

University of Minnesota  
College of Continuing Education  
Program for Individualized Learning

Mechatronics

A dossier submitted to the graduation committee  
as a candidate for the Bachelor of Science degree

by  
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June, 2014

## Table of Contents

- I. Acknowledgements**
- II. Introduction**
- III. Criteria Summary**
  - A) Depth Criteria Summary
  - B) Breadth Criteria Summary
  - C) Learning Matrix Summary
  - D) Reading and Writing Criteria Summary
- IV. Narrative Transcript**
  - A) A Procedural Guide to Adjusting Motor-Controlling Equipment
  - B) Design and Construct a Holonomic Motion Platform and Control System
  - C) Design and Construct an Absolute Heading Sensor for a Mobile Robot
  - D) Design and Construct a Phase Difference LASER Range Sensor
  - E) Attracting Customers: Design and Construction of an Inverted Pendulum Mechanical System with a Closed-loop Control System for use at an industry trade show
- V. Course Work Transcripts**
  - A) Lakewood Community College (Now Century College), 1982 - 1984
  - B) University of Minnesota, 1985
  - C) University of Minnesota, 2000 – 2014
- VI. Major Project - *Implement a Robot for the Trinity College Fire Fighting Robot Competition***
  - A) Analysis
  - B) Proposal
  - C) Final Report
  - D) Evaluation
- VII. Illustrative Materials**
  - A) A Procedural Guide to Adjusting Motor-Controlling Equipment
  - B) Design and Construct a Holonomic Motion Platform and Control System
  - C) Design and Construct an Absolute Heading Sensor for a Mobile Robot
  - D) Design and Construct a Phase Difference LASER Range Sensor
  - E) Attracting Customers: Design and Construction of an Inverted Pendulum Mechanical System with a Closed-loop Control System for use at an industry trade show
- VIII. Degree Plan**

### Acknowledgements:

I wish to express my thanks to my Area Specialist Dr. William Durfee for his willingness to review my projects and to provide encouraging comments in his Narrative Evaluations.

I'd like to thank my Academic Advisor JoAnn Hanson for her guidance on proposal writing and for her patience over the last 12 years.

My gratitude goes to Dr. Maria Gini and Dr. Joseph Talghader for taking time to review projects for me.

I want to thank my wife Maggie Brissenden for her continuous support and occasional forceful and loving shove out of the doldrums of procrastination.

Finally, we all have Rebecca Sanders to thank for encouraging me to apply to PIL.

## **Introduction**

My path to a college degree was filled with twists, turns, dead-ends, ups, and downs. It started in the traditional way of moving directly to college after finishing high school. I started at the Lakewood Community College in White Bear Lake, MN in 1982 and my very first classroom experience was a predictor of many of my college experiences. When I was signing up for courses, I thought “Hey! A 6:30 am course in Calculus would be an excellent way of making sure I got started out right in my college experience.” On the first day of classes, I got ready early, rode my bike to campus, went inside, and there was no one in the building. 6:15 am is not a very active time on a college campus. No one was in the Calculus classroom, there were very few people in the building and around 6:45 AM I realized that the Calculus course I signed up for actually met at 6:30 PM. Wonderful!

My next class was at 11:30, so I went to a lounge and fell asleep for a long time. When I woke up, my body hurt from sleeping in a chair and I was tired and cranky. I felt like an idiot for not even knowing that of course no classes met at 6:30 AM. This experience stayed with me for quite a few years. College and I just did not get along. I spent the next two years struggling to stay engaged in my coursework at Lakewood Community College before transferring to the U of MN in 1984. I only lasted two quarters at the U of MN before dropping out of school and taking a full time job as a programmer at a local supercomputer company. It would be 13 years before I considered college again.

In 1998, I accepted a position at the University of Minnesota’s Center for Computational Genomics and Bioinformatics. The director of our group wanted us to learn as much as we could

about the new fields of Genomics and Bioinformatics, so he allowed us to take one course per semester during work hours without making up the time with extra hours. Around this time, my friend Becca Sanders who was also working at the University of Minnesota told me she had signed up for a degree program with the Program for Individualized Learning (PIL). She explained that this program allowed an adult student to use learning gained through professional activities to count towards a college degree. This sounded perfect. I imagined doing my normal work and being granted college credit. In addition, the U of MN's civil service employment granted employees free tuition, so this really seemed like the perfect way for me to work and earn a college degree at the same time.

Due to my terrible previous college performance (My cumulative Lakewood Community College GPA was 2.63, my U of MN Winter 1985 GPA was 1.625 and my Spring 1985 GPA was zero), I was conditionally accepted provided I attend the U of MN Spring 2000 and pass two courses with an acceptable GPA. My next challenge was to decide what courses to register for in order to demonstrate my commitment to pursuing a college degree through PIL.

Since I was working full-time, I felt it would be best to attend one course during the day and to take one course in the evening. I researched courses and looked for ones that would meet as many of my PIL criteria as possible. I knew that I needed a science course with a lab as one of my requirements, so I chose BIOL1009 General Biology as my day course. Choosing an evening course was more difficult. I had avoided liberal arts courses my entire college career, so I decided to dive into the liberal arts area immediately and see if I had what it takes to get through these kind of courses. Looking at the course guide for spring 2000, I noticed courses in American

Sign Language met in the evenings. The idea of taking a language course had not occurred to me previously, and seeing that these courses could fulfil several of my Breadth Criteria, I decided to sign up for ASL1701, the first semester of American Sign Language. This course would set me on a path that led to some unexpected learning and a change of attitude towards the liberal arts.

On May 22, after completing the spring 2000 semester with a 3.8 GPA, I was fully admitted into PIL. I attended a PIL Degree Planning seminar in the fall of 2000 and decided to commit to earning a Bachelor of Science degree through PIL. I spent the next several months writing up a degree plan in the field of Mechatronics which is the design, construction and programming of robotic systems. A new path to a college degree had been opened, and I was ready to run to complete it.

My area of concentration is the field of Mechatronics. This term is a blend of the words mechanical and electronics. It refers to the analysis, design, construction and control of mechanical systems moved by electrical machines and under the control of software. An example of a Mechatronic system is a robot arm working to perform a task at a factory. The robot arm has an arrangement of surfaces, joints, bearings and linkages designed using mechanical engineering techniques. The robot arm has electrical motors and sensing devices used to move and measure the position of those mechanical components. It has a programmable computer device that is used to receive information from the sensors and send signals to the motors to cause the arm to move in a way that will allow it to accomplish the desired task.

The field of Mechatronics refers to the process of designing a complete robotic system

using knowledge from the disciplines of electrical engineering, mechanical engineering and software engineering. I have chosen to include specific courses in my area of concentration to gain knowledge in each of these disciplines. At the conclusion of my degree program, I was able to demonstrate knowledge in the fields of electrical engineering, mechanical engineering and software engineering through coursework and projects in order to earn a Bachelor of Science degree in the field of Mechatronics.

You likely interact with machines designed using the principals of Mechatronics many times every day. When you put gasoline into your car, the gasoline pump uses many Mechatronics designs. The lever in the handle signals the gasoline pump to begin dispensing gasoline using a electrical signals. The pump measures the amount of gasoline dispensed using mechanical systems, electrical sensors and software. These devices were all designed using knowledge from the field of Mechatronics.

I encountered some challenges during my PIL degree program. One of them was due to the gap in time between the first part of my college career in the early 1980s and the second part of my college career in the early 2000s. A shocking example of this happened the first day of ME5283 System Dynamics and Controls. I walked in, took my place at a desk and waited for the professor to enter the room. He entered, introduced himself and the course, and said “We'll start the course using the multi variable calculus techniques you learned last semester in your mathematics curriculum...” He then started writing and explaining course material using calculus that I had not seen or used in over 15 years. I knew I was not going to succeed in this course unless I immediately refreshed my calculus knowledge. I got out my first-term calculus books

and spent the next two weeks intensely studying calculus in order to get the background required for this course. As I improved my calculus knowledge, I realized that my algebra knowledge was also quite stale. This worried me even more because after two weeks of coursework, I saw that there was much more algebra than calculus required to solve the course problem sets. Luckily, I discovered a calculator that performed symbolic manipulation automatically, so I could use that device (with the instructors permission) to assist me in the complex algebra operations for this course. This device did not exist the first time I went through calculus, and it was a wonderful addition to my set of mathematical tools. I was relieved to learn of its existence. I believe it helped me earn a passing grade in this course.

Studies in my Depth Criteria were divided into two parts: Learning gained through attending University courses; and learning gained through individualized projects culminating in my Major Project. Through coursework, I gained knowledge and skills in the mathematical analysis of mechanical systems through MATH 0141 *Calculus 1*, MATH 0142 *Calculus 2*, MATH 0143 *Calculus 3*, MATH0281 *Calculus 4*, ME3281 *System Dynamics and Control* and ME5286 *Robotics*. I gained additional knowledge in software design through DP0141 *Engineering FORTRAN*, DP0271 *Operating systems design* and DP0256 *Data communications and Distributed Processing*. The knowledge I gained in these courses were the foundation I built upon to be able to successfully complete my PIL projects. My PIL projects built on my coursework and extended my learning beyond that gained in mostly theoretical coursework. My PIL projects were structured to build on one another culminating in my major project. Each project took an aspect of coursework learning and extended it into practical “real-world” demonstrations of knowledge.



There were several areas of unexpected learning outside my area of concentration. I needed to take many liberal arts courses to meet the breadth requirements in my degree since I had mostly taken science courses in the first part of my college career. I decided to take a full two year course in American Sign Language to meet Breadth Criterion 6: Understanding of Place. Initially, I chose this course because it met in the evenings, and would fit well into my schedule. That was a fortunate accident since I really enjoyed learning about deaf culture and language. Over the course of the next two years I would become friends with several of the other students. Several of us made sure to register for the same course so we could see each other often. Learning about deaf culture taught me about the importance of having a group of individuals you can rely on for support with normal and difficult life activities. Members of the deaf community have very close relationships with one another and that made me feel a close affinity towards my classmates. One unexpected learning event occurred when we went to a rock concert performed by and for the deaf community. This concert was wonderfully and incredibly loud. It's almost like a recruiting drive for the deaf.

I also encountered a situation where my opinion differed dramatically with the predominant opinion of members of the deaf community. The view that deafness is a disease that can be treated and cured causes great distress in members of the deaf community. My understanding of their view is that deafness is a shared culture and not a disability. Current medical technologies like cochlear implants can be used to allow profoundly deaf individuals to hear well enough to not need sign language to communicate. This is seen as a threat to the deaf culture and there is great opposition to using these technologies. Sometimes whole families are

ostracized by members of the deaf community when they have a cochlear implant installed in a young child.

We understand that new scientific and technological breakthroughs can have both negative and positive effects such as knowledge of nuclear processes produce both innovative, life-saving medical treatments as well as nuclear weapons. I did not anticipate that devices that can help deaf people hear would be seen as such a good and evil device. Given some moderate breakthroughs in hearing treatments, we may be the last generation to have an active deaf culture. I am conflicted about this. On one hand, the elimination of the deaf culture would be a loss, but the elimination of deafness itself would be a gain. I cannot imagine people fearing the elimination of Leper colonies and that culture through the elimination of Leprosy, but eliminating deafness and the resulting elimination of the deaf culture is something that many members of the deaf community oppose. I did not expect to have this kind of experience when I signed up for my first American Sign Language course. I am glad I did, it enriched my understanding of a group of people with whom I had no prior contact. I learned about how much members of the deaf community value the deep connection they feel for one another through their shared experience. Although I do not wish to be deaf, I do wish I had a closer connection to others in my community. I have changed my behavior to try to build such a connection with others.

Another area of unexpected learning was a course ENGL 3040 – Studies in Film. I took this course thinking it would be a silly liberal arts course, but I learned an entire new language of types of loss, descriptions of loss and the results of loss. The course consisted of watching a sad

movie, writing a one to two page paper about it and discussing it with the class. It was interesting seeing the younger students struggle to write and explain their responses to the movies. I had a very easy time recording my experience and talking about it with the class, but some of the younger students struggled to get their thoughts on paper and discuss them. After three or four weeks, we had a great close-knit class and nearly every student really opened up and started discussing the movies with much greater depth of analysis. This class taught me about how movie producers use cinematic elements such as color or shape to express very specific types of loss. One example of this is in the movie A. I. Artificial Intelligence by Steven Spielberg. In this movie, a humanoid robot named David is rejected by the woman he considers his mother. This results in David having a feeling of not being valued by anyone. Through the entirety of the movie, this loss of feeling valued is represented by the image of Earth's Moon. There are many times when the director uses images of the Moon at a distance or somehow unreachable by David to represent potential or actual loss. There are times when the image is outside a window, and David cannot position himself in order to view the full Moon. There is a very emotional scene where many robots are salvaging parts from a pile of discarded robots, and David sees a very large Moon rising over the horizon. He is excited and attracted to this until the other robots shout out in fear and run to escape the approaching Moon. David is unable to escape and is captured by a Moon shaped hot-air balloon. As the balloon departs taking David away, he is unable to hold on to his robot companion Teddy Bear and the bear is lost. The event leaves David without his companion and once again the director uses the image of the Moon to represent David's loss. I was surprised at the complexity and subtlety of the visual tools used by the movie producers to perform these tasks. I gained a better appreciation of the visual arts and the liberal arts as a whole through my experiences in this course.

My experience in PIL has taught me many things. I have verified that I love learning new things, I love being intellectually challenged and I dislike working alone. I will use these insights to structure my learning opportunities as a part of a group effort rather than individual effort. I have learned that I sometimes lack the discipline to complete a learning task alone, and that I thrive in group learning settings. I am a lifelong learner and I am excited for my next learning event. Using what I've learned at PIL, I will choose a type of learning that best emphasizes my skills and minimizes my weaknesses.

Next, you will find my updated criteria summaries, proposals and narrative evaluations for each of my projects, transcripts of the courses I took at Lakewood Community College and the University of Minnesota early in my college career followed by my coursework transcript from the University of Minnesota's Program for Individualized Learning. This is followed by my major project section which contains a reflective essay on my major project, the project proposal, the project report and narrative evaluation. The illustrative material section contains five projects from my Depth Area of Concentration:

1. A Procedural Guide to Adjusting Motor-Controlling Equipment
2. Design and Construct a Holonomic Motion Platform and Control System
3. Design and Construct an Absolute Heading Sensor for a Mobile Robot
4. Design and Construct a Phase Difference LASER Range Sensor
5. Attracting Customers: Design and Construction of an Inverted Pendulum Mechanical System with a Closed-loop Control System for use at an industry trade show

The final section of my dossier contains my original degree plan for reference.