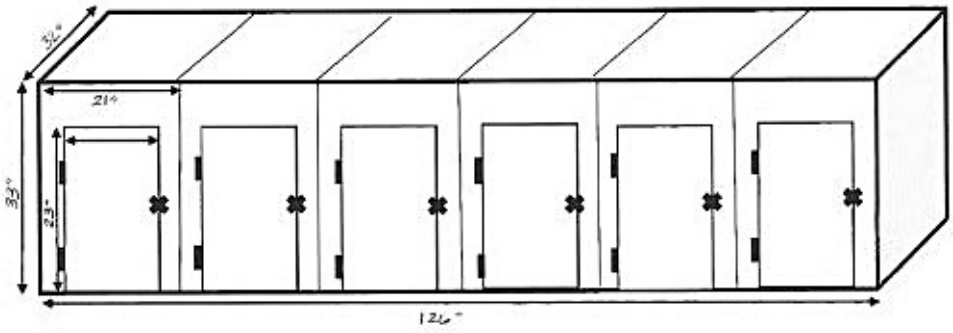
**Senior Design Projects, Winter 2016**

**Leader Dogs for the Blind, Rochester MI**

## Dog Transport System

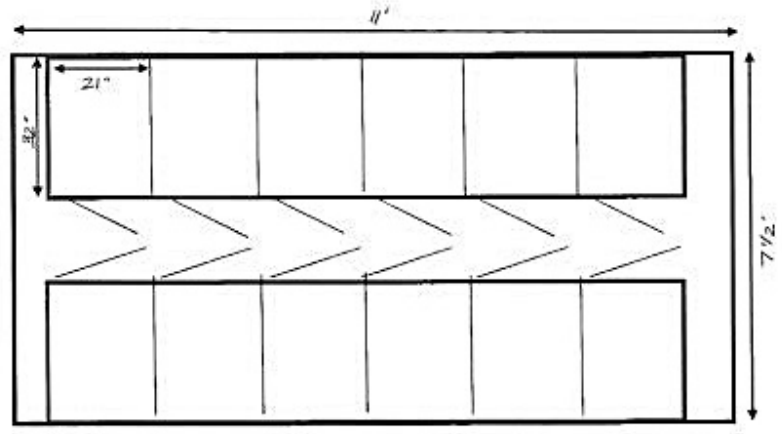
Currently, dogs in training are transported to various locations in large transport vans. The dogs are secured to the sides of the van interior with short tie-downs, a practice that is less than ideal and could be unsafe in the event of an accident. Harnesses have also been tried, with limited success. The LDB is in need of a containment system for safe transport of dogs in training, with the following specifications:

- modular cages, potentially with soft sides to absorb collision impact
- convenient cleaning and adequate air movement are essential
- existing manufactured crates are expensive and must be re-manufactured to integrate into vehicles
- two sizes are necessary, equivalent to 500 and 400 series airline crates
- need to transport up to 12 dogs in a van for a training day
- need to be easy to arrange, move in and out of the van, clean and adapt to various vehicle styles and shapes




Sufficient numbers of the new modular crates will be manufactured to equip up to 4 vans. The LDB has identified Milton Manufacturing in Detroit as a partner for this project. Milton has begun to look at the possibility of developing blast seats for military canines and has expressed an interest in being involved with the project and the students in the initial stages.

Cage Layout for Dog Trucks




**Dog Training Simulator**

Clients of the LDB must be trained in walking cadence, commands, gestures and other dog-handling aspects before being introduced to their dogs. This training is performed by staff members, and consists of walking and practicing on a safe, level surface while "led" by the instructor. The current training techniques (Juno) can be improved by the use of a dog training simulator that places the instructor behind and to the side of the client, however the current dog simulators are expensive and do not offer the adjustments needed by the LDB.

The purpose of this project is to develop and construct 4 dog training simulators with the following characteristics:

- design similar to current dog training simulators (instructor behind and to the side of client)
- harness attachment point must be have vertical adjustment to simulate the different heights of potential dog matches for the client
- optional - harness must bounce, bob and roll to simulate motion of dog (may be enabled/disabled as necessary, not really necessary)

- wheels must have resistance, especially in reverse to simulate "cut back" maneuver, wheels must not "fishtail" (common in shopping carts)
- [option] motorized, computerized version to take clients on tours of the LDB facility

**Interactive Facility Model**

The LBD facility in Rochester has undergone extensive renovation and expansion in the last several years. There is a need for a scale model of the complete facility to be displayed in the new lobby. Because of the unique nature of the LDB clients, this display model must be touchable and as interactive as possible, to allow a client to explore the facility with their hands, with an audible "tour guide" to explain what is being touched. The model will need to be scaled to the current facility yet be limited to an overall size that is easily reached and felt by an individual standing next to a table or platform. The model can be vertical as well as horizontal.

**Alternative Methods of Drive Shaft Balancing**
Sponsored by American Axle & Manufacturing

As a final manufacturing process, automotive drive shafts are balanced by rotating them at high speed to measure their vibration characteristics, and then welding on small weights to correct any unbalance that is found. Up to two balance cycles are applied to any drive shaft, the total time to balance a drive shaft is under 3 minutes.

The small applied weights introduce stress raisers that lead to fatigue failures, and the heat generated during welding slows down the process by altering the dynamic characteristics when verifying the balance corrections. Steel balance weights are applied to steel drive shafts, aluminum weights are applied to aluminum drive shafts.

AAM would like to explore alternative techniques to balance drive shafts that do not involve welding. Any new balancing process must be less expensive and no slower than the current process. It is also desired to eliminate the need to inventory aluminum balance weights, that is, to apply steel balance weights to aluminum drive shafts.

Prototypes and potential systems will be manufactured, assembled and tested at the American Axle & Manufacturing technical center in Auburn Hills.

Students employed by competitors of American Axle & Manufacturing are not eligible for this project; non-disclosure and non-compete agreements are required before work can commence.

**Testing and Further Development of an Innovative Battery Management System**
Sponsored by LogiCoul

LogiCoul is a small business commercializing the Interfacial Process Stimulation IPS ™ technology (US Patent 8,487,627). This technology stimulates a rechargeable battery with a "melody" of electric currents of variable frequency, intensity and duration. The effect of this stimulation is a substantial decrease in the internal resistance of the battery, allowing for deeper and more efficient charging and discharging.

The overall purpose of the project is to advance towards a stand-alone production device, integrated with a battery management system. To that end, LogiCoul is interested in a small (3-4) team of electrical engineering students to carry out the following tasks:

- become familiar with the current testing and analysis procedures used by LogiCoul
- run tests and measurements on existing Li-ion batteries using the existing signal generator
- calibrate and validate a second signal generator for lead-acid batteries
- develop a working breadboard circuit (and documentation) for battery stimulation based on the current signal generator
- begin to develop a second-generation IPS signal generator that (1) minimizes the electronic components used while (2) allowing more variation in the frequency, duration and amplitude of the signals, and (3) allows the superposition of frequencies and (4) the use of different waveforms (sinusoidal, triangular, square wave)
- begin to develop self-adaptive software, the functions of which are described in US Patent 8,487,627

Battery and system testing and measurements will take place in the OU Macomb business incubator. Non-disclosure and non-compete agreements are required before students can commence work on this project.

**Machine Tool Diagnostics using Smart Sensors**
Sponsored by PTC and Civionics

Civionics is an Ann Arbor-based company that develops sensor-driven predictive analytics for advanced engineered systems.

Civionics is interested in refining their analytics for machine tools in order to diagnose adverse conditions (tool wear, bearing wear, maintenance issues, etc) that would affect manufacturing quality. They are particularly interested in reducing the size of the data set necessary for diagnosis, providing smart features at the sensor level.

To explore this area, students will instrument a bench-top metal lathe with, at minimum, sensors to measure vibration, motor current and motor temperature. Base line data will be taken while taking various types of cuts (turning, facing, continuous vs intermittent cuts). Adverse tool conditions (dull cutters, bad bearings, etc) will be introduced and data compared to baseline. Of particular interest will be to determine, and to attempt to generalize, what data is most important for diagnosing machine tool faults.

If time permits, a full-size lathe will be instrumented to see if the generalizations hold true for different machines.

**Skittle® Sorting Challenge**

The challenge - to sort, without error, an entire family-size bag of Original Skittles® candies by color into individual containers as fast as possible, but within 5 minutes.

- There are approximately 1800 Skittles candies in a family-size bag.
- Each of the colors (purple, yellow, green, orange, and red) must end up in a separate container.
- The candies must be visible during at least 90% of sorting process.
- The candies may be poured by the user into the device.
- Upon pouring the candies into the sorter, a visible digital timer will begin counting (to the tenth of a second) as the candies are sorted and deposited into the containers. Above each container, a separate counter will display the number of candies currently in that container. As the last piece is sorted and deposited, the timer will stop and display the elapsed time, and the container counters will display the number of candies of each color.
- The colors are to be sorted in the order they are found, that is, the first color goes into the first container, the second color into the second, etc. There will not be a designated container for red, another for yellow, etc.
- The candies must not be damaged or altered during sorting.
- If more than one design group selects this project, those design groups will compete head-to-head to determine the best design:
    - The competition score will be the total time in seconds, plus 1 second for any improperly sorted candy piece plus 1 second for incorrect color counts, multiplied by the total cost of the sorting device. For example, a single yellow piece in the mostly green container will result in a penalty of 3 seconds - one for the yellow candy in the green container, one each for the incorrect counts of yellow and green. The lowest score wins.
    - Each group will be allowed to take up to three attempts at sorting, the best score will be used to determine the competition standings.
    - Sorting runs that result in one or more containers that cannot be determined to be "mostly" one color, in the judgment of the instructors, will be disqualified.
    - Sorting runs that take more than 5 minutes will be stopped at 5 minutes and the score determined on the candies that have been sorted at that time.

**Military fastener testing**

We anticipate an opportunity to test a new type of fastener for military applications. This test will take no more than 2 weeks and involve no more than 3 students. When the fasteners become available, the selected students will arrange to test them at the FAJRI facilities in Dodge Hall, write a report of their findings and present the results to the fastener company and military contractors. Due to the nature of this project, this opportunity is only available to US citizens.