SYLLABUS AND GENERAL COURSE INFORMATION
ISE 254
SENIOR PROJECT, Spring 2020

Instructor: Dr. Emory W. Zimmers, Jr., Professor of Industrial & Systems Engineering; Director, Enterprise Systems Center / email: ewz0@lehigh.edu

Student Services Coordination and Project Logistics: Mythreyi Sekar and Michael MacDougal (utilizing resources of the Enterprise Systems Center, Lehigh University, Mohler Laboratory, Room 205)

Consultants/Mentors: Gus Gustafson, Tom Brinker, Doug Sunday, Charalambos Marangos, Greg Paul, Vic See, William Henry, Bryan Boos, Laks Srinivasan, Joseph Munley, et. al. (consultants/mentors utilize projects and company partnerships of the Enterprise Systems Center)

Electronic Submissions: Will vary depending on the nature of the project and mentor assigned. The submission will be to one or more of the following: Email to the mentor and/or email to **ise254submissions@gmail.com**. At the beginning of the project the method(s) of electronic submission will be communicated to the student by the project mentor assigned.

Course Description: The use of industrial and systems engineering techniques to solve a problem in either a manufacturing or service environment. Problems are sufficiently broad to require the design of a new or improved system. Human factors are considered in system design. Laboratory.
(Typically, the Senior Industrial Engineer is given the opportunity to put to use appropriate techniques to analyze a real-world problem, design a new or improved system, and in some cases, carry out solutions. Traditional industrial and systems engineering techniques as well as newer approaches will be utilized. The end result will be a formal project report that may be forwarded to the company or partner client by the project mentor or instructor. This includes time and effort reporting forms.)

Course Objectives: Upon completion of this course, students will:

- Be able to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics including the solving of unstructured problems in a real-world setting.
- Be able to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs for new or improved systems as appropriate to the capstone project.
- Know how to select and apply design tools as well as justify and document the tools that were employed.
- Develop and present a comprehensive final report articulating the design process that was followed as well as the final design itself and be able to communicate this (as well as progress reports) effectively to a range of audiences including the use of collaborative technologies such as interactive conferencing. Communicate key aspects of the project using a "poster format" and present using this format at the College Expo and/or other venues (including video capture techniques).
- When appropriate, be able to function effectively on teams and structure meetings.
- Understand the ethical implications of decisions and associated professional responsibilities. (Reference National Society of Professional Engineers, Code of Ethics for Engineers)
- Be able to recognize the ongoing need for additional knowledge pertinent to the work being undertaken. Locate, evaluate, integrate, and apply this knowledge appropriately.
- As time permits, understand and be able to apply the three "C's" of Entrepreneurial Mindset (Curiosity, Connections, Creating Value) and the specific skills which reinforce it (the Entrepreneurial Mindset) (based on opportunity, design and impact) (Ref. KEEN Grant Initiative at Lehigh and nationally)
- As time permits, be able to discuss, present, and where appropriate quantify educational outcomes (e.g. apply creative thinking to ambiguous problems, evaluate technical feasibility and economic drivers,

examine societal and individual needs, form and work in teams, and understand the motivations and perspectives of others) (Ref. KEEN Grant Initiative at Lehigh and nationally. Utilize resources of the Enterprise Systems Center.)

Attendance Policy: Attendance is required. The student is responsible for all material covered in class, including any announcements about quizzes as well as course topic material, short quizzes, and *missed opportunities to answer class questions when absent* (e.g. for class participation part of grade). The poster presentation is required at the College Expo and/or as a video taken of the presentation.

Formal Class Meetings: Please check Course Site for formal class meeting times. In order to optimize the time available for project work with the company, class may not be held at every one of the registrars assigned times. Individual team meetings with mentors and company personnel may be scheduled at various times. (At the convenience of as many participants as possible.)

Quiz Policy: A formal excuse is required for any missed quiz. To the extent possible the time and location of any make-up quizzes which may be given will be scheduled by agreement of those concerned. If a student also misses the make-up quiz, a grade of zero will be recorded. No make-up will be offered for short-quizzes.

Text:

Required Text: *Fundamentals of Project Management*. 5th Edition, Joseph Heagney, AMACOM. ***Reference Text:*** *Work Systems and the Methods, Measurement, and Management of Work,* Mikell P. Groover, Pearson Prentice-Hall. (Purchase NOT required for this course.)

Also, note that additional reading may be assigned during the course. If a student is absent when the reading is assigned and distributed as hard copy, it is his or her responsibility to obtain a copy (e.g. from another student) or to access the information online.

Accommodations for Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact the Office of Academic Support Services, as early as possible in the semester. You should have documentation from the Academic Support Services office before accommodations can be granted.

Policy on video and audio devices: Any student voice or video recording device may be used only with the approval of the instructor and all participants of the course.

Additional Course Information:

- **The final project report must be submitted electronically to both your mentor and ise254submissions@gmail.com.**
- The poster does not need to be printed out on full size paper. It should be submitted electronically. Selected posters may be displayed at the Enterprise Systems Center, used on the Enterprise Systems Center website, an Alumni coordinated site, and/or as part of the College Expo. If you do not wish to have your name displayed as part of the poster, please contact Mythreyi Sekar at the Enterprise System Center. Otherwise we will make the assumption that it is okay to have this as part of the poster content.
- For Spring Semester 2020, please mark your schedule to accommodate for the maximum class time scheduled for ISE 254 on **Tuesday (4/28/2020), Thursday (4/30/2020), and Friday (5/1/2020).** This is necessary because the final presentations will take the full scheduled time allocation. Time reduction will be taken to compensate for the extended time required the last week.
- Depending on project scheduling, the lecture content from Tuesday and Thursday may be presented as a single presentation on Friday. When this is done, scheduling will be announced both in class and posted on Course Site.

Grade Distribution and Deductions

Grade Distribution

Hour Tests (2) at mid semester and at end of semester (Tests are generally announced two weeks prior to their being given.)		38%
Project & Associated Work		38%
1.	Final Report and Project Poster	
2.	Final Class Presentations (in class and/or at College Expo) (Required to get ANY Design Project Credit)	
3.	Final Video Presentations (individual and team) (Required to get ANY Design Project Credit)	
4.	Progress Reports (2)	
5.	Design Project Definition (incl. Gantt Chart (1%))(Gantt Chart is required to get ANY Design Project Credit)	
6.	Work logs (10)	5%
7.	Weekly Reports (10)	5%
8.	Class Participation, Mentor evaluation and Short Quizzes	14%

Progress Reports, Work Logs and Weekly Reports should be submitted as specified by your project mentor: Failure to hand in will result in a value of zero for that specific submission. (For example, one missed work log is $1/10^{th}$ of 5 %.) (Work Logs (usually 10) and Weekly Reports (usually 10) also must be submitted in the Appendix of the final project report or no grade will be given for the Project.) If you did not visit the office or work place, please note this in your weekly report explaining the reasons.10% of the value of the Final Report will be deducted for every day late.

Contents

Submission and Presentation Dates

(Submission and presentation dates are approximate and subject to change as approved by mentor and/or instructor.)

Dates	**Course Submission**
Monday, February 10, 2020 (For some groups this date may be earlier at the discretion of the assigned mentor. Any change will be announced to the student team.)	Design Project Definition Gantt chart Weekly Report #1 Work Log #1
Monday, February 17, 2020	Weekly Report #2 Work Log #2
Monday, February 24, 2020	Weekly Report #3 Work Log #3
Monday, March 2, 2020	First Progress Report Weekly Report #4 Work Log #4
Monday, March 16, 2020	Weekly Report #5 Work Log #5
Monday, March 23, 2020	Weekly Report #6 Work Log #6
Monday, March 30, 2020	Weekly Report #7 Work Log #7
Monday, April 6, 2020 (includes electronic draft of poster)	Second Progress Report (includes electronic draft of poster) Weekly Report #8 Work Log #8
Monday, April 13, 2020	Weekly Report #9 Work Log #9
Monday, April 20, 2020	Weekly Report #10 Work Log #10
Week of April 27, 2020	Final Group Class Presentations
Monday, May 4-8, 2020 (Expo date will be announced later)	Individual Video Presentations Possible College Expo at Mountain Top Campus
Monday, May 11, 2020 (Electronic by midnight)	Project Report and Poster (Electronic Copy)

ISE 254 Reading Assignments

Fundamentals of Project Management (Fifth Edition) - Author: Joseph Heagney

Chapter 1. An Overview of Project Management
Chapter 2. The Role of the Project Manager
Chapter 3. Planning the Project
Chapter 4. Incorporating Stakeholder Management in the Project Planning Process
Chapter 5. Developing a Mission, Vision, Goals & Objectives for the Project
Chapter 6. Creating the Project Risk and Communication Plans
Chapter 7. Using the Work Breakdown Structure to Plan a Project
Chapter 8. Scheduling Project Work
Chapter 9. Producing a Workable Schedule
Chapter 10. Project Control and Evaluation
Chapter 11. The Change Control Process
Chapter 12. Project Control Using Earned Value Analysis
Chapter 13. Managing the Project Team
Chapter 14. The Project Manager as Leader
Chapter 15. Closing the Project
Chapter 16. How to Make Project Management Work in Your Company

Additional readings on Ethics, the KEEN Grant Initiative, and the reference text titled "*Work Systems and the Methods, Measurement, and Management of Work*" may be made. This will be announced in class.

Timeline for ISE 254 Senior Project

(Submission and presentation dates subject to change as approved by mentor and/or instructor.)

WEEK 1-3	Activity:	Course overview and project company assigned.
		Project Management Initial Concepts (proven useful before project start)
		Project teams assigned. Develop design project definition (including problem statement and design objectives) and complete a client visit or on-site meeting at Enterprise Systems Center if possible.
	Submission:	Design Project Definition. Includes problem statement, design objective, "as-is" description (if appropriate), plan of approach (use a Gantt Chart as part of plan presentation), and deliverables
	Due:	**February 10, 2020 (may be earlier/later at discretion of assigned mentor)**
WEEK 4-6	Activity:	Data collection, literature search, analysis, and identification of potential improvement areas.
	Submission:	Progress report. Typically, this will include: data gathered to date, discussion of alternatives leading to new or improved system design and design tools to be utilized. Preliminary "to-be" description.
	Due:	**March 2, 2020 (may be earlier/later or modified at discretion of assigned mentor)**
WEEK 7-10	Activity:	Completion of data collection and analysis. Development of preliminary recommendations and design concepts. Preparation of analysis and creation of engineering presentation graphics (utilizing analytics as needed) and/or system specifications. Prepare electronic draft of poster.
	Submission:	Progress report. Typically, this will include analysis, preliminary recommendations, system specifications, and new design concepts. Electronic draft of poster.
	Due:	**April 6, 2020 (may be earlier/later or modified at discretion of assigned mentor)**
WEEK 11-12	Activity:	Develop system design, recommendations, and formal presentation for management, including technical details and cost/benefit analysis
WEEK 14	Activity:	Final Presentations (in class, also at client site by team)
	Due:	**Week of April 27, 2020**
	Activity:	Video Presentation: Executive Summary Style (done by each student individually)
	Due:	**May 3-8, 2020 (at the Enterprise Systems Center)**
	Activity:	Submission of Final Projects and Poster **Note: A report submission with company names and pertinent date and a redacted version without company names and redacted key data will be required. This will allow future use of the work product to help other students and communicate the nature of the product to alumni or other authorized persons.**
	Submission:	1 Electronic Copy of Final Project and poster
	Due:	**May 11, 2020**

STUDENT'S NON-DISCLOSURE STATEMENT

I hereby acknowledge that during my visit to the business premises or during other discussions, that I may receive or be exposed to information that is considered to be confidential and/or proprietary, and as a condition of being permitted to visit the premises, I hereby agree that I will not disclose such information to any third party nor use it for any purpose other than the purpose of the visit or associated project work, without prior written consent.

Effective Date: ____

Student's Signature: ____

Student Name (printed): ____

Name of Company: ____

Company Representative (Name, title, date) (optional):

____

____

Lehigh University Faculty (include date signed):

____

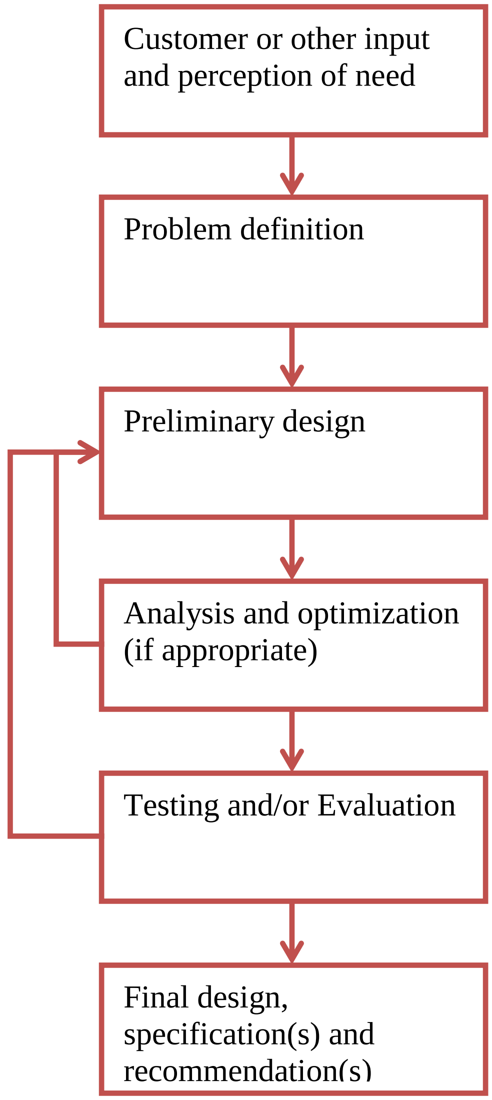
Dr. Emory W. Zimmers, Jr.

Director, Enterprise Systems Center

Engineering Design

Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which generally accepted industrial and systems engineering design tools are applied to convert resources optimally to meet these stated needs. (*Derived from: "Criteria for Accrediting Engineering Programs", ABET Engineering Accreditation Commission and KEEN Grant Initiative guidelines.)*

The General Design Process.



(Above diagram adapted from: **Mechanical Engineers' Handbook**, Volume 2: Design, Instrumentation, and Controls, editor Meyer Kutz, from Chapter 1, Computer Aided Design, by Emory W. Zimmers, Jr., Sekar Sundarajan, Charalambos A. Marangos, and technical staff of the Enterprise Systems Center, P.C. Rossin College of Engineering and Applied Science, Lehigh University, *publication March 2, 2015.)*

Industrial Engineering Design Tools and Related (Partial listing based on information available at the time of table structuring. Some course numbering and content may have changed.)

(Provided to the student as a starting point. This may not exactly reflect current semester course content since new techniques and course content changes are continuously being made. Students should use online course catalog or online reference to course syllabi for most current course content.)

Design Tool/ Technique	ISE #	Course
C++	111	Engineering Probability & Statistics
Probability Models		
Analytics Fundamentals	112	Computer Graphics
CAD Drawings 2D&3D		
Documentation Graphics		
Effective Presentation/Communication Techniques		
Engineering Graphics And Design		
Parametric Modeling And Design		
Presentation Graphics		
Problem Identification And Ideation		
Statistical Inference	121	Applied Engineering Statistics
Hypothesis Testing		
Non-Parametric Statistics		
Parameter Estimation		
Regression And Correlation		
Statistical Quality Control		
Ampl	122	Software Tools
Excel Solver		
Forecasting		
Vba		
Compensation Systems	131	Works Systems And Operations Management
Ergonomics And Human Factors		
Facility Layout Planning And Design		
Lean Production, Six Sigma		
Learning Curves		
Logistics Operations, Material Handling, Service Operations And Office Work		
Manual Assembly Lines		
Methods Engineering And Operations Analysis, Charting Techniques, Motion Study		
Predetermined Motion Time Systems, Standard Data Systems, Work Sampling, Computerized Work Measurement		
Productivity, Manual Work, Worker-Machine Systems		
Projects And Project Management, Cpm/Pert, Gantt Chart		
Work Flow, Batch Processing, Work Cells		
Work Measurement, Direct Time Study		
Work Organization, Worker Motivation And Social Organization		
Assembly Line Operation	132	Work Systems Laboratory

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Flow Process Charting - Analysis		
Flow Process Charting - Design		
Manual Methods And Work Organization		
MTM And MOST		
Performance Rating		
Pert		
Plant Layout Design		
Work Element Definition		
Workstation Design		
Developing A Mission, Vision, Goals & Objectives For The Project Planning The Project Work Breakdown Structure (Wbs) Producing A Workable Schedule Ergonomics And Human Factors Professional Ethics Project Control Using Earned Value Analysis Project Management Risk Analysis Teamwork And Leadership Professional Ethics The Change Control Process	254	Senior Project
Machine Learning Mathematical Optimization Numerical Analysis Regression Analysis Scientific Computing	155	Senior Thesis I
Machine Learning Mathematical Optimization Numerical Analysis Regression Analysis Scientific Computing	156	Senior Thesis Ii
Aggregate Planning Basics Of Math Programming Deterministic Inventory Control Engineering Economy Forecasting Modern Production Systems /Wrap-Up Operations Scheduling ; Project Scheduling Push/Pull Systems Supply Chain Management	168	Production Analysis
Algorithm Analysis Algorithm Design Data Structures	170	Algorithms In Systems Engineering (C++)
Algorithm Implementation C++ Java	171	Algorithms In Systems Engineering Lab

Algorithm Analysis Algorithm Design Applications: Pattern Matching, Image Analysis, Cryptography Data Structures Networks: Trees, Tree Algorithms, Graphs, Shortest Paths, Minimum Spanning Trees Recursion And Recurrences Sorting And Searching: Hash Tables And Sorting Algorhithms	172	Algorithms In Systems Engineering (Python)
Bulk Deformation Electronics Manufacturing Integrated Manufacturing Systems Joining And Assembly Processes Metal Casting Metal Forming Metal Machining Numerical Control And Robotics Powder Metallurgy Shaping Processes For Plastics Sheet Metalworking	215	Fundamentals Of Modern Manufacturing
NC Part Programming – EMCO Turning Center, CNC Mill Orthogonal Cutting & Cutting Fluids Press Working Safety Surface Finish In Turning Tool Life Testing Torque In Drilling	216	Manufacturing Laboratory
Duality And Sensitivity Integer Programming Linear Programming And Simplex Markov Chains Network Optimization Models Nonlinear Programming Queuing Models Transportation And Assignment Problems	220	Intro To Operations Research
Database Application Design Database Application Using Internet Technology Database Design Using Entity-Relationship Models Database Processing And Development Entity-Relationship Model Relational Implementation Relational Model And Normalization Sql	224	Info Systems Analysis & Design
Annual Cash Flow Analysis Choosing The Best Alternative Depreciation & Income Taxes Economic Analysis In The Public Sector	226	Engineering Economy & Decision Analysis

Engineering Costs, And Cost Estimating, Project Management (EVA Analysis)		
Interest And Equivalence		
Making Economic Decisions		
Other Analysis Techniques		
Present Worth Analysis		
Rate Of Return Analysis		
Replacement Analysis		
Uncertainty In Future Events		
Continuous-Time Markov	230	Introduction To Stochastic Models In Operations Research
Decision Analysis		
Discrete-Time Markov Chains		
Inventory Theory		
Markov Decision Processes		
Probability Review		
Queuing Theory		
Branch-Bound-Cut Methods	240	Introduction To Deterministic Optimization Models In Operations Research
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Linear Programming		
Network Optimization Models		
Nonlinear Programming		
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Production Scheduling		
Supply Chains / Multiechelon Inventory Control		
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Optimization Modeling		
Auto Identification Systems	319	Material Handling & Facility Planning
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Facilities Location		
Industrial Trucks, Automated Guided Vehicle Systems		
Material Handling Systems		
Monorails, Hoists, Cranes		
Plant Layout/Facility Planning		
Product, Process, And Schedule, Activity Relationships, Personnel Requirements		
Quantitative And Computer-Aided Plant Layout		
Systematic Layout Planning		
Warehousing And Storage Systems, Automated Storage/Retrieval Systems (As/Rs)		
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Research		
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Building Blocks Of Automation, Basic		
Cell Design And Control		
Control Systems, Robot Motion Description		
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History Of Robotics		
Projects		
Robot Technology And Programming		
Safety In Robotic Systems		
Comparing Two Treatments	328	Engineering Statistics
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Inferences Concerning Variances		
Organization And Description Of Data		
Probability Distributions		
Probability Theory		
Quality Improvement		
Regression Analysis		
Sampling Distributions		
Aoql	332	Product Quality
History Of Quality		

Information Engineering And Decision Analysis		
Intelligent Process Control		
Minitab		
Problem Solving Toolkit.: Tools For Planning; Seven Old Tools; Graphs And Charts; Seven New Tool And Other Useful Tools		
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Quality And Organizational Structures		
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SPC By Variables		
Statistical Process Control		
Analysis Of Annual Meeting Proxy Statements From Major Companies	334	Organizational Planning & Control
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Brownian Motion	339	Stochastic Models & Applications
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Renewal Theory And Applications		
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Process Planning /Process Planning Interactions		
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Production Equipment /Tooling Selection		
Work-Holder Design And Set-Up Reduction		
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Data Communications Fundamentals		
Data Link Layers Analysis		

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Security And Performance Analysis		
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Dynamic Models		
Index Tracking		
Measuring Risk And Return, And Risk-Adjusted Return Measures		
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Sharpe And Sortino Ratios, Expected Utility Functions		
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Two-Stage And Multi-Stage Stochastic Optimization Models		
Value At Risk And Probability Constraints		
Analytical Hierarchy And Analytical Node Processes	356	Introduction To Systems Engineering And Decision Analysis
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Classical Decision Theory		
Decision-Making Under Uncertainty		
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Functional Flow Block Diagrams(FFBDS)		
Functional, Physical, And Operational Architectures		
Idef Models (Emphasis On Idef-0)		
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Introduction To Qfd		
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Supply Chain Drivers And Metrics		
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Districting		
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Inventory Optimization		
Long-Term Workforce Scheduling		
Multi-Objective Modeling		
Priority Queues		
Resource Allocation		
Short-Term Workforce Scheduling		
Vehicle Routing		
Reduced, And Generalized Reduced Gradient Methods	355/455	Optimization Algorithms And Software
Barrier And Penalty Methods		
Basic Network And Milp Models (Assignment, Tsp, Milp)		
Convexity Of Sets And Functions, Calculus, Linear Algebra		
Derivative Free Algorithms		
Global Optimization – B&B Approach		
Gradient And Newton Methods		
Kkt Optimality Conditions		
Local Neighborhood Search		
One Dimensional Minimization (Line Search)		
Optimality Conditions		
Sequential Linear And Quadratic Programming		
Stochastic Search Heuristics For Discrete And Continuous Optimization:		
Stochastic Search; Genetic Algorithms And Simulated Annealing		
Trust Region Methods, Conjugate Gradient And Quasi Newton Methods		
Artificial Variables		
Computational Relations Between The Primal And Dual Problems	357/397	Introduction To Industrial Engineering Math & Operations Research
Degeneracy And Cycling		
Duality		
Introduction To Linear Programming		

Linear Transformations		
Matrices And Vectors Calculus		
Simplex Method For Problems In Standard Form		
The Duality Theorem		
Vector Spaces		
Application Of Data Mining Tools To Solve Real World Problems	357/397	Data Mining
Contemporary Data Mining Issues And Uses		
Data Mining Algorithms		
Data Mining Model Evaluation		
Data Understanding And Preparation		
SAS Enterprise Miner Software Training		
Semma Data Mining Process		

ISE-254 Organization of Final Report (Example format)

1. Abstract.
2. Introduction.
3. Design Problem Definition (including "as-is" description and design objective/s).
4. Procedure/Method of Approach/Design Tools and Techniques Utilized.
5. Data, Findings (if appropriate).
6. Analysis (including specific technique(s) identified and rationale for use).
7. Discussion/Review of Design Alternatives, as appropriate to project.
8. Proposed Design
9. Recommendations for Implementation (if applicable).
10. Areas of Future Work or Additional Design Improvements (as appropriate).
11. Footnotes/Bibliography.
12. Appendix
    a. Project Poster
    b. Final Report (Class/Client) Presentation PowerPoint (grayscale, 6 per page printout is acceptable) and Exhibits
    c. Semester Progress Reports
    d. Semester Weekly Reports
    e. Semester Work Logs

Other Considerations for Grading Purposes:

- Clarity of Presentation
- Understanding of Key Design Concepts
- Workmanship
- Effective use of Engineering Graphics, of Graphs, of Charts, of Diagrams, etc.

Sample Sections from Previous Final Project Reports

SECTION 1: ABSTRACT

This project designed a process to reduce the cost of COMBIVAX HB filters. The alternatives examined for reducing the annual cost of these filters were: renegotiation of purchasing contracts, filter optimization, and filter cleaning and reuse. Different levels of reuse and optimization were examined through the economic analysis. The range of potential annual savings is $575,000 to $2,000,000 depending of the combination of alternatives that are implemented.

There are substantial potential savings from each of these alternatives. Purchasing agreements can be renegotiating with little or no cost and will provide significant savings. It is also recommended that both optimization studies be performed, as well as research to develop specific cleaning procedures. The implementation of these alternatives could result in a savings of over two million dollars a year depending on the level of reuse established. The projected cost of implementing filter optimization and filter cleaning and reuse is between $480,000 and $1,230,000. This represents a high return on investment.

This design project was proposed because of the concern for the high annual filter expenditures. The high annual cost is the result of XYZ's current policy of filter usage. Currently, XYZ uses each filter one time and then disposes of it. This results in an annual cost of approximately one million dollars a year on COMBIVAX HB alone. The production of this product is scheduled to move to a new facility where production levels will be increased by a factor of about four. This increase in production will require the use of more filters, thus driving filter expenses even higher.

SECTION 2: INTRODUCTION

XYZ Company, Inc. is a world leader in the production of pharmaceutical and biological products. The focus of this study is on one of its major biological products, COMBIVAX HB. The production of COMBIVAX HB consists of three areas: fermentation, recovery, and purification.

The production capacity of XYZ's existing facilities at 100% utilization is 25 million doses (10 microgram). Because of increasing demand for this product, XYZ has begun construction of a new facility for its production, the Biotechnology Manufacturing Complex (BTMC). The production capacity of this facility at 100% utilization is 135 million doses (10 microgram). This scale-up of production is expected to drive production prices up significantly. However, it is the goal of this new facility to produce the product at a lower standard cost. This project is aimed at driving down the annual filter component of the production cost.

SECTION 3: DESIGN PROBLEM DEFINITION

The major goal of this project was to design a process for the reuse of filters based on an examination of whether or not filter reuse is feasible and economically justified. Other methods of reducing filter expenditures and their economic justification were also examined.

The following is a description of the situation that prompted this project. Currently, XYZ spends approximately one million dollars a year on filters to be used in the production of COMBIVAX HB. Production of this product is scheduled to move to a new manufacturing complex. At this new facility the production levels are about four times that in current facilities. This will result in a substantial increase in the annual cost of filters for production. XYZ would like to find a way to reduce the cost of filters used for the production of this product.

In existing operations, most filters are used one time and then discarded even though the filter manufacturers claim that they can be reused. It has therefore been suggested that cleaning and reusing filters would be one way of lowering annual filter costs.

SECTION 4: METHOD OF APPROACH

1. Identify all filters used in current operations.

Because BTMC operations are basically just a scale-up from current operations, this listing can also be used as a valid listing of the types of filters to be used in the BTMC.

2. Determination of all filters to be included in the study.

Two reasons were used to eliminate filters from the study. First, all vent filters were eliminated because their reuse potential is already being fully utilized. Secondly, all sterile filters were eliminated from the study. This is because XYZ standards will not allow any sterile filter to be reused. This table can be seen in Exhibit 1 of Appendix I. The shaded blocks represent the filters to be included in the study.

3. Design calculations.

These calculations are contained in Exhibit 2 of Appendix I. The table in Exhibit 2.1 is for current operations. Exhibit 2.2, for BTMC operations, was formed by using the same filters as in the first table and multiplying by the appropriate scale-up factor. It should be noted that BTMC operations contain a filter in the Alum Diluent stage that will be included in the study, as well as Engineering Economy calculations and the value of economic projections.

4. Development of alternatives.

The alternatives that were considered in the redesign of this process included:

1. Redesign Using of New Technology
2. Renegotiation of Purchasing Contracts
3. Design of Filter Optimization Process
4. Design of Procedures(s) for Filter Cleaning and Reuse

These alternatives are discussed in detail in Section 5 of this report.

5. Determination of feasible process design alternatives.

New experimental technology were ruled out because that would require the revalidation of the entire production process. Filter optimization was deemed feasible because it does not alter the production process. Cleaning and reuse is feasible as long as it can be shown that the cleaning method that is developed by process engineers returns the filter to its original condition. This will need to be evaluated through filter integrity testing.

Tools and Techniques

Tool/Technique	Use
Project Management	Defined deliverables, project plan and schedule including a Gantt chart.
As-Is Analysis	Determined baseline costs for comparison to proposed improvements.
Process Analysis and Redesign	Proposed and evaluated alternatives to existing practice.
Engineering Economy	Evaluation of implementation costs for the newly designed process, determination of payback period and ongoing savings resulting from the process change.

Organization of Class & Video Presentations

ISE 254 Class: Format for Final Presentation (in class) (client site presentation may also be required)

Group Presentation: Time: 7 to 10 minutes per group

Suggested Outline:

1. Introduction
2. Design Problem Definition
3. Procedure/Method of Approach (including specific techniques and design tools employed)
4. Analysis (including cost/benefit projections and analysis tools utilized)
5. Overview of Design
6. Implementation Recommendations (for system designs)
7. Conclusion of Summary

ISE 254 Class: Video Presentation: Executive Summary Style (done by each student individually) (Presentation at Expo may replace the video presentation capture at the Enterprise Systems Center. Student video submission will then be done via smart phone.) (Note: video should be done in a "sanitized" version. In other words, no specific company names or critical data should be included.)

- Sign-up sheet is at the reception desk in the ESC lobby area, 2nd floor
- A support staff person will be assigned to help you with the system in the room assigned
    A. Executive Presentation (suggested outline): Time: 3 – 5 minutes

        1. Your Name
        2. Senior Industrial Engineer
        3. Objective of Project
        4. Approach to Your Design (including iterations and specific design techniques deployed)
        5. Overview of Your Final Design
        6. Benefits: (of working on this project)

            a. For the company or client enterprise. (How the new design will help meet desired needs)
            b. For you (How you benefited personally and professionally)

<u>Information on any additional required presentations will be provided during the semester.</u>

Example Format for Recommendations: Department of Banking

This department regulates state-chartered banking, savings, trust, mortgage, loan, and miscellaneous consumer credit institutions. It up-holds the laws and publishes rules and regulations concerning prevention of fraud and safe conduct of business as well as protection of the public interest.

CURRENT OPERATING METHODS

The Secretary of Banking is appointed by the Governor for a term of four years. The department, including the Pennsylvania Securities Commission, incurred expenditures of $X-million for fiscal XX and budgeted this amount for fiscal XX. Current staff totals 192 with 16 additional positions authorized. Of these, 113 are located in the XXXXXX and XXXXXXX regional offices, including 108 examiners. The department is organized into Banking, Savings Association, Consumer Credit and Administration Services Bureaus.

The Banking Bureau supervises the granting of charters and regulates XXX state-chartered banks and XXX branches with assets of $XX-billion. The Savings Association Bureau supervises and regulates 499 state-chartered institutions with assets of $X-billion. Consumer Credit regulates per-sons engaged in financing installment sales of motor vehicles, making loans of $XXXX or less, pawnbroker operations, and credit unions. The Administrative Services Bureau manages intern-al affairs for the department. The Pennsylvania Securities Commission regulates dealers and salesmen offering securities to the public. Department expenses are recovered from the people and institutions supervised and it transfers the excess of about $XXXXXX yearly to the general fund.

APPRAISAL OF OPERATIONS

Department personnel are knowledgeable in current banking affairs. The Savings Association Bureau is particularly well managed. However, the remainder of the department is overstaffed and organizationally disjointed. Specifically, the Consumer Credit Bureau, except for regulating credit unions, and the Pennsylvania Securities Commission bear little direct relation to the basic functions of the department. In addition, fees charged state-chartered institutions are in excess of department operating costs. Duplication of bank examinations is common. Most state-chartered banks are members of the Federal Deposit Insurance Corporation and some are members of the Federal Reserve System, making them subject to examinations from these agencies as well as the commonwealth's Department of Banking. The majority of activities of the Pennsylvania Securities Commission duplicate those performed by agencies such as the Securities and Exchange Commission.

One very concise sentence communicating the recommendation

RECOMMENDATIONS

Action Verb

1. Reorganize the Department of Banking and transfer consumer-oriented activities to the Department of Justice.

Except for regulation of credit unions, activities of the Consumer Credit Bureau relate to the protection of the general public. Consolidation of this function within the Department of Justice would be appropriate and can be achieved without additional personnel. Implementation will provide more effective use of administrative, legal, clerical, and examining personnel and make it possible to eliminate eight positions for annual savings of $XXXXX.

Discussion and Logic

2. Abolish 16 vacant positions.

The majority of these authorized positions have been vacant and remained on the rolls for more than 90 days, violating an executive order to eliminate positions not filled within that period. Indications are that utilization of clerical personnel ranged from 25% to 75%. Annual savings would be $XXXXX.

Action Verb

3. Reduce the size of the examiner and clerical staffs.

The number of examiners in the Banking Bureau has increased by 43% since XXXX, while the workload has grown less than 20%. Although the number of banks, including branches, has increased XX% during this period, the number of institutions examined has decreased 11% and the value of loans is estimated to have increased by only 18%. In view of the bureau's current and anticipated workload, the personnel should be reduced by six examiners and five clerks, resulting in annual savings of $XXXXX.

Action Verb

4. Reduce the number of examiners in the Banking Bureau by using the examination system and forms developed by the Federal Deposit Insurance Corporation.

Use of the FDIC system and forms facilitates collection and review of the data required by FDIC examiners. If used by examiners in the Banking Bureau and modified to allow for other requirements.

ISE 254 Practical Considerations for Project Reporting

1. Be clear and concise.
2. Keep it simple. Shorter is generally preferred.
3. Keep your points in an ordered sequence.
4. Tell the readers what they need to know, no more, no less.
5. Check spelling (e.g. use "spell check") or equivalent.
6. Try to limit use of acronyms and technical language unique to the specific company. Spell out the meaning of the acronym the first time you use it. Some technical terms may be unfamiliar to the reader.

Example of Design Project Definition

To: Dr. Emory Zimmers

From:

Date: September 13

Subject: Project Definition

Design Project Definition:

To design and implement a system for forecasting future sales of a furniture manufacturer. The Microsoft Data Analyzer will be deployed to analyze current data trends, mine relevant data sources and predict (forecast) volumes for different products and time periods. In addition, a user interface will be created to allow the manufacturer to forecast volumes based on actual data. Based on the analysis, hidden problems, opportunities and trends will be identified.

As Is

1. Currently the company has a sales file that contains the current sales records. In addition, they have access to a file that lists the defects that are recorded for each item number.

Plan of Approach

1. Review current sales data.
2. Define inputs to use in database.
3. Define relationships for database.
4. Use Microsoft Data Analyzer to analyze current data and find trends in data.
5. Create a user interface.
6. Create database using historical data.
7. Compare historical patterns to current trends.
8. Research various furniture retail stores to find underlying trends for furniture sales.
9. Recommend and test rules to be used when forecasting.
10. Forecast future sales.

Deliverables

1. A database that allows for a user to forecast future sales based on actual and historical data.

2. An analysis using Microsoft Data Analyzer showing the different trends in furniture sales including graphs and charts.
3. A set of rules that should be applied to forecasting sales.
4. A user interface.

Additional Submissions

1. Client Interaction reports describing the weekly meetings that take place.
2. A project timeline showing the stages of our process.
3. Oral Project/Video Presentation during November 25th – December 6th.
4. Final Presentations during the week of December 2nd
5. Final project report on December 16th.

Example of Design Project Definition

To: Dr. Emory Zimmers

From:

Date: September 12

Subject: Project Definition

Design Project Definition:

To design a system that will provide efficient access to information archives. The project will research, evaluate, and implement a desk-top search engine for use on an existing peer-to-peer network at the offices of XXXXXXX in Allentown, PA. The goal is to provide efficient access for each of the seven local network nodes to the knowledge database maintained on XXXXXXX corporate systems located worldwide.

Contacts:

David Servas

As Is:

1. At the present time, XXXXXXX is experiencing difficulty gaining efficient access to their information archives for use in ongoing business.
2. Executives are not sure whether their best option is to install a search engine that is compatible with their current peer-to-peer network to enable access to distributed information, or to create a centrally located "master" archive which would be accessible from each of its seven current nodes of operation.

Plan of Approach:

1. Research possibilities for the acquisition of search engine software/hardware compatible with existing archive infrastructure.
2. Research advantages and disadvantages of the option to centralize the company's data and understand any required changes to the architecture of their current network.

3. Document the design alternatives.
4. Present the design alternatives and recommendations on areas to pursue more thoroughly to XXXXXXX.
5. After obtaining management approval of resources required, organize and set up simulations of the preferred network design in a controlled setting.
6. Analyze results of simulations. Project findings to the more realistic, larger scale quantities of information and traffic that XXXXXXX will have to accommodate for full implementation.
7. Present findings including final design recommendations and the underlying rationale supporting our conclusions for the proposed IT improvement.

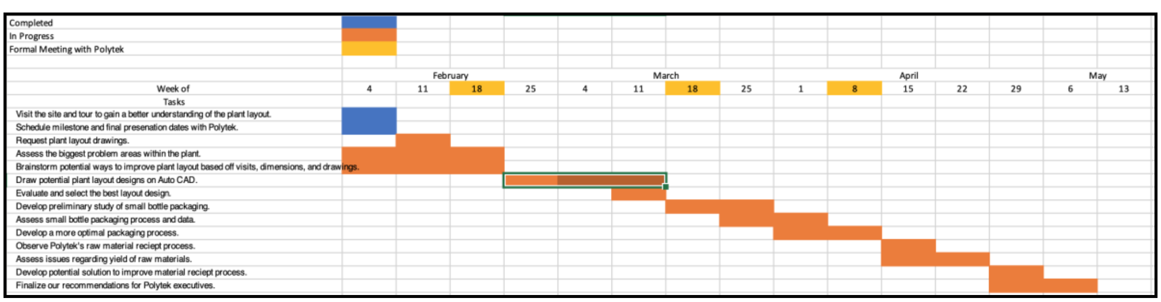
Deliverables:

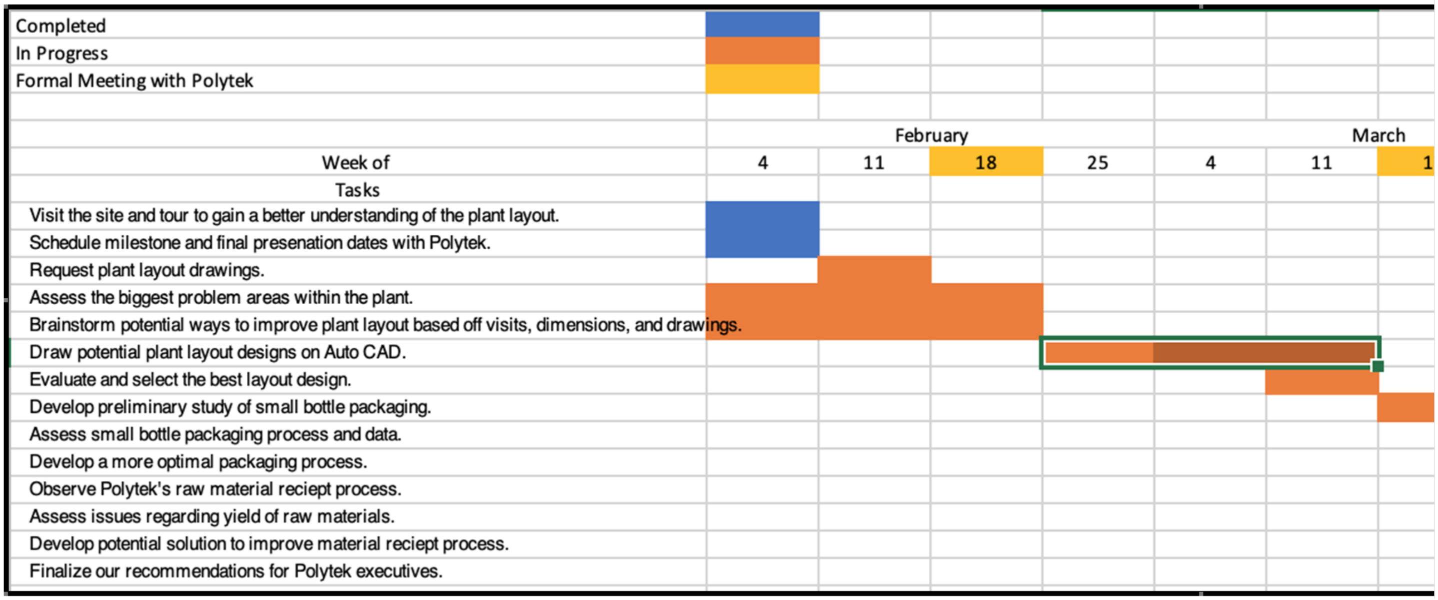
1. Research findings and preliminary designs including a ranked list of suggestions of alternatives deserving further investigation due to their promising nature and recommendations.
2. Set up simulated network of the chosen design alternative (to be approved by management after our presentation of design recommendations and our research findings).
3. Accessibility, reliability data on the performance of the simulated network along with projections and estimates of the same information for the system when fully implemented on the actual XXXXXXX network.

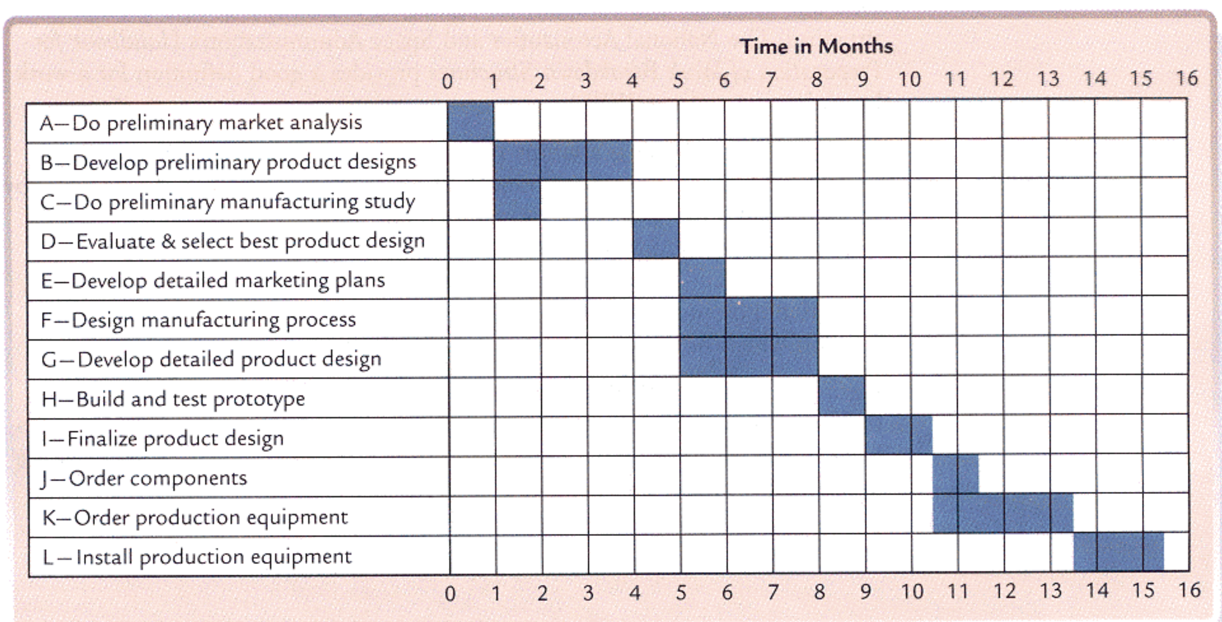
Additional Submissions:

1. Weekly work log and Client Interaction reports to be submitted to Professor Zimmers and the client.
2. Progress reports submitted at various points throughout the semester.
3. Individual Video Presentation during week of April 30 to May 4
4. Final Group Class Presentation during week of April 26 and April 27
5. Final Project Report May 7

Example Gantt Charts




Completed
In Progress
Formal Meeting with Polytek
February
March
Week of
4
11
18
25
4
11
Tasks
Visit the site and tour to gain a better understanding of the plant layout.
Schedule milestone and final presenation dates with Polytek.
Request plant layout drawings.
Assess the biggest problem areas within the plant.
Brainstorm potential ways to improve plant layout based off visits, dimensions, and drawings.
Draw potential plant layout designs on Auto CAD.
Evaluate and select the best layout design.
Develop preliminary study of small bottle packaging.
Assess small bottle packaging process and data.
Develop a more optimal packaging process.
Observe Polytek's raw material reciept process.
Assess issues regarding yield of raw materials.
Develop potential solution to improve material reciept process.
Finalize our recommendations for Polytek executives.


Time in Months
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
A—Do preliminary market analysis
B—Develop preliminary product designs
C—Do preliminary manufacturing study
D—Evaluate & select best product design
E—Develop detailed marketing plans
F—Design manufacturing process
G—Develop detailed product design
H—Build and test prototype
I—Finalize product design
J—Order components
K—Order production equipment
L—Install production equipment
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Bimbo Bakeries USA – Hazleton Cakes: Weekly Report – Page 1 of 1

To: Dan Mulholland

CC: Doug Sunday, Company Contacts

From:

Date: November 18

Subject: Bimbo Bakeries USA – Hazleton Cake Update – w/e November 19

Accomplishments for this week:

- Simulation
  - Continued work on Arena Simulation model
  - Recorded process times for Pearson and HSR
  - Began working on animation
  - Meetings with Doug Sunday on November 15 and 16.
- Overtime analysis
  - Recorded data received from Michele Sodrosky regarding OT
- Final Presentation
  - Confirmed for Monday, December 12th at 10:00 AM

Upcoming goals:

- Complete Arena Simulation model for Line 1
- Conduct hopper agitator experiment for Chocolate Chip Loaf product (if possible)
- Follow-up as necessary regarding implementation of VFD for depositor (anticipated by Thanksgiving)

Comments:

Due to next week's holiday, the plant will be closed Thursday, November 24 – Friday, November 25.

I will follow up regarding the status of the VFD for the Line 1 Depositor with a target experiment date of Friday, December 2.

If implementations have not occurred by Friday, December 2, but are expected the following week, I may need to become available, and will do so as schedules permit to provide adequate time to analyze the data and include in the final presentation.

At a minimum, the final presentation will include topics regarding: findings regarding overtime reduction as a result of throughput increases, Line 1 batter depositor agitator experiment, and Arena Simulation analysis.

PPL: Weekly Report

To: Company Contacts, Doug Sunday

From: Tim

Date: 11/14

Subject: BBNP CWWRP Evaluation

Accomplishments Versus last week's plan:

- Continue to develop mathematical model to accurately describe situation
  - Ongoing
- Complete and submit project update to Professor Smith
  - Completed
- Work on draft of term paper
  - Completed
- Continue to investigate how full blow down pipe will be, and how materials of construction for the pipe will affect heat transfer.
  - Ongoing

Next week's plan:

- Continue to develop mathematical model to accurately describe situation
- Work on draft of term paper to produce final paper on Dec 6th
- Continue to investigate how full blow down pipe will be, and how materials of construction for the pipe will affect heat transfer.
- Prepare materials for next meeting in early December.

Example of Progress Report

To: Dr. Emory W. Zimmers, Jr.

From:

Progress Report

A new process design is required. The Portion Control Lines are currently wasting a lot of time during the changeovers. We observed a modified final changeover from KFC BBQ to Burger King Sweet & Sour on Thursday, 10/5. We learned that it is a very lengthy procedure, but that it can be expedited. The definition of a changeover is the time gap between the last product A to the first product B. The time they took to do the change over was approximately three hours. This practice is not satisfactory and it is costing the company a lot of money.

We have started to enter data from the downtime logs regarding all downtime, not just that from the changeovers. We will continue to enter this data for downtime only, unless Cindy _____ requests otherwise. The following is a list of the data gathered to date:

- List of the Hassia products (lines 9,12).
- Product changeover matrices for processing and packaging sections.
- Procedures for various changeovers for the packaging section.
- Down time log for both sections of the line.
- Microsoft Access ‘forms’ for past data.
- Observed a changeover from KFC BBQ to BK Sweet & Sour.

The following was noted during the modified final changeover on 10/5:

- The worker doing the changeover on the packaging section was relieving another worker on a running line in order to finish the tartar sauce order. They said there were not enough hours in the week to finish the order and it had to get done.
- Many times, when the packaging line is almost done with the changeover, they have a big problem with the registration, which is often not ready when the product is.

Example of Progress Report

To: Dr. Emory W. Zimmers, Jr.

From:

Subject: Progress Report on Kraft Project about Cleanout Training Manual for Pourables Using Newly Designed Procedures

Date: October 7

Objectives: Creation of a system for documenting processes as a reference for current employees and for the purpose of training new employees. The system will include both manuals and video reference materials.

Progress to date:

Assessments and recommendations on the 8oz Pourables Line have been made by the project group who did the work.

Progress to date on the cleanout training manual for pourables is as follows:

- Initial visit to Kraft has been made. Met with contact person Ray _____, Kermit ______, who managed the implementation of upgrades for 8oz Pourables line and Tim _________, who is the supervisor in charge of the line for changeovers.
- Got introduced to the system and got familiar with the work done on the line.
- Information for the four different pourable changeover procedures has been received from the Kraft Personnel.
- Project report for the changeover improvements for 8oz pourables has been received.
- Project report has been analyzed to get familiar with what the system is and what changes were made.
- Pourables changeover procedures were analyzed to understand how the job is done and an initial discussion on how to structure the manual has been done in the project group.

Next steps:

- Second trip has been planned to Kraft to observe the changeovers for Friday, October 10th (If there is no changeover, trip will be postponed to Monday, October 13th).
- Decisions on how to structure the manual and how detailed it should be will be finalized.
- Each different procedure will be observed as preliminary studies for the manual.

Bimbo Bakery, Albany, NY: Weekly Report

To: Dan Mulholland, Doug Sunday, Company Contacts

From: George and Ken

Date: 8/8

Project Name: Bimbo Bakery, Albany, NY Project

Accomplishments versus last week's plan (8/1 – 8/7)

- Manual implementation of recommended load distribution scheme.
    - Complete
- Collect data on current and new load distribution schemes.
    - In process
- Collect data on and investigate turned loaves problem.
    - In process

This week's plan (8/8 – 8/14)

- Collect data on current and new load distribution schemes.
- Investigate turned loaves problem.

Comments

None.

Avantor
Weekly Report

To: Dan Mulholland, Mentor

From: Julia

Date: June 13

Subject: Avantor WWTP

Accomplishments versus last week's plan:

- Talk to WWTP staff about data, what they collect, where exactly it is collected, etc
  - Complete
- Determine data that could present trends
  - Have begun process
- Gather recorded ranges for different parameters of normal WWTP operation
  - Have greater understanding of ranges
  - Definite ranges in manual
- Revise WWTP schematic, talk to WWTP staff about accuracy
  - Complete

Next week's plan:

- Complete tables of inputs and outputs to system
- Meet with Jim and touchbase
- Determine data that could present trends

Company Name
Weekly Report Template

To:

From:

Date:

Subject: Project name

Accomplishments versus last week's plan:

(Copy prior week's goals into this section. Then, use sub-bullets to indicate what was accomplished – either completed or current status)

- To calculate the reorder point and safety stock
    - Received holding cost today
    - Still need to complete calculation
- Correct invalid data on ethyl acetate raw material data sheet
    - Completed
- Modify process map
    - Completed
- Calculate cost savings that will result from the connection of the three receiver tanks
    - Still validating cost savings
- Analyze QC test data
    - Received QC test data from Ryan
    - Analyzing
- Receive inventory holding cost value from Matt
    - Completed and received as of Monday

Next week's plan:

- Finalize calculation of the reorder point and safety stock
- Validate total cost savings from the connection of the three receiver tanks
- Complete analysis of QC test data
- Determine scope of final presentation

Comments: Include anything you believe you should say regarding your project. Indicate surprise findings, concerns, questions, and/or where you need our help.

Example of Clear and Direct Meeting Report Style from a Larger Project

July 29,

Sam :

XYZ Building Systems

Re: 7/25/ meeting at Enterprise Systems Center

Sam:

This report provides the minutes and results of the meeting at the Enterprise Systems Center on July 25, (4:30 – 6:45 PM) scheduled to continue with the design for the ideal future state (IFS) for a XYZ Plant. Attending the meeting with us were Don XXXXXX, Charlie XXXXX, Jose XXXX, and by teleconference Jeff from Bloomington and Harry from Sandusky, OH.. The meeting results and responsibilities follow.

Review minutes and assignments of 7/18 meeting

- The minutes were approved after some wording corrections.
- Harry completed the video-conferencing connections in the plant.
- Nothing new to report on the adhesive investigation.
- Jose completed the Gannt chart in MS Project Manager of the "As-Is" using the time estimates provided by Jeff. 36 tasks over 40-days.
- Jeff had no additional cost information for in-house build of the opening cutter.
- There was no progress on the panel take-off decision process
- Don/Charlie/Jose presented additional research into two-axis CNC controlled EPS wire cutting machines for cutting window and door openings automatically.
- Don submitted a detailed plan with calculations for forming a metal header. All drawings were presented using Don CAD.
- Don submitted the deflection calculations for Jeff's proposed ¾" drive screw for the opening cutter machine.
- Don also submitted a second-round drawing of a wall segment assembly fixture.
- Charlie led discussions of the IFS plant design using an updated AutoCAD drawing prepared by George.

Internet video conferencing

- Harry and Jose had the video camera operating in the Bloomington plant, displaying real time in the ESC projection room.
- Internet log-in is User is XXXX, password is XXXXXX.
- We moved to the conference room to gain telephone conference and maintained the video projection.
- This was very effective, allowing the group to see all of the existing equipment and take digital photos of the critical areas.

- Bloomington has DSL but does not have high-speed cable connection; therefore we had some choppiness waiting for the image to download. **Harry** will investigate upgraded Internet service. **Jose** will obtain the administrator's password to allow full video file saving to disk.

Virtual Plant Tour - observations

Harry and John conducted a virtual plant tour via the video-conference and cell phone. Jose managed the technology in Bethlehem and captured a series of digital photos of each critical area. There were several interesting observations:

1. The "knife" is a wire bent to form the channel cut-out dimension. This must be standardized.
2. The panel moves readily down the 4% slope that is built into the groover discharge.
3. The steel studs stay embedded into the grooves when a panel is lifted into a vertical position after a stud is placed into the groove.
4. Sufficient detail was obtained to create a reasonably detailed scale drawing of the footprint.
5. The ceiling height is only ten feet.
6. The panel handling is on one side and the metal works on the other side with the assembly floor area in the center. There is an exterior garage door in the center.

AgilePA Project Proposal

Bob will inform the group when the project is officially approved.

Wall panel shop drawing take-off form

No additional work was accomplished on this task. **Sam** will arrange for copies of the initial production house layouts to be provided to Jose for empirical development of the decision trees and algorithms. An additional specific task was added: including the header specifications as part of the take-off that may be summarized in a separate schedule for the house.

Panel assembly & squaring fixture

Don presented a second draft of an assembly fixture to continue brainstorming. **Don** will lead brainstorming with **Bob and Jose** for the best way to accomplish each function and then how to meld them together in an optimum method.

Jeff commented that he felt requiring the tie-screws to be applied from a vertical position would be too physically stressful for the operators. He suggested testing the force required to attach the self-tapping screws. **Sam** will bring samples back from his trip for an exact test to be performed. Alternate attachment methods will also be investigated.

Opening cutting device

Charlie investigated the cost of drives for assembling this device in-house. The motors are not costly, however, the minimum of two drives required cost $1500 each.

Don made recommendations for the slide system required for an in-house machine. He calculated that a 10' stainless steel ¾" rod will deflect ¾" under its own weight plus up to an additional 1" loaded. Therefore, this design would require supports at two-foot intervals.

Sam requested that **Charlie** continue to investigate the options for purchasing a two-dimension automated wire cutter.

Metal Headers

Don presented detailed calculations and production methods for creating metal headers. **Sam** will take these for **Jeff**'s review and comment. There was agreement on the value of pursuing this approach and that engineering seals must be obtained in LA using existing connections.

"IFS" plant design

Charlie reviewed the latest AutoCAD drawings with the group. Several additional design criteria evolved.

1. We agreed to include PLC design into the system to control the flow logic.
2. A device is required to guide the panel through the channel knife.
3. The channel knife only requires adjustment once per house.
4. The groove knives will be mounted on two independent housings. The two-position end knives with the two stationary knives on one support and the three variable knives on another.

Project Priorities and Assignments

Steve

- Investigate alternate adhesives for the EPS connections.

Sam

- Take Don's drawings and calculations to Bloomington for review and comment.
- Bring samples of actual studs with holes punched and screws for the force study.
- Bring additional house design architectural prints for Bob.

Harry

- Investigate ability to improve band width of the Internet connection and obtain a tripod.

Jeff

- Review the steel header design and calculations. Be prepared to comment.

Jose/Don

- Begin scenarios for line balance of IFS using MS Project.
- Design third draft of assembly table using brainstorm results for individual operations.

- Develop panel take-off methodology and decision rules with Bob. This should be suitable for training a panel engineer and panel groover plant operator, including quality and efficiency standard expectations.

Charlie

- Focus on plant design for IFS, particularly transfer of EPS panels from channel groover to opening station and then to assembly station.
- Continue investigation into purchased opening cutting equipment.
- Develop automation plan for knife placement of grooves and hot-wire movement for openings.

Bob

- Develop panel take-off methodology and algorithms with Don/Jose.

Next meeting: 4:00 PM Wednesday August 2, ESC 2nd Floor

Sam will be in Bloomington next week. The meeting will focus on brainstorming the three main tasks:

- Panel take-off method
- Panel assembly method
- IFS plant design

There will be no conference call to Bloomington or formal assignment review. This will be strictly a work session. Bob should make an effort to attend or schedule a separate meeting to review take-off progress.
Thanks,
Steve
Cc. Jeff, Harry, Don, Charlie, Bob, Jose, Dr. Smith,

EXAMPLE WORK LOG

	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
7:00-8:00							
8:00-9:00							
9:00-10:00							
10:00-11:00			Meet with Mentor				Skype w/Mentor
11:00-12:00							
12:00-1:00							
1:00-2:00	Data Analysis				Work at Client Site		
2:00-3:00	Data Analysis				Work at Client Site		
3:00-4:00	Team Meeting				Work at Client Site		
4:00-5:00							
5:00-6:00							
6:00-7:00							
7:00-8:00							
8:00-9:00							

Industrial and Systems Engineering Department

Capstone Course

Sanitized Project Title
OR if company approves we insert their company name & Logo
Fall Semester 2019

Project Objective

Clear statement of design problem/project objective

Company Background

May need more generic description if company requests that the presentation is "sanitized" (usually can be obtained from mentor or company website)

Design Process

1. Procedure/method of Approach (including specific techniques and design tools employed)
   - Refer to syllabus pages 11-19 and 21-22 (techniques need to be linked to courses and IE curriculum)
2. Analysis (including cost/benefit projections (if possible) and analysis tools utilized)
3. Overview of Design and discussion (e.g. of positive features and potential extensions of work, e.g. follow-on phase if appropriate)
4. Implementation Recommendations (for system designs)/ R and D opportunities (e.g. future work and ISE techniques to be used)
5. Additional input may be suggested by mentor

Exhibits

Emphasis should be placed on rapid communication of key techniques and deliverables using diagrammatic, graphical, photographical approach

Could be dynamic (e.g. video or animation) to help in understanding.

Student Impact

Quotes from students

See sample posters on Course Site

Company Impact

Quantified Value Add, Dollar Value Impact Estimates

Explain how obtained

Potential Research Opportunities

(Potential for creation of new knowledge that is fundable and relevant)(Capstone Course work executed by creative and entrepreneurial mindset students is a critical part of the University ecosystem (e.g. it feeds into the research development functional area))

Team Members | **Acknowledgements**

Industrial and Systems Engineering Department
Capstone Course

[redacted] **Forecast Optimization Project**

[redacted]

Project Objective

The nature of this project was to optimize the forecasting process for the production scheduling team at [redacted]. [redacted] current method of forecasting entailed the use of several Excel spreadsheets that were manually sourced into a template file. This process was highly prone to human error as a great deal of forecast imprecision could propagate from simple mistakes like sourcing the wrong the SKU codes or entering incorrect values. To mitigate the chances of mishandling data, our team delivered two highly functional tools that would reduce the impact of human error considerably, in addition to a comprehensive business analysis based on recent sales data.

Company Background

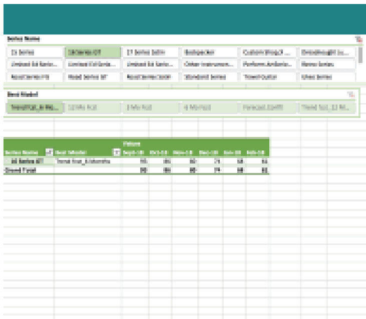
[redacted] This project was aimed at accounting for every product's recent sales history and leveraging that data into actionable insight in the form of a comprehensive forecasting tool.

Design Process

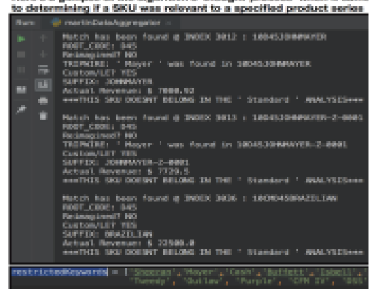
The following outlines the design project objectives. Objectives were then bifurcated into short term and long-term objectives. Short-term objectives should be accomplished by the end of the Fall 2018 semester, and long-term objectives should be accomplished thereafter.

1. **Review current Excel forecast model *(Short-term)***
   Evaluate forecast accuracy as compared to industry comparison and best practice
2. **Review/Analyze current historical sales data *(Short-term)***
   Provide analysis of trends, grouping alternative, etc.
3. **Perform Forecast segmentation analysis at SKU level**
4. **Review Syteline and Board *(Short-term)***
   - Research demand planning capabilities
   - Determine options for sales forecasting / demand planning
5. **Create SKU data aggregator in Python *(Short-term)***
   - Parse ERP output data
   - Develop algorithm to aggregate sales data from SKU level to product family
   - Incorporate ability to export to Excel
6. **Develop Monthly statistical forecasting model *(Short-term)***
   - Generate 12 forecasting models
   - Determine forecast accuracy using mean absolute percentage error based on historical data ("MAPE")
   - Develop interactive dashboard to simplify forecast
7. **Verification and Validation *(Long-term)***
   - Ensure two models are generating the same output
   - Continue to check accuracy of forecasts to validate models
   - Consolidate output as much as possible
8. **Demand planning work process *(Long-term)***
   - Perform work process mapping of current demand planning activities
   - Identify process improvements – streamline process / reduce cycle time
   - ERP add-on fit assessment

Exhibits



Here's a glimpse at the algorithm's 'thought-process' when it came to determining if a SKU was relevant to a specified product series



Student Impact

It was very rewarding to work on a project that drew upon so many aspects of our industrial engineering curriculum. Though there were many challenges along the way, this project gave us invaluable experience as it demonstrated that most real-world solutions do not conform to the niceties of textbook theory so much as they are subject to the iterative process of constant questioning and reformulation.

Company Impact

Both the Python data aggregator and the dashboard spreadsheet tool will significantly reduce the time needed to draft a forecast from a month down to a few minutes. The value creation from a streamlined forecasting methodology cannot be understated as it is a crucial element to any company's tactical planning. What's more, this revitalized platform will be accommodating to future product nomenclature changes.

Potential Research Opportunities

Additional design improvements and future work can be directed toward developing a solution that may supplant the necessity of purchasing a proprietary ERP plugin. The rationale behind our choice to build a Python framework was so that a web interface could be connected to diminish the need to purchase an expensive plugin. The benefits of an internal web interface would be made manifest by having a real-time forecast analysis available to any manager's device within the organization.

Enterprise Systems Center

Team Members

[redacted]

Acknowledgements

[redacted]

LEHIGH UNIVERSITY

Industrial and Systems Engineering Department
Capstone Course

LEHIGH UNIVERSITY

The Enterprise Systems Center partners with the ISE Department to provide funded industry projects, experienced mentors, laboratory facilities and leadership development.

Finishing Process Redesign – Spring Semester 2018

Project Objective

- Improve the material flow in Finishing Stage
- Reinvent the Finishing Process
  - Reduce the Non-Value Added Activities
  - Redesign the drying process to improve efficiency
- Cut lead time from 4 days to 2 days

Company Background

Founded in 1983, the company is a premier designer, manufacturer and distributor of fine garden accents to independent garden centers throughout the United States and Canada. The company is headquartered in Pennsburg, PA where it houses its offices, showroom, production, warehousing, and shipping operations. It also maintains a showroom in Atlanta, GA.

Design Process

Approach

- Conduct time study and work methods analysis
- Develop process and material flow chart
- Map and redesign area layout using AutoCAD
- Interview workers about process problems
- Reduce waste in system and standardize work methods
- Detailed solution design
- Financial costs and benefits estimate

Current State Observations

- Excess touchpoints for the pallet queues in the front of finishing line
- Lack of standardization across flow and processes
- Excess non-value added actions
- Long drying time leads to long idle time for workers
- Unnecessary unloading actions

Future State Design

- 3-Pallet sized set of rollers built into the floor right before Finishing lines
- First slot will have powered lift
- RFID for automated material data tracking
- Standardize methods of painters based on best performing workers
- Display live metric (Average Standard Cost) on TV screens in the Finishing lines area to track performance
- Combination of fans and heat tunnels to control and shorten drying time

Impact Analysis

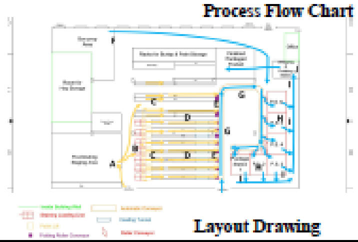
- Reduce excess touchpoints and staging area waste in system
- Eliminate unnecessary unloading time
- Standardization
- Optimize worker energy and improve ergonomics
- Eliminate NVA time
- Screen shows performance will help manager to monitor operation
- Improve throughput rate

Implementation Recommendations

- **Phase I (short-term)**
  - Set up the new drying lines with fans and heat tunnels
  - Apply new metric display system
  - Standardize methods around new layout
- **Phase II (medium-term)**
  - Fully integrate with new RFID tracking system
- **Phase II (long-term)**
  - Fully automate conveyor system

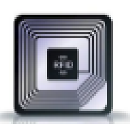
Exhibits

Process Flow Chart



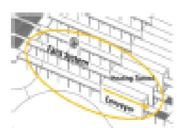
Layout Drawing

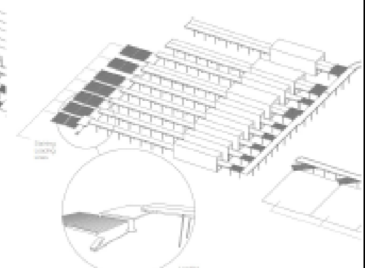
Performance Metric Screen



RFID Tracking

Preliminary Improvements Design And Features





Student Impact

- "Throughout the whole process, it was so cool how much creative freedom we were allowed in our approach to the problem." "We were able to use several classic industrial engineering techniques during our time observing and analyzing the current system at the company, it really made me value the ISE department here at Lehigh."

Quantified Company Impact

- Reduces drying time and increases the throughput in the finishing process up to 40%
- Eliminates extra touchpoints for loading pallets and saves 5 minutes per piece by adding rollers and lift
- Enables metric tracking for each individual finishing line and allows manager to supervise with more transparency.
- Eliminates unnecessary unloading actions at the end of finishing lines, can save up to 7 minutes per piece

Potential Research Opportunities

- Arena Simulation
- Finishing Formulation
- Just-in-time Production
- Andon System
- Circular Pallet Flow Model

ESC Enterprise Systems Center

Mission Statement

"Maintain the dual commitment of helping students learn, while simultaneously providing value for our clients." "Conduct research and undertake programs driven by industry needs and enabled by close partnerships and collaboration."

Team Members

Students [redacted]

ESC Mentors [redacted]

Acknowledgements

Other Support [redacted]

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