homes and offices now, and similarly, pouch laminators are available in a desktop size for office or home use. The project sponsor, ACCO Brands, is an American corporation that is one of the world's largest suppliers of business, consumer and academic products. ACCO Brands manufactures and sells various types and sizes of laminators through their GBC and Swingline brands. The purpose of the project is to do a feasibility study on creating a pouch feeder that will be sold as an attachment to existing pouch laminators. A design of the proposed pouch feeder and its parts were created in SOLIDWORKS. The key goal for the housing design is the ability to connect the device to currently available pouch laminators. With this project, the sponsor wants to explore the potential of introducing a pouch feeder to the market that can aid the user's experience when laminating multiple documents at a time. Lamination pouches are activated with heat and pressure in a process that cannot be rushed. The pouches must be held while being fed through the laminator since laminator designs typically do not have a loading tray that will support the pouches by itself. It takes manual labor to laminate a single document and laminating multiple documents at a time will require the user to support the pouches until all the documents completely pass through the pouch laminator. The pouch feeder will eliminate the need to stay by the laminator machine. It aims to allow the user to leave loaded pouches in the pouch feeder and do other tasks as the machine runs the lamination process.

1.MIE.20

Design of a Drum Lifter for the Pharmaceutical Industry

Nassim Ben Makhlouf, Alex G Delacuba, Diego Perez Tinoco

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Austin Martel, Triangle Metals

Sponsor: Triangle Metals

Abstract

Today's industries frequently use good material handling to operate better, efficiently and safely and ultimately produce their product. Drum lifters are widely used in the pharmaceutical and food industries. This project covers the designing and prototyping of a drum lifter. A literature survey was completed to learn the product's history and to ascertain what machines are currently available on the market. Design criteria is crucial and multiple criteria are considered including the ability to lift a full 55-gallon drum, tilt it and pour its contents into a different container. Design assumptions include the weight of a full drum is 500lb, and the torque and the lifting force needed is considered at least twice as much as the calculated values. Design limitations include using stainless steel, the stainless-steel sheet dimensions, and the capability of Triangle Metals to produce the lifter. The fishbone diagram and the metrics are critical for producing a correct design. The resulting proposed solution consists of a chain gear system lifter, rack and pinion system and mechanical arm system lifter. All systems include an automatic, semi-automatic and manual version. After market consideration and decision matrix completion the manual rack and pinion system is selected as the best design due to its high rank in several parameters. The methodology to design and build a lifter shows all steps necessary to reproduce the machine. All necessary calculations are completed such as the force and torque. Those calculations are shown in the methodology and the results sections. The parts are designed using Inventor driven by Excel. Strength analyses, stress analyses and deformation and safety factor calculations are completed to ensure functionality and safety. A final assembly is shown in the results. Future consideration can transform this design to an electric lifter by using an electric motor with sufficient power.

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PROJECT ABSTRACTS BY DEPARTMENT

14.MIE.21

Design of a Shipping Robot with Detection System for Warehouses

Lei Wang, Weihe Xu, Shizhao Zhu

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Abstract

In today's society, logistic systems are more and more important and significantly useful. Amazon's warehouses already have shipping robots which are able to move whole package shelves to specific address, where few workers will pick up the items and leave them on the conveyor. The overall goal of this project is to maximize the efficiency of the automatic system and increase the speed of the entire process. In order to replace workers, this new robot is designed to receive the orders and pick up the items. The prototype robot consists of two main systems. The whole control system of the prototype robot is based on Arduino since it's easy to prototype with the limited budget. However, in real warehouse, out of reliability, a better processor may be used to improve the real-time rapid reaction. The basic function is that by controlling valves and motor, Arduino is able to control all the cylinders, at which point it will combine the functions of sensors and cylinders to have a more accurate location. The whole pneumatic system is a main specialty in this project in order to maximize the speed and the practicality of it is better in real warehouses. Two cylinders will adjust the address of gripper and the valves will control the opening of gripper. Then the items in the orders will be gripped and the motor controlled by Arduino will rotate the gripper to transport the item.

6.MIE.22

Design of an Indoor Custom Gas Grill for High-End Luxury Homes

Rocco J Cordaro, Lyle A Kuykendall, Lynette S Sugatan, Rachel E Winckler

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Rebecca Hoklas, Triangle Metals

Sponsor: Triangle Metals

Abstract

While high-end designers produce an array of countertop appliances, there is the scarce presence of residential products that parallel commercial indoor grills, as seen in the restaurant industry. Thus, in this work, we have designed a customizable countertop grill, targeting high-end, luxury homes that desire a unique cooking apparatus for their kitchens. The final design is a scalable gas delivery system consisting of a regulator, tubing, valves, and U-shaped burners from third-party components. Using Inventor, a final 3-D model of the grill assembly was arranged. Since our design has a rectangular geometry, personalization is a straightforward process. The design model has a fixed width and is scalable in length. By knowing the length of the cooking surface, the requisite number of burners per unit length is determined and then assembled onsite. Particularly, the grill itself has a cooking surface with a layer of lava rocks underneath for even heating distribution and for minimizing excessive grease. Sloped, interior walls are designed for the grease to run down towards the grease collector. Further FMEA and safety analysis are applied to ensure proper use of a working grill indoors. This work was done in collaboration with Triangle Metals Inc., which aims at starting its own production line with this product. Due to their manufacturing capabilities, Triangle Metals Inc. can fabricate the shell of the grill, as well as assembling the entire system. The company can also directly sell to the customer, reducing the final cost.

ENGINEERING EXPO 2018

PROJECT ABSTRACTS BY DEPARTMENT

26.MIE.23

Design of Multi-positional Snacktray for the Commercial Bus Industry

Temidayo Jaiyeola, Fakrogha Edwin Porbeni, Juan Carlos Romero-Salinas, Piotr Scislowicz

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Sam Cardone, Freedman Seating Company

Sponsor: Freedman Seating Company

Abstract

Safety is at the forefront of all day to day operations in every industry. In the commercial transport industry, the goods and services provided are specifically catered towards the consumer's needs. This project aims to improve the design of a multi-positional snack tray used in the commercial bus industry. Currently, the trays on the bus only deploy to 90 degrees and their stowed position, while the seats can recline to angles of 102-108 degrees relevant to the floor. In such a scenario, when a passenger reclines to these angle's, the tray of passenger behind is no longer parallel to the floor causing items, such as a laptop or drink, to tip over and fall. Several solutions are proposed to solve such issues. Contemplating these solutions in SOLIDWORKS and testing them with ANSYS simulations, the final design could then be determined. The most challenging aspect of this design is the mechanism that allows the tray to be adjusted. In the various designs, the tray is unable to support the target weight or is unable to be adjusted to angles of 102-108 degrees. The final design consists of a snack tray mounted to a support arm that is easily attached to a pre-installed plate on the back of the seat. The mechanism connecting the tray and support arm is composed of two metal pins and slots that allow the tray to be adjusted. Once implemented, the new design will be able to stay level in a position parallel to the floor and stowed in a position aligned with the seat. The tray can be adjusted to a 108-degree position allowing the passenger to continue using the tray when the seat in front of the passenger is reclined.

14.MIE.24

Development of a Robot That Is Fast, Maneuverable, and Capable of Launching Various Projectiles

Mohammad Ezzat Aldweik, McKinley D Jackson, David John Kneip, Bassam Ousta

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.

Sponsor: UIC American Society of Mechanical Engineers

Abstract

This project features a multifunctional robot that can steer, reach high speeds, launch a tennis ball, and hit a golf ball. The robot was originally used for the American Society of Mechanical Engineers (ASME) 2017 Student Design Competition but suffered from poor performance and reliability. With the intent of using the robot for promotional purposes after the competition, ASME contracted a Senior Design team to modify the robot and improve its performance. Given the robot's condition, the team opted to perform a complete redesign while leaving the original frame intact. Since the project is costly to construct, various preventative measures were taken to minimize the opportunity for error. The tennis ball launcher loading mechanism was constructed with cardboard to validate the design's performance before using more expensive materials, and the golf ball hitter proof of concept was developed by modifying an inexpensive rat trap. In-context design was implemented in SOLIDWORKS when creating assemblies, and an entire virtual 3D model of the robot was developed to check for clearance problems. The goals of the finished robot are to reach speeds over 4 miles per hour, launch a tennis ball 40 feet, hit a golf ball at least 3 feet, and have remote-control capabilities.

ENGINEERING EXPO 2018

PROJECT ABSTRACTS BY DEPARTMENT

9.MIE.25

Efficient Atomization of Viscous Fluids Using Intra-Nozzle Heating

Edgar Ulyses Garcia, Nitin Issac, Anuj Ashish Parikh, Nirav Rajesh Patel

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Kyle Bade, Spraying Systems Co.
Rudi Schick, Spraying Systems Co.

Sponsor: Spraying Systems Co.

Abstract

Atomization deals with reducing a fluid into fine droplets so that it can be sprayed easily. The applications range from properly watering crops, painting surfaces, to coating foods with ingredients. The desired fluid for atomization in this work, methylcellulose, is a high viscosity fluid and is difficult to atomize properly. A way to improve atomization is to heat the fluid to decrease viscosity. Conceptually, this works because the temperature is inversely correlated with viscosity. In this project, a body chamber with an immersion heater attached is used to quickly heat the fluid inside the body via the heating element. This enhances the atomization process and reduces the droplet size. Through sufficient heating inside the chamber, the surface tension holding the fluid together decreases and thus destabilizes the fluid. This allows for a smaller droplet size as it exits the flat tip spray nozzle. For this project, the desired decrease in droplet size after heating is between 10% and 30%. Additionally, insulation is incorporated inside the chamber so that the body does not heat up. This also minimizes the risk of danger to people and the surrounding environment. The current work includes: testing the prototype with new modifications to the design, collecting the desired data, and determining if the current improvements aid the atomization of methylcellulose. The result from initial experimentation is that the device is capable of spraying methylcellulose at higher pressures. However, improved temperature control for heating during testing is essential for better results in future experiments.

26.MIE.26

Electronically Actuated Shifting Mechanism for the SAE Formula Car

Mina A Agamy, Zaid Manaweil Alaraj, Abdelaziz Mohammed Alhammadi, Vaso Dragicevic

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Sponsor: UIC Society of Automotive Engineers

Abstract

Started in 1980 by Ron Matthews, professor of mechanical engineering at the University of Texas, the Formula Society of Automotive Engineers is an international competition which plays host to scientists, engineers, and practitioners seeking to construct and assemble self-propelled vehicles. Taking part in this competition for several years, the University of Illinois at Chicago's contribution of formula racing cars equipped with pneumatic shifting mechanisms have been uniquely innovative. These formula racing cars employ highly sophisticated, semi-automatic, fluently shifting gearboxes. In comparison to manual cars, drivers are not required to manually operate the clutch. Instead, changes in gears occur by pressing buttons or paddle shifters located on the steering wheel. Without the need to stop acceleration, the vehicle is designed to smoothly switch gears without losing speed. A shifting mechanism this nimble requires a correspondingly rapid actuating solenoid. Installing an electric solenoid eliminates the need for a heavy air tank used in the pneumatic method. Further, it improves the accuracy of each subsequent shift. The electric solenoid uses a cylindrical coil of copper wire with an armature in the middle to create an electromagnet field for operation. This results in the consumption of less energy for every stroke extended and retracted. Simultaneously, it maintains an accuracy of ten thousand of an inch each time. The minimum required force for the lever mounted on the actuator is experimentally determined and can be adjusted to ensure successful actuation. Following the customer's safety and cost design criteria, the "PINGEL" electronic actuator has been selected and implemented into the design that is set to race in the formula racing competition in 2018.

11.MIE.27

Ergonomic Study: Improving The Design of Three Assembly-line Hand Tools

Kameron Bourne, Anthony Diaz, Luis Linares, Oscar Ivan Vargas

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Carter Henricks, Thule

Sponsor: Thule

Abstract

Thule is a leading company in the design and manufacturing of rooftop cargo carriers. Currently, their production line uses various custom hand tools. Since the tool dimensions are not standardized, the Thule maintenance team must handle both repairs and replacements. This is detrimental to the production line as the fabrication of new hand tools are both expensive and time consuming. In addition, the custom hand tools lack the ergonomic study required for optimal use. The solutions to these problems include the following: (1) creating ergonomic designs for efficient manufacturing of replacements, and (2) implementing a simple maintenance procedure for tool repairs. These solutions are applied to the following hand tools in the rooftop cargo carrier production-line: rivet cover inserter, scraper, and strut wrench. For the rivet cover inserter, the solution involves creating an alternative design that considers the ergonomics of hand tools. The final design is manufacturable by conventional means, but it can also be 3D printed to eliminate manufacturing processes. For the scraper, the solution involves the implementation of a simple maintenance process. This innovation will decrease the repair time needed for the scraper and improve the ergonomics of the maintenance process. Lastly, the solution for the strut wrench involves creating an alternative design. The final design will emphasize on improving both the ergonomics of the handle, and the manufacturing process. The end goal for the three tools is to have cost-effective hand tools that promote efficient manufacturing and simple maintenance.

4.MIE.28

Forearm Stabilization During Microscopic Surgery

Luis Florentino Rodriguez, Jose D Rojas, Gonzalo G Romo, Ricardo Zepeda

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Dr. Michael Scott, Ph.D., UIC MIE Dept.
Kimberlee Wilkins, UIC School of Design

Sponsor: UIC Innovation Center – UR*Lab

Abstract

Microscopic surgery can be a delicate and extensive procedure for surgeons. With the methods used today, the lack of forearm support may lead to discomfort during or after procedures. The current technique used at the University of Illinois Medical Hospital involves padding oversized arm rests with towels. This technique is time-consuming, unadaptable, and needlessly extends the sterile field. The goal of this project is to design and prototype a device that will more effectively provide forearm support for a surgeon. The device is intended to attach to the operating table railing system and to be easily adjustable. Based on data obtained from the client, the ideal device will possess two degrees of freedom: vertical and horizontal translation. The product of this project will be testable by surgeons to determine whether it is sufficiently supportive and easily adjustable.

26.MIE.29

FSAE Suspension and Tire Analysis

Sean Micheal Garcia, Rino J Muringothu, Bryan F Murman-Freer, Peter S Tselepatiotis

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.

Sponsor: UIC Society of Automotive Engineers

Abstract

The project is designed to provide a simulation environment for adjustments made to SAE's formula vehicle. The simulation environment takes input parameters and gives a graphical analysis of the output variables. These output variables will give SAE the data to improve their design before buying the material for it. This allows SAE to save time and money on their projects. Several programs were considered when creating the analysis, however, ADAMS was the most beneficial to the user. To achieve the desired outcome ADAMS simulation will be created along with a comprehensive guide and video tutorials to help users quickly utilize simulation.

7.MIE.30

High Efficiency Lithium Ion Battery System for Mopeds

Rahul J Dahya, Michael T Karas, Rahim A Lalani, Kamran A Siddiqi

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Max Berniker, Ph.D. UIC MIE Dept.

Sponsor: Dr. Max Berniker, Ph.D. UIC MIE Dept.

Abstract

The standard Internal Combustion Engine (ICE) based automobile industry has been drastically disrupted by the introduction of mass produced electric vehicles (EV). In addition to having a smaller carbon footprint, EV's are significantly more efficient than their ICE counterparts. In this project, an older model ICE powered Pacer Super Sport Moped is converted to an electric powertrain complete with custom lithium-ion batteries. The first objective is to successfully convert to electrical power while maintaining the original aesthetic of the bike. The second objective is to perform cost analysis in order to prove the efficiency of the next generation lithium ion batteries over conventional Internal Combustion Engines. Previously, the bike was fitted with a high output DC motor paired to inefficient lead-acid batteries. Real world-tests were conducted to determine the power consumption of the electric bike during regular use on city streets. This data was extrapolated over a specified six-mile route to estimate the total power consumption. This information was used to source the lithium ion batteries for the bike. In an effort to maintain the original aesthetic of the bike, the gas tank was removed, and a battery mount was designed to be attached to the frame in its location. The mount is attached to the frame of the bike where the gas tank was originally mounted. The battery mount is manufactured from corrosion resistant sheet metal, and the new batteries are secured to the mount using nylon straps. Additional modifications are made to the bike in order to achieve roadworthiness such as the installation of headlights and tail lights, turn signals, power gauges, speedometer, and a horn.

10.MIE.31

Improved Yard Utilization to Increase Throughput at YRC Freight Distribution

Agata K Chmiel, Adriana Garcia, Kristian Pierre Mai, Abiturab Mithaiwala, Rory John Pognant

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Helda Fragoso, YRC Freight

Sponsor: YRC Freight

Abstract

With the growth of e-commerce and digital marketing, an increasing number of vendors have unique shipping requirements that do not require the use of a full trailer. Accordingly, new emphasis on increasing efficiency and shortening the length of supply chains in the $36 billion less-than-truckload (LTL) transportation industry has driven companies such as YRC Freight to be at the forefront of innovation. The team's proposal details layout alternatives for YRC Freight's largest terminal, located in Chicago Heights, IL, which receives roughly 22% of the operation's freight in the United States. The design effort was focused on activities performed by yard personnel. By modifying space allocation and designated storage locations, the team aims to reduce the facility's expenses associated with flow on the yard. Using data analysis techniques, the team was able to analyze historical data to predict allocated space requirements for maximum utilization and address the various flows on the yard. Using CRAFT (Computerized Relative Allocation Facilities Technique), the team was able to make measurable improvements on the yard. Finally, by use of 2D modeling in AutoCAD, the team created detailed alternative layouts that address the issue of waste generation by current operational processes and storage areas. The associated documentation offers insight into the process of creating the recommendations offered as well as justification for the selected layouts, including the costs of material handling and capital.

26.MIE.32

Independent Rear Suspension for SAE Formula Race Car

Wei Li, Xing Li, Tao Lu, Yixiu Tao, Minkun Xiao

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Sponsor: UIC Society of Automotive Engineers

Abstract

The UIC SAE team has maintained excellent records in the competition for many years. It is not possible to get this result if the car does not have a well-performing suspension. This project is about the design of rear independent suspension for SAE team's Formula SAE car. It is based on the existing problems of the previous formula car's suspension which makes the race car has relatively large swings when cornering and encountering bumps. The first step is deciding the basic structure of the rear independent suspension, and after contrasting every suspension structure's advantages and disadvantages, the Double-wishbone suspension is selected. The second step is optimizing the previous rear suspension by use of ADAMS software. According to the optimization result of ADAMS, several hard points are changed. The next step is fitting and drawing the new rear suspension in SOLIDWORKS according to the new hard points. After drawing the suspension, the strength of the suspension is analyzed in ABAQUS to ensure safety and durability. Finally, the overall cost is calculated to guarantee a low cost resulting in a high score in the FSAE cost report event.

10.MIE.33

Lou Malnati's Pizzeria: Process Improvement

Andrejus Cernicenko, Wesley Allen Dilday, Nandini Gupta, Mariane Nozari Hernandes

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Jim D'Angelo, Lou Malnati's
Alex Kuperman, Lou Malnati's

Sponsor: Lou Malnati's Pizzeria

Abstract

This project follows a group of mechanical and industrial engineers on their work to solve a problem that has been plaguing Lou Malnati's since their first store has opened. How can we make pizza as fast as possible without sacrificing the quality demanded by Lou? This question is the entire basis of this project and the group will solve this by understanding the pizza making process at Lou Malnati's, interviewing workers as well as the management staff, collecting data by time studies, piloting the suggested solution and analyzing the results of those solutions over the period of two semesters. Thorough analysis and observations let the group down a long path that ultimately ended with the conclusion that the ovens need a closer look. Simple oven signalization along with optimal oven rotation methodology should help with cooking and locating the pizzas faster and would decrease the total time it takes for a pizza to be produced. This idea will be piloted and further tested to confirm that the production time is lowered.

15.MIE.34

M.A.C.R.A 6: Mechanical Arduino Controlled Robotic Arm with 6 degrees of freedom

Alexis B Beltran, Christian Isaac Lopez, Abdul Rehman, Mahmood Zohaib

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.

Abstract

The fields of automation and robotics have greatly advanced within the last two decades. Newly developed CAD tools have made it easier than ever to create tangible systems from desktop to printer. Utilizing these new tools, including 3D printers, SolidWorks, and ANSYS, the MACRA 6 team has developed a state-of-the-art robotic arm. The MACRA 6 is designed to win a pick and place competition with ease. With its small cost and minimal secondary machining, the MACRA 6 has an ideal cost efficiency. 3D printing most of the parts enables the arm to remain low in cost and is easily manufacturable. MACRA 6 has optimal gear ratios connected to its two servo motors and four direct current motors. It has 6 degrees of freedom, allowing it to maneuver within a 2,744-cubic inch space. It is controlled using an Arduino microcontroller connected to an ergonomic custom remote control.

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PROJECT ABSTRACTS BY DEPARTMENT

14.MIE.35

Modular Coordinate Measurement Machine for Reverse Engineering

Monica Delgado, James T Keopraseuth, Mateusz Kubak, Vladica Nikolic, Jude Ademola Nwokenkwo

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Abstract

A coordinate measurement machine is used to precisely measure an object's dimensions and convert them into coordinates. This allows for intricate measurements of irregular shapes that would prove difficult for other conventional means. Currently, many industry standard machines are only large scale and do not meet the client's requirements. Laser scanning based devices can be small or large, however, they employ expensive components and are costly to produce and operate. Research using patents, books, and journals determined that while there are desktop devices that utilize laser scanning technology, there is no desktop gantry-styled machine that uses a 3 DOF contact probe. Certain machines can measure in 6 DOF, however, most are expensive and are unable to convert measurements into a format suitable for reverse engineering purposes. An object is measured in an XYZ coordinate plane using a probe. For the electrical component, it has been determined that the use of quadrature encoders is far more accurate than the optical or laser standards in consumer products used today. The measurements are recorded into a text file using an Arduino microcontroller which is then converted into a PointCloud format. This format is a collection of data points in a coordinate plane and represents the surface dimensions of an object. The file is then imported into a CAD software, such as SolidWorks, where the points are used to create a 3D mesh surface. This can be used for 3D printing or can be edited by the user to create a new object. With an accuracy to within two-thousandths of an inch, this device can also be used for quality control purposes. Through our research and simulations, we have generated a modular design similar to many 3D printers on the market today that is sufficiently accurate and precise while keeping a low product cost.

11.MIE.36

New Material for the Ultima 65 Laminator Rollers through Heat Analysis

Emilio Garcia, Nabeel Haider, Miguel A Jimenez, Bill Alejandro Ortiz

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Aaron Melamed, ACCO Brands

Sponsor: ACCO Brands

Abstract

Schools and businesses have the need to protect and preserve important documents. In this project we partnered with ACCO Brands who is the brand leader in a broad range of product categories including binding and laminating. The goal was to find a better material for the roller to increase efficiency and lower the total cost of production, making it more affordable for the consumer. The original rollers are made of steel wrapped in silicone. The three material substitutes were aluminum, zinc, and tin. With the use of ANSYS Steady State and Transient Thermal simulations analysis were performed on the Ultima 65 laminator heat rollers. After testing the rollers using ANSYS, aluminum was best choice of material for the new heat rollers. Once the tests were completed, the appropriate loads were imported into ANSYS Static; Structural to visualize the thermal expansion that the rollers will undergo. The rollers will be exposed to vast cycles of heating and cooling which will introduce additional stress to the roller. Completing these computational analyses will ensure that proposed material is profitable and proficient of the tested materials. The final design will be lighter, more cost effective, and thermal efficient.

10.MIE.37

Optimization of UIC's Extreme Supercomputer Scheduling System

Sara S Imburgia, Lovely A Luna, Asad Mehmood, Maria Sandoval

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Sponsor: UIC A.C.E.R.

Abstract

High-performance computing is a powerful tool that supports scientists and engineers in understanding nature and making technological breakthroughs. Optimizing the performance of supercomputers has been researched thoroughly due to the high direct and indirect costs of running efficient systems. In this study, workload characterization is used to understand the performance of the University of Illinois at Chicago's supercomputer, Extreme. A year's worth of job script submissions is gathered as data to give the group a good foundation of how the queueing system has functioned in the past. The current first in first out (FIFO) model is simulated in Python by using the arrival times, processing times, and resource requests from the data. These metrics negatively impact the user's wait time; therefore, the goal is to understand those metrics and manipulate them to minimize queue times and improve efficiency. Discrete event simulation and analytical modeling are used to understand the performance of Extreme and to make recommendations for improving the current scheduling policy. Existing data suggests that the user's estimation of requested wall-clock time is a significant factor impacting the performance and resource usage in the scheduler. A new priority-based model is designed and tested in efforts to increase the overall throughput of jobs and minimize user queue times. Intentions of this study are to improve resource utilization and educate users about how their requests affect the supercomputer. Informing the users may result in far more accurate requests and as a result, an improved queueing model.

11.MIE.38

Optimizing Nylok's Quality Department

Rodrigo Ignacio Garrido, Anurag Gupta, Bricelda Morales, David Villalpando

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Bryan Mace, Nylok LLC

Sponsor: Nylock LLC

Abstract

The purpose of this project is to analyze processes for self-locking, self-sealing, and protection of fastener threads. Nylok LLC adds resin to nuts, bolts, screws, and special fasteners. Nylok's primary markets include automotive, aerospace, machinery and equipment. For this project the team has been assigned to the investigate and analyze the quality department. The team specifically is looking into increasing the accuracy of torque testing as well as decreasing the time taken to record and store results. Solutions will be devised by interviewing operators, performing time studies, and creating process maps, fishbone diagrams, etc.

11.MIE.39

Pick-and-Place Robot Arm with Five Degrees of Freedom

Jose A Chico, Michael C Ekwueme, Kurt Russel Moran, Michael Alex Pham

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.

Abstract

This project features a design process for a 'pick and place' robot arm. The arm is designed to have five degrees of freedom with the ability to pick up a jenga piece and place it upright into a cup. It is required that the arm's motion stay within an arc with a width of two inches while moving the block. To accomplish the five degrees of freedom, the device is split into seven primary components: the base, the shoulder, the elbow, the wrist, the lower arm, the forearm, and the claw. The base is powered via a stepper motor (17HS16-2004S) that allows for rotation of the entire device. The shoulder, elbow, wrist, and claw are powered by a total of four servo motors (Tower Pro SG90) to allow the joints to rotate and hold their positions. These five joints account for the five degrees of freedom. The device is designed in SolidWorks and simulations are run via ANSYS. The components are manufactured in the ME 250 lab and the UIC Makerspace utilizing 3D printers and laser cutters. The manufactured parts are made of primarily printed PLA and laser cut acrylic. The device is controlled via a single Arduino and a single stepper motor control board (A3967 microstepping driver) with user inputs coming from potentiometers and a single button. The arm can pick and place the jenga block in under ten seconds and within (±?0) 1cm of the desired location.

6.MIE.40

Pneumatic T-Shirt Delivery System for Use at UIC Sporting Events

Brian Alexander Diaz, Alexis Kay Gaul, Peter August Pacini, Vasilios Nikolaos Trakas

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.
Kyle Decker, UIC Athletics

Sponsor: UIC Athletics

Abstract

One of the goals of a sports team is to create a fun, exciting atmosphere for their fans. One of the best ways to accomplish this is to engage the fans on an interactive level. This occurs through a "t-shirt toss" done by the Spirit Squads (dance and cheer teams). As the UIC basketball team improves, more fans come to games, thus filling the Pavilion. As seats in the upper deck become filled, it becomes difficult for Spirit members to throw t-shirts to the fans sitting up high. So, UIC Athletics decided to employ a t-shirt delivery system to launch t-shirts into the cheering crowd. This project requires a device to be designed to deliver t-shirts to the stadium decks of the UIC Pavilion in a safe, easy, accurate, and efficient manner. Based off of the constraints of the project and given by UIC Athletics, early considerations to deliver a t-shirt included a cannon, slingshot, crossbow, and a catapult. From there, a decision matrix was made to weigh the safety, weight, ease of use, accuracy, cost, and crowd appeal of each design consideration and given a rank. The final design was decided to be a compressed air cannon. This design is the best option because safety features can be added on, it is simple to use, and can be simple to aim and take a shot, and in the end a "T-shirt cannon" is a design that will get the crowd up and cheering during a t-shirt toss. The design made in SolidWorks included a muzzle, a solenoid valve, a regulator, a ball valve, and a pressurized tank. Safety factors such as recoil, safe material, handling the device, and possible failures are considered.

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PROJECT ABSTRACTS BY DEPARTMENT

6.MIE.41

Product Profitability Analysis

Farbod Baharkoush, Alicja Ligas, Awni Mazen Samkari, Chris Taci

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Paul Grzebielucha, ICP Industrial

Sponsor: ICP Industrial

Abstract

This project focuses on the crucial area of product development with the astute use of time study technique mixed with product profitability analysis. Also, we will perform a plant layout analysis using the principles of lean flow. Time Studies are so important because that is the best way for a company to evaluate and analyze costs and productivity by highlighting where a facility needs to improve to cut costs and improve efficiencies. But to do so, the various activities or processes involved need to first be accurately identified and tracked. The aim of layout design is to provide smooth flow of workers, materials and information through the system. An effective facility layout design reduces manufacturing lead and increases overall productivity and efficiency of the plant. Our sponsor, ICP Industrial, is a specialty coatings production company that combines two trusted, market leading brands, Nicoat® and MinusNine, to form a high-performance portfolio of water based and UV based specialty coatings. They provide customized coatings specific to meeting customer needs. Our goal is to make recommendations that are best suited to improve the processes and procedures by providing an authentic manufacturing cost and factual profit margin. By accomplishing these goals, the company will benefit from a detailed analysis of their product development process. On top of this, our plant layout analysis will benefit the company with a better physical working environment which will result in the reduction of unnecessary fatigue.

10.MIE.42

Quality and Ergonomic Improvements of a Composite Drum Assembly for Mass Production

Arian R Anderson, Chloe S Engels, Ross C Jurek, Juliana Ramirez, Alexander Eugene Romza

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Kyle Miner, Greif

Sponsor: Greif

Abstract

Greif is a world leading industrial packaging manufacturer, and one of their products is a composite drum. A composite drum is a 55 gallon steel drum that has a 55 gallon plastic bottle on the interior, which then becomes a tight head composite drum. A problem that Greif faces during manufacturing is that the production team uses multiple people, who are conducting various and inconsistent processes, it fails to focus on ergonomics, and could cause several types of injuries. The objective of this project is to be able to assemble the drums continuously at a rate of 250 drums per hour, and to eliminate the intensive manual labor that could cause injuries, otherwise known as eliminating hazards. Although there are numerous solutions, the best expected outcome is to install a pneumatic press on the production line that will operate using a two-hand anti-tie down actuator that will press the plastic bottle into the steel shell. Additionally, the location of where the plastic bottle is dropped into the steel shell will have to be moved farther up in the line to allow for gravity to pull the bottle into the shell gradually; and allow for the steel drums to be potentially hotter and allow the plastic drums to slide in more easily. The most important factors to consider are customer specifications, safety/OSHA regulations, production volume, cost, and ergonomics. This project consists of an ergonomic analysis of the current process versus the projected process. A new floor plan has been developed and a simulation in ANSYS was performed to analyze the force on the composite drum during assembly to ensure there would be no damage to the product. Using a pneumatic press on this line should noticeably increase the safety and overall performance of the assembly line.

6.MIE.43

Rapid Beverage can dispenser

John Furxhi, Bogdan Yuriy Gulyk, Felipe De Jesus Munoz, Jevon Diesel Plog

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Dr. Atif Yardimci, Ph.D., UIC MIE Dept.

Abstract

The sponsor is a UIC student that, like everyone, noticed beverages tend to get stored in aluminum cans. These beverages tend to get drank directly from the can or will get poured into a secondary container to be served. As the liquid starts to leave the can through a pour, air needs to find its way into the can to replace the volume of liquid. This exchange of liquid and atmosphere in and out of the can tends to cause disruptions in the exiting fluid. These disruptions cause turbulent flows that are easily witnessed during daily activities.We have all witnessed the “glug” phenomenon as we pour a beverage increasing the time needed to empty the can. The goal is to research current designs on the market, brainstorm new ways to solve the problem, research consumer wants and needs as well as the required production changes needed to incorporate the new design.

12.MIE.44

Semi-Automated Architectural Column Sanding System

Walid Hamarneh, Linh Huynh, Hai Phuoc Vo, Loi Vo

Advisor(s): Dr. Michael Brown, Ph.D., P.E., UIC MIE Dept.
Andy Savenok, Royal Corinthian
Anzelmas Tursa, Royal Corinthian

Sponsor: Seven Oaks Millwork, Inc DBA Royal Corinthian

Abstract

Semi-automated architectural column sanding system is a project about designing, analyzing and testing a high efficiency sanding machine for 16 inches diameter and 12 feet long columns. The device is built after running and testing in Solidworks and Ansysworkbench software based on the most common used machine from the sponsor company. These two engineering softwares are used to design the model and analysis the simulation of the machine. The report contains introduction, the sponsor company’s background,metric product specification, technical content, financial analysis, grant chart, CAD drawing, simulations, and software flow chart. The prototype is built and tested to show how the pros and cons of the machine. Overall, the machine works well for most various diameter columns, more efficient and time saved.

26.MIE.45

Vehicle Dynamics' Analysis and Design of Roll Reduction Assembly for Formula SAE Racecar

Thomas P Bernacki, Michael Hawking, Gerardo Torres, Jeremy J Villarde

Advisor(s): Jonathan Komperda, UIC MIE Dept.

Sponsor: UIC Society of Automotive Engineers

Abstract

The Society of Automotive Engineers' formula car is experiencing undesired body roll when navigating a corner. This project seeks to design an anti-roll bar assembly that is compatible with the current formula car chassis and layout of the vehicle's suspension components, which would control the roll rate more effectively. The anti-roll bar also incorporates the ability to adjust the mounting positions of the bar relative to the suspension components. Adjusting the mounting position of the bar enables the ability to vary the effect of roll rates for data and testing of the vehicle's performance and to fine tune the handling characteristics of the vehicle to the preference of the driver. The simplistic form of the anti-roll bar promotes future formula SAE chassis designs to incorporate a roll reduction device to aid in vehicle stability while driving around corners. Finite element analysis was performed on the model of the anti-roll bar to determine how the assembly would react to the forces that a vehicle's suspension components experience in a racing environment. Based on the cost analysis and the results from the finite element analysis, it was determined that the material chosen for the construction of the anti-roll bar would be 6061 aluminum alloy for its strength, relatively inexpensive price, and low weight. After the production of a prototype, live testing of the anti-roll bar was performed and compared with the assembly mated to the chassis as well as the anti-roll bar not installed on the vehicle. It was observed that with anti-roll bar installed on the vehicle, a reduction in body roll was experienced, the vehicle's cornering ability increased, and the competitive expectation was met.

6.MIE.46

Volumetrically Configurable Conical Beer Fermenter for Consumer and Professional Applications

Lukasz M Dabros, Joseph Daniel Martin, Joseph M Somerville, Charles Victor Wiseman

Advisor(s): Jonathan Komperda, UIC MIE Dept.
Jocelyn Painter, Triangle Metals
Sady Wootten, Triangle Metals

Sponsor: Triangle Metals

Abstract

The popularity of both craft beer and homebrewing has exploded in recent years. As a result, a large market for specialized brewing equipment has formed and continues to expand. Fermenters are a vital part of the brewing process. A fermenter option, which is customizable to meet the needs of the end user, is something that is currently not available to most consumers. Working with Triangle Metals, a company that specializes in custom, rolled, sheet metal fabrication, this team has designed a volumetrically configurable conical fermenter for use both by homebrewers and on the professional brewing scale, in small pilot-systems. This fermenter has been developed using industry-standard components and geometry, while adhering to all applicable food safety requirements and providing the same feature-set as competing options currently available in this tier of product. 3D models and drawings have been created parametrically, such that as the design is customized, all applicable documentation is updated with minimal effort by the fabricator. Finite element analysis has been performed to ensure that the fermenter can support the weight and potential pressure of fermenting beer for all allowable volumes of the product. Materials, finishes, and weld specifications have all been verified to comply with FDA guidelines for products in direct contact with food and beverages. Finally, the fermenter has been designed to use industry-standard tri-clamp couplings which allow the use of a multitude of readily-available accessories and fittings for maximum utility and customization. The feature set and customizability of this product make it one of the most attractive options available.