

SmERT

(Small Engines Research Team)

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Project Needs

Provide accurate vehicle emissions testing capability to:

- Graduate students
- Formula Hybrid
- Clean Snowmobile
- Other research teams

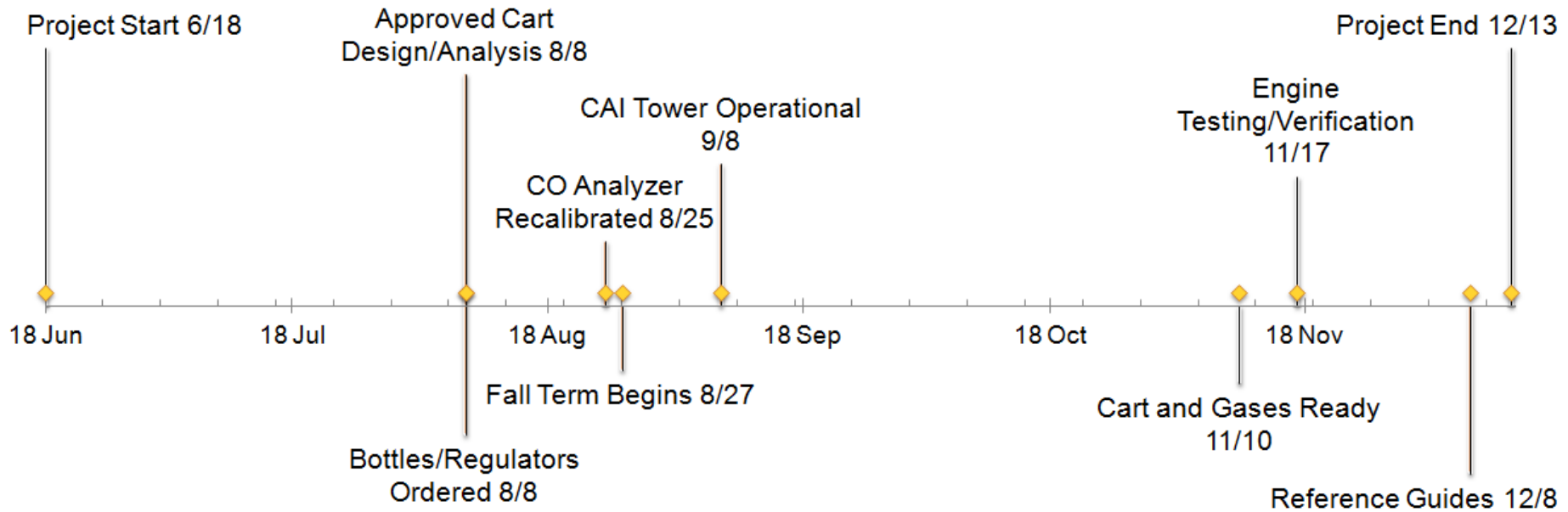


Design Task

Setup and verify the functionality of the professional grade emissions analyzer in the SmERF:

- Recalibrate the range of the CO analyzer
- Identify and purchase the correct calibration gases
- Design and build a cart to store and transport gas cylinders
- Verify/test gas analyzers via engine testing
- Create a set of user manuals for the analyzer

Timeline



CO Analyzer

Uses NDIR (non-dispersive infrared) technology to measure dual low and high level CO



Problem

- Wrong range for CO detection
- Does not measure a high enough concentration

Solution

Sent to CAI for recalibration
CO Low: 0 - 100, 0 - 1000 PPM
CO High: 0 - 0.5%, 0 - 5.0%

Calibration Gases

	Need	Have	
Bottle #	Description	Description	Machine
1	Vehicle emissions grade Nitrogen	Nitrogen Vehicle Emission	Zero N2
2	40% H2/60% He	FID Mix 40% H2/60% N2 (2 bottles)	FID Fuel
3	Oxygen	Oxygen compressed	NOx Analyzer & Gas Divider Ozonator Air
4	90ppm C3H8 (propane) balance Air	90ppm C3H8 (propane) balance N2	THC Analyzer (300ppm range)
5	90ppm CO balance N2	90ppm CO balance N2	COL range Span
6	4.5% CO balance N2	4.5% CO bal N2	COH range span
7	18% CO2 balance N2	18% CO2 balance N2	CO2 range span
8	21% O2 balance N2	4500ppm CO 21% O2 Bal N2	O2 range span
9	2700 ppm No bal N2	NOTHING...	NOx converter efficiency test

Key
Need to order
Need to return
Can be used in O2 analyzer

Calibration Gases Quotes

Cylinder #	Description	Norco	
		Gas	Cylinder
1	Vehicle emissions grade Nitrogen	N/A	N/A
2	40% H2/60% He	\$236.82	*
3	Oxygen	\$442.31	*
4	90ppm C3H8 (propane) balance Air	\$201.07	\$180.00
5	90ppm CO balance N2	\$201.07	\$180.00
6	4500ppm CO balance N2	\$201.07	\$180.00
7	18% CO2 balance N2	\$201.07	\$180.00
8	21% O2 balance N2	\$201.07	\$180.00
9	NO (depends on range) bal N2	?	?
*Rental price is \$10-\$12 per month		\$1,684.48	\$900.00
Waiting on quote from Oxarc for changes...		Total	\$2,584.48

Gas Cylinder Cart Specifications

- Secure cylinders valve end up
- Cylinders can be removed individually
- Accepts cylinders up to 9.25" in diameter
- Locking casters
- Can be moved by one person
- Holds up to 10 cylinders
- 1000lbs capacity
- Stable/won't tip over

Competition



USA Safety 6 Cylinder Heavy Duty Gas Cylinder Cart

Cost: \$695

Cart Capacity: 1- 6 cylinders

Weight Capacity: 2,000 lbs.

Dimensions: 52" x 24" x 30"

Weight: 183 lbs.

Ground Clearance: $\frac{3}{4}$ "

Restraint: 1-1/2" polypropylene straps and cinch buckles



MECO Cylinder Truck – 8 Cylinders

Cost: \$714

Cart Capacity: 1- 8 cylinders

Weight Capacity: 1,500 lbs.

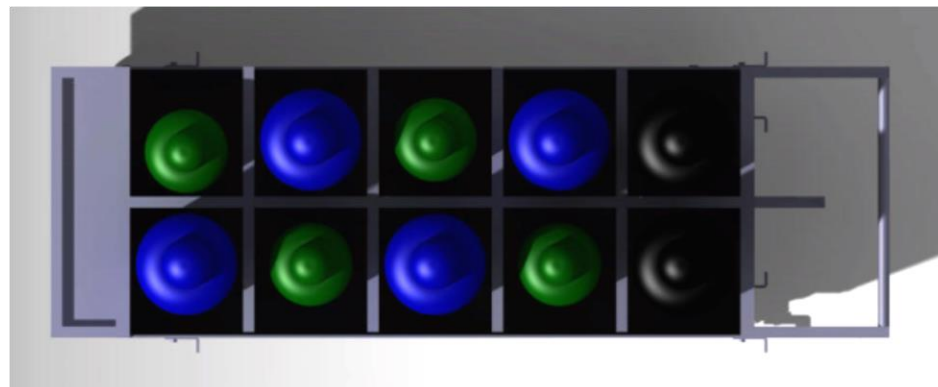
Dimensions: 60-1/2" x 24" x 42"

Weight: 331 lbs.

Ground Clearance: Unknown

Restraint: Chain and hinged ramp

Cart Concept #1



Cart Concept #1 Specifications

Features

- Loading ramp
- Shelves for regulators
- Hook for hoses
- High ground clearance
- 4 swivel casters



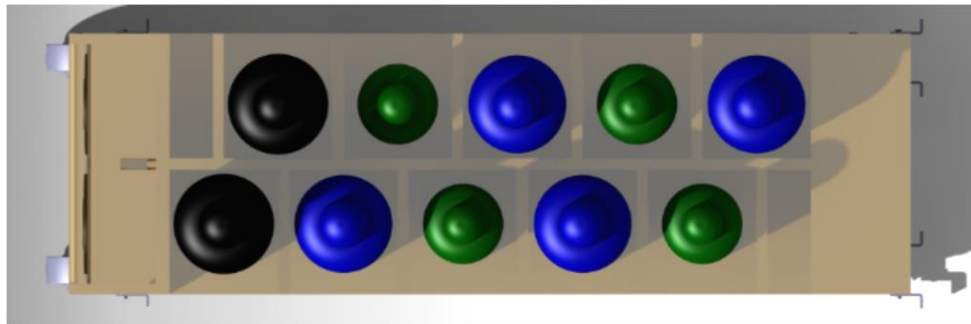
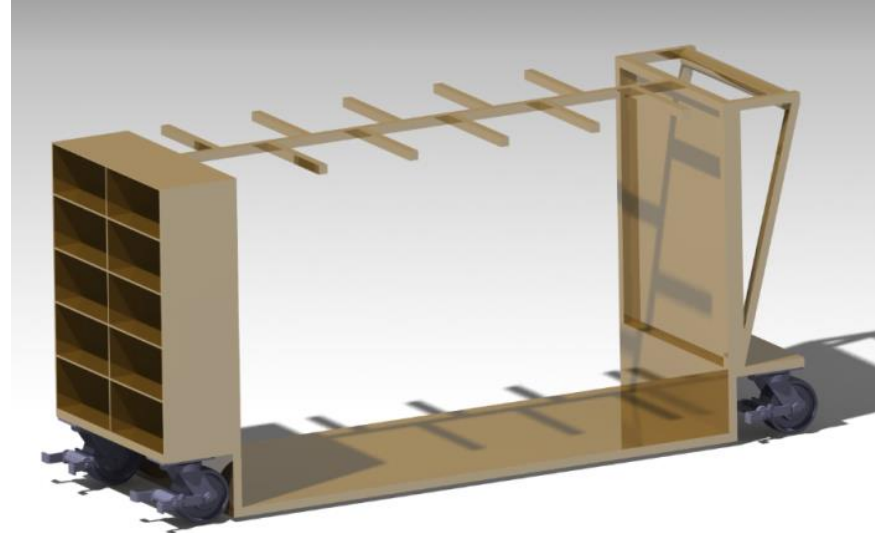
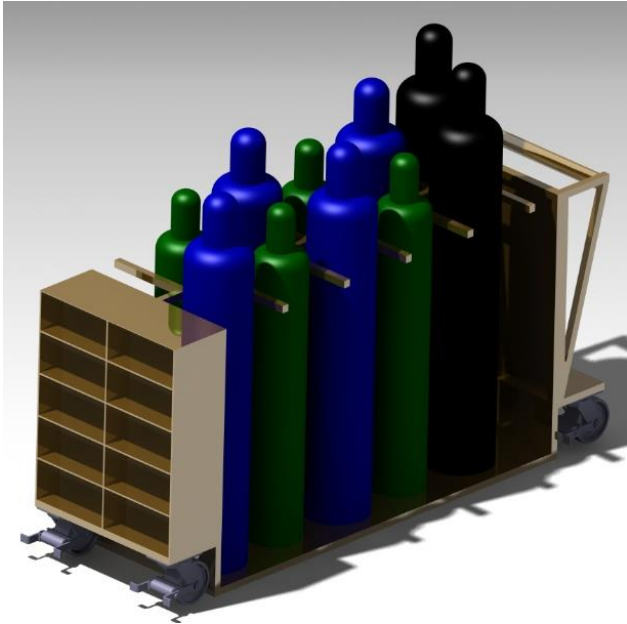
Pros

- Simple to build
- Compact
- Easy to load\unload
- High ground clearance

Cons

- High center of gravity
- Difficult to maneuver
- Hard to see over cylinders when moving

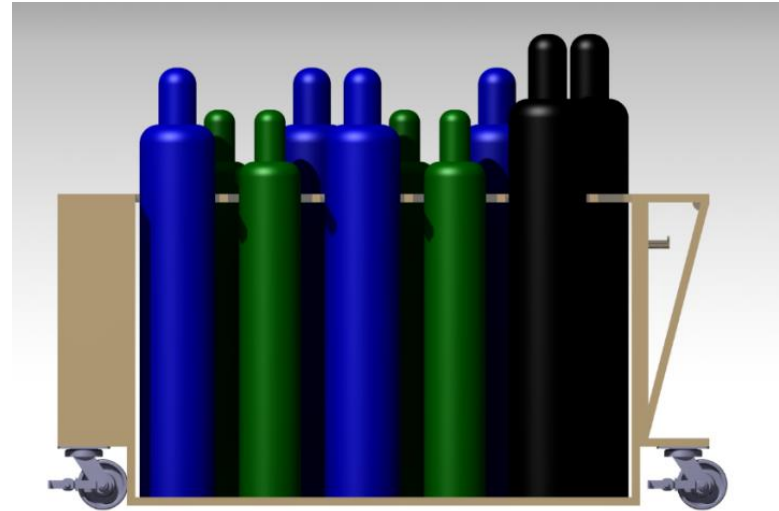
Cart Concept #2



Cart Concept #2 Specifications

Features

- Lowered floor
- Shelves for regulators
- Hook for hoses
- 2 swivel, 2 fixed casters
- Staggered cylinders



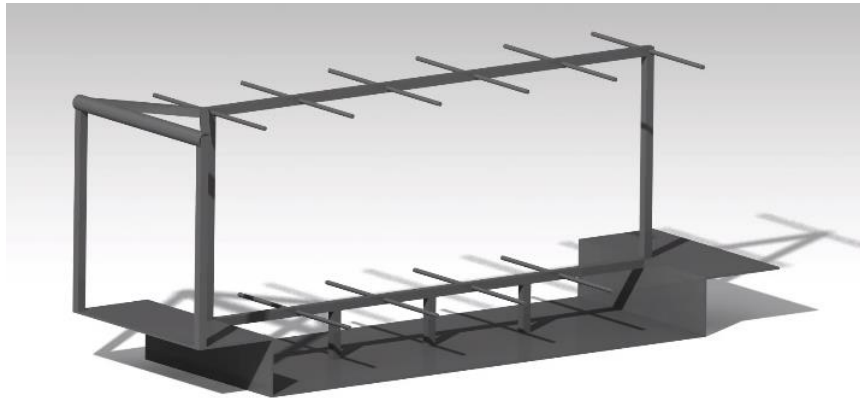
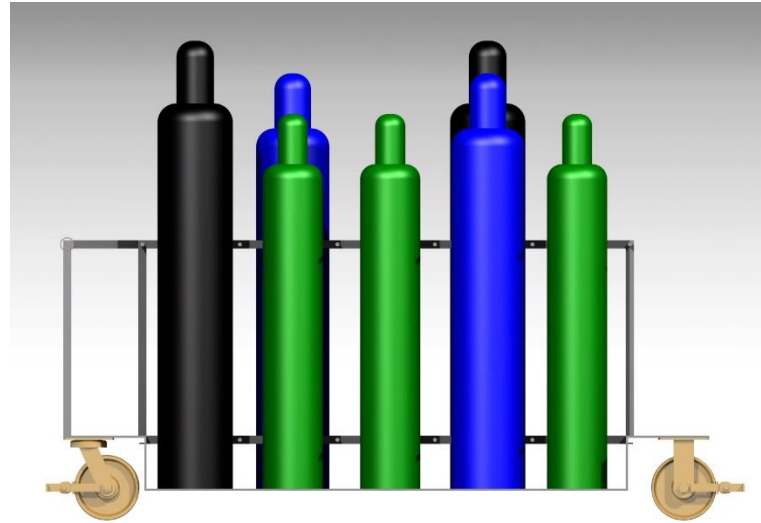
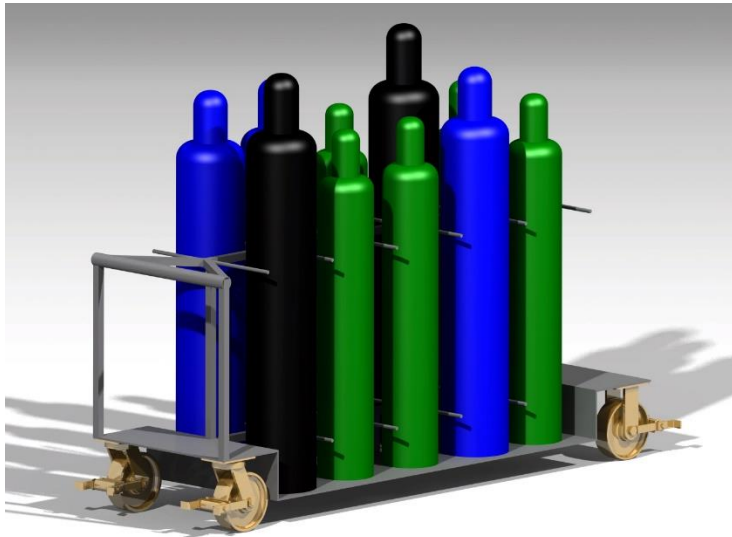
Pros

- Stable
- Easier to see over cylinders
- Easy to load\unload
- Staggered cylinders

Cons

- Expensive
- Difficult to build
- Very long

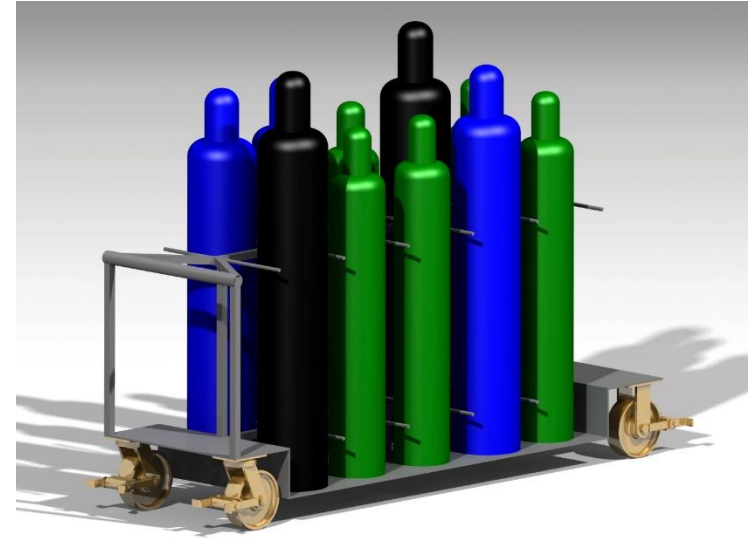
Cart Concept #3



Cart Concept #3 Specifications

Features

- Lowered floor
- Hook for hoses
- 2 swivel, 2 fixed casters
- Light weight



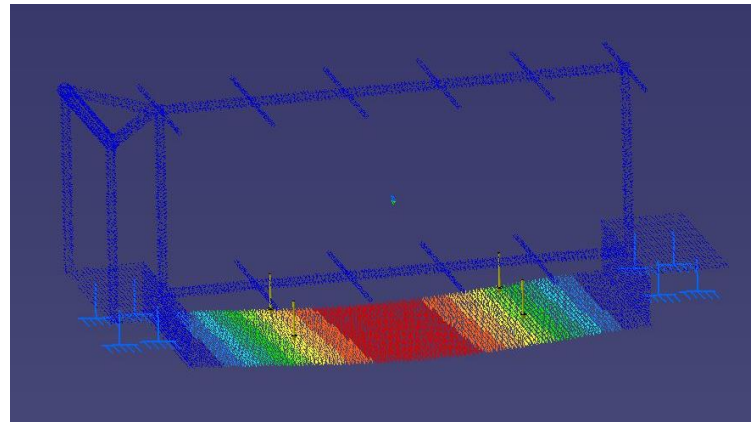
Pros

- Stable
- Easier to see over cylinders
- Easy to load/unload
- Simpler design

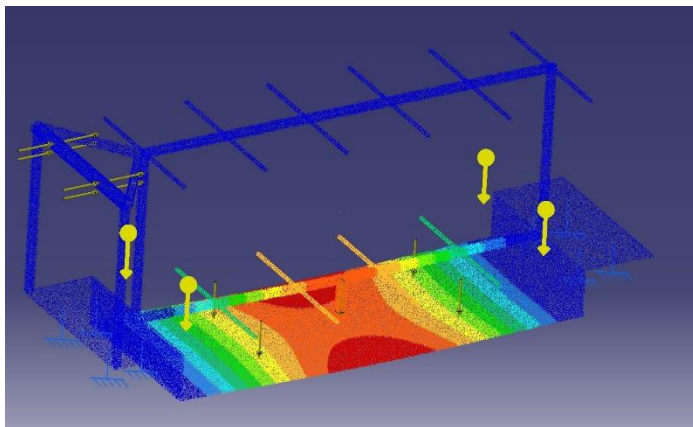
Cons

- No racks for regulators
- Labor intensive

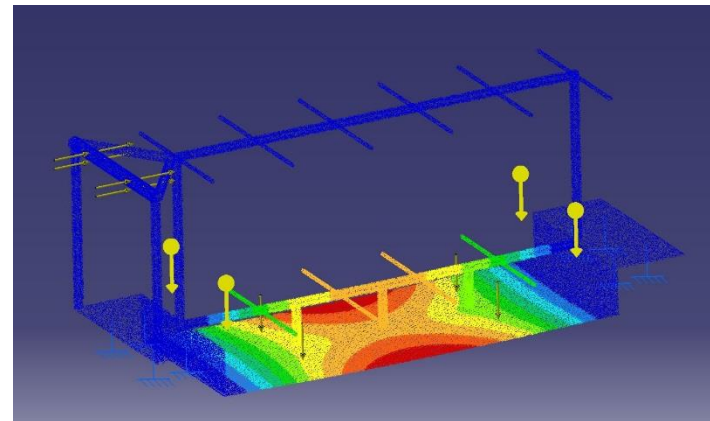
FEA Displacement



No vertical supports



One vertical support



Three vertical supports

Estimated Project Costs

Concept	BOM		Est. weight (lb)	Est. material cost (\$)
	Tubing (ft)	Sheet metal (ft ²)		
#1	51	33	300	\$912
#2	45	26	280	\$794
#3	47	16	220	\$610

Swivel Casters	\$74 each
Fixed Casters	\$52 each
Tubing	\$2.61/ft
Sheet metal	\$14.66/ft ²



Problems and Constraints

Suppliers - Still waiting on quotes and information



Budget - Not clearly defined, limited



Time - Short term, waiting for information, parts, and service

Documentation - Limited, hard to find



EHS Approval - Cart must meet their requirements



Project Learning Summary

EHS - cart needs to meet University and OSHA regulations for safety

Ergonomics - handle height & diameter, push style, and steering type

FEA - CATIA analysis to verify cart design

Emissions analyzers - learning in progress

Moving Forward...

- Finalize cart design
- Purchase gases and materials
- Build and test cart
- Verify/test gas analyzers
- Create user manuals



Questions?

