Welcome to the 2013 Senior Design Clinic! What you see here today are 22 working prototypes which 8 months ago were nothing more than ideas. Ten companies and non-profits have engaged our students with the real life experience of asking, “is it possible?” then letting the teams go to work. The teams will all tell you that at times it got tough and they themselves weren’t sure how it was all going to unfold. And that is exactly what we are trying to capture in the St. Thomas Senior Design Clinic. Where the comforts of well-defined textbook problems are abandoned, real engineering emerges. What you see here today is the manifestation of that uncertain process of translating ideas into reality.

In short, what you see here today is engineering.

On behalf of the School of Engineering faculty, I would like to thank you for coming today. We are grateful for the support of the sponsoring companies and non-profits who have committed the funds, equipment, and time to truly make this a great experience for our students. And lastly, we are especially grateful for the support of the family and friends that each one of our seniors has relied upon to make it this far in their incredible life journey.

Again, thank you and enjoy!

Don Weinkauf - Dean of Engineering
To find out more about how your company can get involved with the Senior Design Clinic at St. Thomas, just call our main office.

(651) 962-5750

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Silicone Transfer Reduction

Team
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Faculty Advisor
Katherine Acton

Company Sponsor
Casey Arends

Project Summary
Andersen Corporation is one of the largest manufacturers of doors and windows in the world, producing more than 6 million doors and windows annually. One of the more popular windows produced is the 400 series double hung window. In its production, silicone is used as a sealant holding the outside frame member of the window to its wood counterpart. As the window components are pressed together in the line, silicone squeezes out to ensure a proper seal. This silicone squeeze out is uncured and possesses a sticky and malleable nature. As the window continues through the production line the silicone squeeze out transfers onto machine parts, sensors, and anything else it contacts. The transferring of the silicone is the cause of over 30 hours of unexpected downtime annually, amounting to over $25,000 lost. The growing problem gained attention and placed an emphasis on finding a solution.

Design Goal
The objective of this project is to reduce or eliminate downtime caused by excess silicone transferring on the 400 series double hung window manufacturing line. The team was tasked with designing and constructing a working prototype to be placed, and tested within the current manufacturing line at the Bayport, MN facility.

Design Constraints
- Device must operate autonomously between break times (2 hours)
- Device must adapt to changing window sizes on the line
- Must be able to operate for entire shift, averaging 800 windows over 8 hours
- Device may not interrupt production line
- Device must not add to existing station cycle time of 19 seconds
Reservoir Volume Sensor and Over-Pressurization Prevention Mechanism

Team
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Clinic Advisor
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Industry Representatives
Alex Espe, Keith Miesel, Nicholas Whitehead

Project Summary
The Medtronic SynchroMed II programmable infusion system for intrathecal drug delivery is an automatic pump device that dispenses precise amounts of medication from a reservoir. The current model relies on internal pump firmware algorithms and memory lookup tables based on catheter measurements to gauge the volume of medication within the reservoir. This project seeks to design and test a proof-of-concept prototype of a sensor-based method for accurately gauging volume while preventing over-pressurization of the reservoir - the Reservoir Volume Sensor and Over-Pressurization Mechanism (RVS-OPM) outlined in U.S. Patent #8083730.

Design Goal
The objective of this project is to develop and augment a proof-of-concept prototype based on Medtronic’s patented design concept utilizing Linear Variable Displacement Transducer (LVDT) sensor technology that the company hopes will accurately determine the volume of medication within the reservoir with reduced overhead and complexity, and that is not corrupted by MRI exposure.

Design Constraints
- Circuit supply voltage range of 0V – 3V
- LVDT coils must not draw more than 10mA
- Must prevent overfilling by closing off reservoir when full
- Must fit within cylindrical volume with diameter of 0.3165 inches and a depth of 0.413
- Must include hermetic barrier between fluid path and electronics chamber
Unmanned Aerial Vehicle (UAV) Autopilot with System Identification

Team:
Billy McKee, Ryan Delaney, Dan Rosenthal, Matthew Schmidtbauer, Neil Zumwalde

Clinic Advisor
James Ellingson and Christopher Greene

Industry Representative
Scott Morgan and Todd Colton

Ground Control System, interfaced with a consumer laptop. As an acceptance method, the team will be comparing testing data gathered from the system with both computed and simulated values for the controls gains.

Design Goal
To create a system identification toolset for fixed-wing, unmanned aerial vehicles.

Design Constraints
- Total cost of less than $1500
- Must be capable of providing real-time position, altitude, and velocity data
- Must be capable of autonomous and manual flight
- Must be based upon the Paparazzi autopilot software suite
- The system must operate on a standard laptop

Project Summary
The University of St. Thomas’ Unmanned Aerial Vehicle (UAV) team is developing an autopilot system that will determine the controls gains of the airframe that it is installed in by using a system identification toolset they develop. By modulating Paparazzi, an open-source autopilot software, and by programming an autonomous set of maneuvers, the controls gains of the aircraft can be calculated onboard the UAV. The autopilot will be able to be controlled via a
Basketball Training System

Airborne Athletics recently developed a ball return system that installs on most home basketball goals. The company sponsor approached the Design Clinic to improve the design. The current system (the iC3) shown in the figure is the only at-home basketball trainer that combines high-reps with proper arc shooting for improved performance. The current system has been shown to increase shooting repetitions by 300% with up to 16 shots per minute. The improved design will allow individuals to train smarter to improve faster. Airborne Athletics makes several types of basketball training equipment, including systems with customizable practice drills, shot counters, and software and sensors for recording training. The design from this year leveraged the sponsor’s strengths to improve the design of the iC3. (The final design will not be available at the Show because the company is in the process of securing IP.)

(Erik Wimme, Brian Nyberg, Thomas Metzler, Josh Pozner)
Negative-Pressure Breathing Device

Team
Andrew Coleman, Erin Foley, Neel Sharma, and Taylor Trowbridge

In cooperation with
Fredrik Kronqvist (Royal Institute of Technology, Stockholm, Sweden)

Clinic Advisor
Surya Iyer

Industry Representatives
Mark Radbourne (Breathing Innovations), Lars Oddsson (Sister Kenny Research Institute)

Project Summary
Historically, patients suffering from extreme breathing difficulties were confined to negative-pressure chambers to improve their condition. Currently, the medical solution for such issues is via the use of positive-pressure ventilation devices (CPAPs). While the current devices do successfully assist in helping patients breathe, these devices reduce mobility and have associated health risks due to forced airflow.

Breathing is a negative-pressure mechanism, drawing air in as the lungs expand. This device aims to improve the natural breathing mechanism, reducing other medical complications, while also increasing mobility and comfort for users.

Design Goal
The objective of the project is to develop a wearable, portable, negative-breathing assistance device.

Design Constraints
- Deliver 1-1.5 inches of compression to the abdomen
- Deliver no more than 15 pounds-force to the abdomen
- Have manual and electrical safety mechanisms
- Entire device weigh less than 10 pounds
Inspection Presentation
System

Team
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Nathaniel Roweckamp

Clinic Advisor
Chris Haas

Industry Representative
Steve Floeder

Design Goal
The final goal is to develop a high precision, highly customizable film inspection system for the simulation of current 3M optical film inspection systems and for the research and development of new optical film inspection systems.

Design Constraints
- The Z movement of the sample tray must be limited to 500 microns when the sample tray is in motion.
- The inspection equipment (lights and cameras) must be rigidly mounted to the inspection stand and adjustable within the range of inspection.
- The sample tray motion is driven by either an AC or DC servomotor and servo drive.
- A simple Windows computer program will be written in order to communicate with the sample tray control system.

Project Summary
The team developed a highly customizable, high precision optical film inspection system with the Film Manufacturing Supply Chain Operations group at 3M. The films 3M manufactures are used in LCD screens for display protection, information privacy, and display enhancement. At 3M, our system will inspect film found within cell phone and TV LCD screens. The system has a twofold purpose. First, our system will simulate current 3M globally deployed inspection systems to identify and remedy issues within the system. Second, the system will aid in research for developing production inspection methods for new products. The system will enable a 3M application engineer to easily configure optics and imaging for film while gathering functionality data for a product under investigation.
Project Summary

Oil is one of the most sought after natural resources today. When oil is extracted from the ground, multiple fluids are present, such as water, oil and gases. There are several methods currently used throughout industry to measure the composition and flow rates of these fluids. The most common method used today employs gamma ray radiation. This is undesirable because of security and environmental issues regarding a nuclear source as well as being prohibitively expensive for some installations. Emerson has asked the team to create a system that is capable of measuring the composition and flow of these fluids utilizing differential pressure measurements.

Design Goal

The objective of this project is to design a prototype capable of keeping the fluids mixed within one regime, along with being able to measure the mass flow rate and percent composition by using the differential pressures of a multiphase flow consisting of water, oil, and air.

Design Constraints

- Prototype will be able to handle pressures up to 120 psi and flows up to 60 GPM
- The flow composition is to remain in one flow regime throughout metering sections
- Measure the composition and flow rate of mixture with less than or equal to ± 10% error
Paint Booth Improvement

Team Members
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Clinic Advisor
Dr. Robert Monson

Industry Representatives
Steve Joseph, John Henderson

Project Summary
The team worked with the Automotive Aftermarket Division of 3M to develop a solution to improve the efficiency of the painting process in automotive shops. The system uses a pneumatic air knife to blow compressed air over a freshly painted surface, creating a buffer zone of clean, purified air directly over the part. While the project was initially focused on preventing particle contaminants from landing in the wet paint, it was discovered the solution drastically reduced drying time of paint as well. If implemented, the prototype would reduce labor costs of the machine shop because painters will not have to wait as long for their paint to dry. It also decreases the amount of defects that occur during the painting process.

Design Goal
The goal was to improve the efficiency in the painting process in automotive shops.

Design Constraints
- Solution must be automated (require little or no set up from the painter)
- Solution cannot have any sort of ignition sources (electricity, rotating components capable of static discharge, etc)
- Solution can’t get in the painters way while performing day to day tasks
PAPR Noise Attenuation

Team
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Clinic Advisor
Ranjan Chakravarty

Industry Representatives
Sponsorship of this project is confidential

Project Summary
A powered air-purifying respirator (PAPR) is a device which provides respiratory protection by drawing contaminated ambient air through a filter and delivering the clean breathable air to the worker’s hood by means of a flexible tube. PAPR systems are commonly worn for the entire length of a shift. Although all commercialized products are tested and approved to be below industry standards, the goal of this project was to fully understand the source of PAPR noise and potential options to minimize its impact. The project is to design solutions to address noise levels without inhibiting any other design aspects of the product.

Design Constraints
• Every common sound solution affects backpressures of the system. Backpressures in the system reduce battery life and cannot be tolerated above a nominal rate. The team designed to balance the attenuation needs with the backpressure constraints.
• As a portable unit, our solution cannot impede movement or range of motion. To achieve this, the team designed to the contours of the human body and its natural movements.
• The solutions have to be easily implemented into current manufacturing processes. The team worked closely with industry engineers to ensure compatibility.
Lightweight Machine Vise

Team
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Clinic Advisor
Dr. Chris Haas

Industry Representative
Steve Tschida

Project Summary
KURT Manufacturing is the industry leader in workholding solutions. The goal of this project is to produce a new vise that is more lightweight than the current vises KURT produces, but still has all the quality attributes that are KURT’s standard, such as clamping force, durability, and accuracy. The presented solution is to replace the ductile iron comprising the current base and jaws with magnesium alloy. To compensate for the comparatively lower tensile strength and increased deformability of magnesium, the base was redesigned to be thicker, and the stationary jaw has been integrated with the base. In addition, the stationary jaw and jaw plate are angled to cause pull-down, supplementing the patented KURT Ang-Lock design and compensating for deflection.

Design Goal
Create a machine vise with less than 70% the total weight of a current KURT D688 machine vise.

Design Constraints
- Must weigh less than 55 pounds in total
- Must be able to sustain a maximum clamping force of 8000 pounds
- Must have no more than 0.003” of stationary jaw deflection at maximum clamping force
- Must be as durable as current KURT vises
Thin-Film Flexible Cooling Device

Team
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Clinic Adviser
Surya Iyer

Industry Representative
Isaac Remer

Aerospace, Defense, Semi-Conductor Manufacturing, Telecommunications, HVAC, as well as other commercial and industrial applications. Often in these applications, space is at a premium, and the room available for a heating/cooling device is limited. Minco wants to offer a complete thermal management solution to their customers, which includes both heating and cooling. The design team has been asked to develop a thin film, flexible cooling device that would allow Minco to provide an effective cooling solution to suit their customers’ needs.

Project Goal
The project goal is to design and manufacture a thin-film flexible cooling device.

Design Constraints
- Size: 4” X 4” Panel Dimensions (±0.015”)
- Thickness: 0.030” Max (±0.005”)
- Minimum Operating Temperature: 150°C
- Temperature Uniformity: ±10°C
- Dielectric Strength: 500 VAC min.
- Minimum Bend Radius: 0.500”
- Minimum Heat Flux (Watts/in²): 20 Watts/in² at 100°C
- 50% or more manufacturing processes should be processes native to MINCO
- Product must be patentable

Project Summary
Minco is a global provider of heating solutions using customized flexible thin heaters for their customers in industries such as Medical,
Project Summary
Many people depend on wheelchairs to move around in daily life activities, especially those who spend majority of each day in a wheelchair. Ottobock specializes in custom wheelchair seating by capturing the individual’s human contours. Ottobock uses bean bags to hold an individual’s total human contours, which is followed by the step of capturing the contours. Ottobock’s current capturing system is effective, but the system also has several difficulties. These difficulties include the following: the system is thirty years old, too complex for operators, time-consuming, inaccurate, and not cost-effective. The team decided to focus on improving the capturing system for Ottobock.

Design Goal:
The final goal for the project is to create a new method of capturing an individual’s human contours. The goal is for the new system to be very simple to use for any operator, cost-effective for Ottobock, and have more accurate calculations of the contours.

Design Constraints
- The new system’s design shall be portable by weighing less than fifty pounds and by fitting in a standard car.
- The Microsoft Kinect for Windows shall be used to capture the depth of the contours.
- The new device shall be user-friendly and simple for any operator to use.
- The new device shall be able to capture the overlaying contours, such as arm supports.
- The capture system shall capture a range of patient’s contours, which vary in size and support needs.
Pitch-Controlled Vertical Axis Wind Turbine

AF Energy

Team:
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Clinic Advisor:
Greg Mowry

Industry Representatives:
John Alexander, Steve Fuchs

Project Summary:
The project sponsors purchased the US patent 2009/0136346 Al and asked the team to develop a functioning prototype that could exercise the ideas presented in the patent. The goal of this US patent is to maximize wind power efficiency with pitch-controlled airfoils. These airfoils continuously adjust the angle of attack to maximize the power output of the wind turbine. The objective of this invention has three main parts:
1. Optimize blade positioning relative to oncoming wind to maximize or minimize particular forces on each blade
2. Continual optimization of each blade angle relative to oncoming wind, to maximize the force on the respective blades at each position during their rotation around the turbine axis
3. Employ an airfoil pitch control enabling efficient operation in light winds

Design Goal
The goal of this project is to develop a continual pitch control system for a vertical axis wind turbine (VAWT) to achieve greater efficiencies than current H-rotor stationary-blade VAWTs.

Design Constraints
- Turbine can be assembled or disassembled by two trained professionals in 12 hours
- Turbine weight<250 lbs
- Base structure weight<550 lbs
- One disassembled, all parts must fit inside an army tricon container (approximately 6’4” by 7’4” by 7’8”)
- Turbine electrical components are must handle 3-5 KW in power output
- Generator, controls & software system provided by sponsor
Global Lynx Deshingler

Team
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Clinic Advisor
Kundan Nepal

Industry representative:
Seth Lieffort, Dwight Schoenherr

Project Summary
The Intelligent Return Sortation System (IRSS) is an automated library solution developed by 3M to aid the sortation of returned library items. The Global Lynx Deshingler is a device that will be retrofitted with the IRSS and it will be able to accept a stack of various library items (e.g. paperback and hardcover books, DVDs, VHS tapes etc.) break the items down into a single row and feed them one at a time into the existing IRSS conveyor system. The IRSS currently requires the presence of a user to manually feed the library items one at a time into the sorting system. This manual process slows down the entire system by a great deal and fails to take advantage of the speed gained by using Radio Frequency Identification (RFID) to identify the library items. The Deshingler the team designed will automate this feeding process and as a result increase the overall speed of the system.

Design Constraints
- Deshingler module shall be able to accurately separate the items without damage to delicate library items such as CDs, tapes, magazines, or paper bound items
- System should be capable of sorting a minimum of 45 items per minute into collection bins
- The Deshingler module should be able to transform a stack of 20 library items into a single row of items spaced a minimum of two inches apart.
- Design must run off a 24VDC power supply.
Formula SAE Air Intake

Team
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Advisor
Chris Haas

Industry Representative
Steve Vermeer

Summary
Each year the University of St. Thomas competes in Formula SAE, an international competition where students design, build and race an open-wheeled race car against other universities. For the 2012-13 season a senior design team focused on the design and build of the air-intake manifold. The manifold was designed to comply with Formula SAE rules and optimizing air flow. The intake manifold delivers both fuel and air to the engine. The intake manifold was partially 3D-printed with PPSF and machined out of aluminum. Air flow analysis was done using computer models, flow bench testing and engine testing. The new intake manifold is able to deliver more air to the engine than the design from the previous season.

Goals
Improve air delivery compared to previous intake manifold designs.
Improve reliability and longevity compared to previous intake manifold designs.

Design Constraints
- Air must be restricted to a cross section of 20mm
- Intake must be housed within the envelope of the car as dictated by FSAE officials
Bicycle Fork Quick Release Mechanism

Switch-A-Roo, LLC

Team
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Clinic Advisor:
Todd Jones

Industry Representatives:
Bob Erickson, Jeff Seltz

Project Summary

Switch-A-Roo LLC, a small start-up company, requested St. Thomas engineering students to design a quick release device that would allow for multiple front-end configurations for a children’s bicycle. The yearlong project entailed designing, fabricating and testing prototypes. The team’s solution is a triple tree assembly that includes a clamp and a lever. The mechanism works by raising and lowering the lever. Raising the lever will loosen the clamp allowing the user to interchange the handlebars and/or wheels. Lowering the lever will tighten the clamp, which will secure the handlebars and wheels in place.

Design Goal

Create working prototypes that include a quick release mechanism for the front fork of a children’s bicycle to allow for interchangeabele handlebars and wheels.

Design Constraints
• Bicycle Size: 12” to 24” tire
• Intended User: Children age 7 to 11
• Cost: under $100, retail, bicycle including the quick release mechanism
• Quick (2 minute change of fork and handle bars)
• No tools required
• Meets US Consumer Product Safety Commission standards
Haptic Controls Evaluation, Integration, and Demonstration

Team:
Ryan Quade, Omar Watson, Christina Davis, and Stephen Varney

Clinic Advisor:
Michael Hennessey

Industry Representative:
Adam Marsh

Project Summary:
PaR Systems has played a significant role in the hazardous material handling industry by specifically designing and manufacturing robotic manipulators. PaR seeks to improve its control method as it currently requires repetitive motions, limits complex motions of the manipulator, and can allow for mishandling of materials. The purpose of this project was to integrate a commercial haptic feedback device to PaR’s current control method. Haptics refers to utilizing the sense of touch by applying forces as a form of feedback to the operator. PaR down-selected SensAble’s Phantom, as the commercial haptic device, and the Parker 514C DC drive, which were interfaced with a software design. This software design also provides PaR with a visual representation of the position and forces from the Parker and Phantom.

Design Goal:
The objective of this project was to design a software interface that integrates a haptic control device to a motor and provides visual feedback to the operator.

Design Constraints:
The software design shall:
- Interface with the SensAble Phantom Premium 1.5
- Interface with the Parker 514C SSD Drive
- Receive and display position and force information from the Phantom and Parker
- Implement direct and indirect kinematics for 1 degree of freedom in the x-coordinate plane
- Send force information to the Phantom device
- Send position information to the Parker drive
PGW SeaGlider Navigation System

Team
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Clinic Advisor
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Industry representative:
Scott Morgan

Project Summary
The Persistent Gliding Waterframe (PGW) project is a joint operation between the University of St Thomas and the University of Beira Interior, Portugal. This is the third year of a five year project that will culminate with an autonomous underwater vehicle which can travel from Boston to the Azores in Portugal. During its journey, the PGW will take in data on blue-green algae that it comes across which will aid in future agricultural endeavors. Our team’s mission was to create and implement in hardware a navigation system initially developed by previous senior design teams. In order to achieve goal this we are constructing a vehicle similar to the PGW which will run via the navigation and control systems previously mentioned.

Project Goal
To build a prototype that can incorporate the navigation system that was designed by a Senior Design team in the previous year.

Design Constraints
- Create a prototype modeled after the PGW
- Create a physical implementation of the navigation Kalman filter in hardware and software
- Analyze the data obtained from navigation testing
Non-Newtonian Viscometer

Team
Cameron Cochran, Andrew Kitzman, Alexis Marthaler

Faculty Advisor
Ranjan Chakravarty

Company Sponsor
Roger Pihlaja

Project Summary
A viscometer measures the viscosity and density of a fluid. To support the oil industry it is desirable to be able to measure these properties in real time for oil drilling and hydraulic fracturing fluids. Since these fluids possess special properties, the devices currently used in industry are unable to meet the requirements. The ability to measure viscosity and density in real time would make oil drilling and hydraulic fracturing processes more efficient and safer. Emerson Process Management, a Fortune 500 company that possesses a diverse portfolio of measurement, control, and automation products is interested in providing such a device.

Design Goal
The senior design team was to design and build a non-Newtonian viscometer demonstrator. This is a continuation of work started during the 2011 Fall/Spring design clinic offering.

Design Constraints
- No moving parts in the viscometer
- Measures and reports viscosity once per second
- Measures and reports density once per second
- Use Emerson products as much as possible
Acoustic Damping Structure

Team
Aisha Adam, Ali Al Madan, Seng Cheng, Tom Flake

Clinic Advisor:
Don Weinkauf

Industry Representative:
Mimi Hui

Project Summary
Restaurants, offices, and convention centers all share something in common, they all are public spaces. One way to grant individuals in a sociable environment some privacy is by sound proofing a space in large room. People in sub groups need a solution that they can install themselves within a few minutes in order to absorb unwanted noise and provide a private and peaceful space. The solution also has to be decorative and/or customizable. It may not be destructive to the room and must be a portable module, seeing as people often change destinations quite frequently.

Design Goal
Develop a modular acoustic damping structure that is effective at blocking sound (particularly the human voice), easy to set up, portable and storable, visually appealing, and preferably made from materials that are eco-friendly and renewable.

Design Constraints
- The materials and manufacturing cost should not exceed roughly $6 / 9 sq feet.
- The design may not utilize flat panels, as that technology is already on the market and there exists little room for improvement or creativity.
- The solution should include visually appealing curves, textured surfaces, and a clean look.
- Use eco-friendly and renewable materials
Control Disk Throttle
Body Design

Team
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Clinic Advisor:
Tom Shepard

Industry Representative:
Fisher Company

Project Summary
This is the second phase of a project involving the utilization of a redesigned butterfly valve from Fisher to be used in an automotive application. The Control Disk was developed to control liquid flow in industrial piping systems. It is to be used in a precision flow system where flow controllability is crucial.

Fisher is hoping to affirm an assertion that the company’s patented contoured Control Disk will be effective in an automotive application. In order to deliver this affirmation, the team will implement the Control Disk in the University of St. Thomas’ Formula SAE car and verify an improvement in controllability.

Design Goal
The goal is to prove that the Fisher Control Disk offers improved throttle control and a comparable power output compared to the existing butterfly valve system in automotive applications.

Design Constraints
- The design will use a standard size cone air filter to help keep lead times to a minimum.
- The new system will have provisions to use the current throttle position sensor.
- The new system will use a cable linking from the throttle body to the gas pedal for throttle actuation.
Kinetic PVC Fittings

Team
Scott Bugasch, Adam Gibson, Mallory Marcotte, Jeff Riepe

Clinic Advisor:
Kundan Nepal, Michael Hennessey

Industry Representative
Don Weinkauf

Project Summary
Project kits for making structures from collections of relatively standard elements are a popular product for entertainment and education. There are small kits such as LEGO®, Tinkertoys®, and K’NeX®, but these make relatively small projects. The sponsor saw a need for a large construction kit made of unique PVC joints that allow for kinetic movement and incorporate readily available parts from a hardware store. PVC is in widespread use throughout the country. It is strong, safe, inexpensive, and versatile and could be used in many more applications if new methods of connection were made available. These connections would allow for PVC to be connected in unique ways: new angles, more connections, variable angle, and kinetic joints.

Design Goal
The team was to design and build the necessary unique joints and control system to allow for movement with the use of Bluetooth communication with motors. A kit was to be formed of the unique joints, the control circuit, and other products that would not be readily available at a hardware store.

Design Constraints
- Made of PVC
- Be safe when children are on or around the structures
- Be larger than LEGO but small enough to be played with indoors
- Be educational and fun
Thank you, Seniors!

Engineering at St. Thomas