



RYERSON'S INTERNATIONAL HYPERLOOP TEAM

**Using AIA/NAS 3D digital standards to
accelerate the design process**

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Presentation Overview

- ∞ What is a Hyperloop?
- ∞ What is the SpaceX Hyperloop Competition?
- ∞ Ryerson's International Hyperloop Team and the Hyperloop Deployable Wheel System
- ∞ Designing the Hyperloop Deployable Wheel System
- ∞ How CADENAS PARTsolutions got involved
- ∞ The application of 3D digital standards in the HDWS design process
- ∞ Conclusion: A key part of RIHT's success
- ∞ Conclusion: Why we'd use CADENAS digital standards in the future
- ∞ Appendix: Photographs from SpaceX Hyperloop Competition Milestones

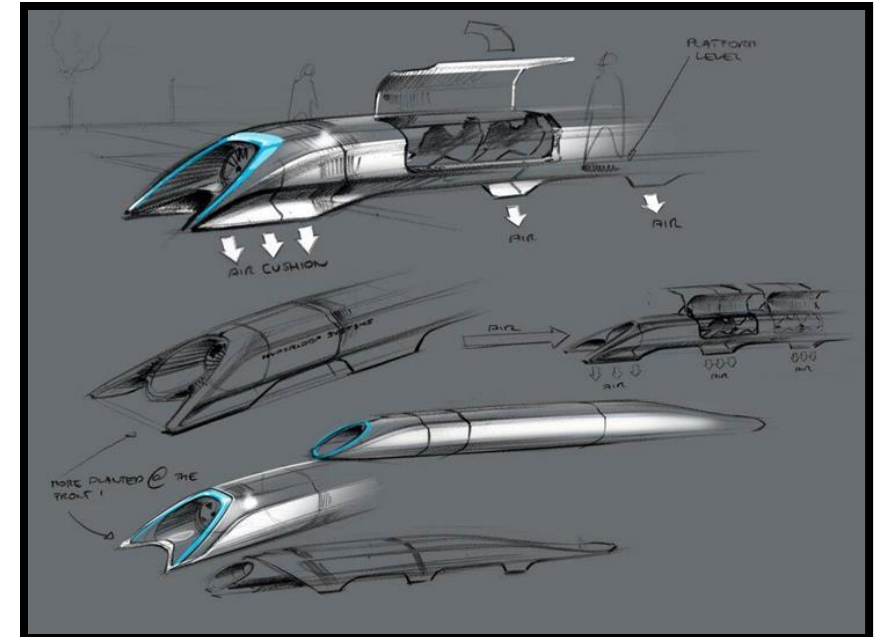


What is a Hyperloop?

Elon Musk (SpaceX, Tesla) and his colleagues unveiled the concept in the 2013 Hyperloop Alpha document

To be the World's 5th mode of transport, the Hyperloop will:

- ∞ Travel at speeds approaching 700 MPH
- ∞ Use a linear induction motor for propulsion
- ∞ Operate in a near-vacuum low pressure tube environment
- ∞ Use any combination of wheels, magnets and air bearings for levitation purposes
- ∞ Be resistant to extreme weather and natural disasters



Alpha Concept Sketch

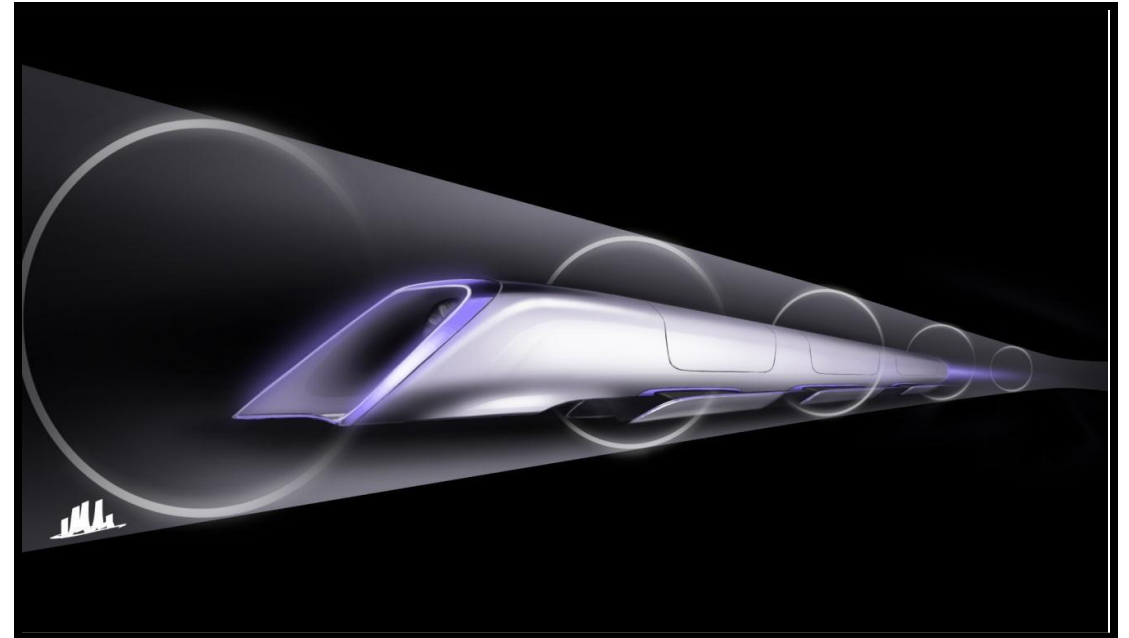
Musk, E., "Hyperloop Alpha," Website, August 2013. Retrieved from, <http://www.spacex.com/sites/spacex/files/hyperloop_alpha.pdf>



What is a Hyperloop? (cont'd.)



LA to San Francisco in 35 min or less



Passenger Capsule Render

Musk, E., "Hyperloop Alpha," Website, August 2013. Retrieved from, <http://www.spacex.com/sites/spacex/files/hyperloop_alpha.pdf>



SpaceX Hyperloop Competition I

- ∞ SpaceX wanted to accelerate the development of functional Hyperloop prototypes
- ∞ In June 2015 SpaceX announced the Hyperloop competition with an aim to design and build the best Hyperloop pod
- ∞ The competition is the first of its kind anywhere in the world
- ∞ SpaceX constructed a one-mile long test track adjacent to its Hawthorne, California headquarters





SpaceX Hyperloop Competition I

Accelerated Timelines



IMPORTANT DATES
JUNE 15, 2015 COMPETITION ANNOUNCED
AUGUST 20, 2015 DETAILED RULES RELEASED BY SPACEX (UPDATED OCTOBER 20, 2015)
SEPTEMBER 15, 2015, 5 P.M. PDT DEADLINE FOR ENTRANTS TO SUBMIT THEIR INTENT TO COMPETE
OCTOBER 2015 DETAILED TUBE AND TECHNICAL SPECIFICATION RELEASED BY SPACEX
NOVEMBER 13, 2015 DEADLINE FOR ENTRANTS TO SUBMIT PRELIMINARY DESIGN BRIEFING
JANUARY 20, 2016 DEADLINE FOR ENTRANTS TO SUBMIT FINAL DESIGN PACKAGE
JANUARY 29-30, 2016 Design Weekend IN-PERSON DESIGN WEEKEND WITH ALL INVITED ENTRANTS; RESULTS. LOCATION: TEXAS A&M UNIVERSITY, COLLEGE STATION, TEXAS
January 27-29, 2017 Competition Weekend I Selected pods compete at Competition Weekend I. SpaceX Hyperloop Test Track

Hyperloop. (2017, 02 23). Retrieved from SpaceX: <http://www.spacex.com/hyperloop>



SpaceX Hyperloop Competition I (cont'd.)

Global Innovation Initiative

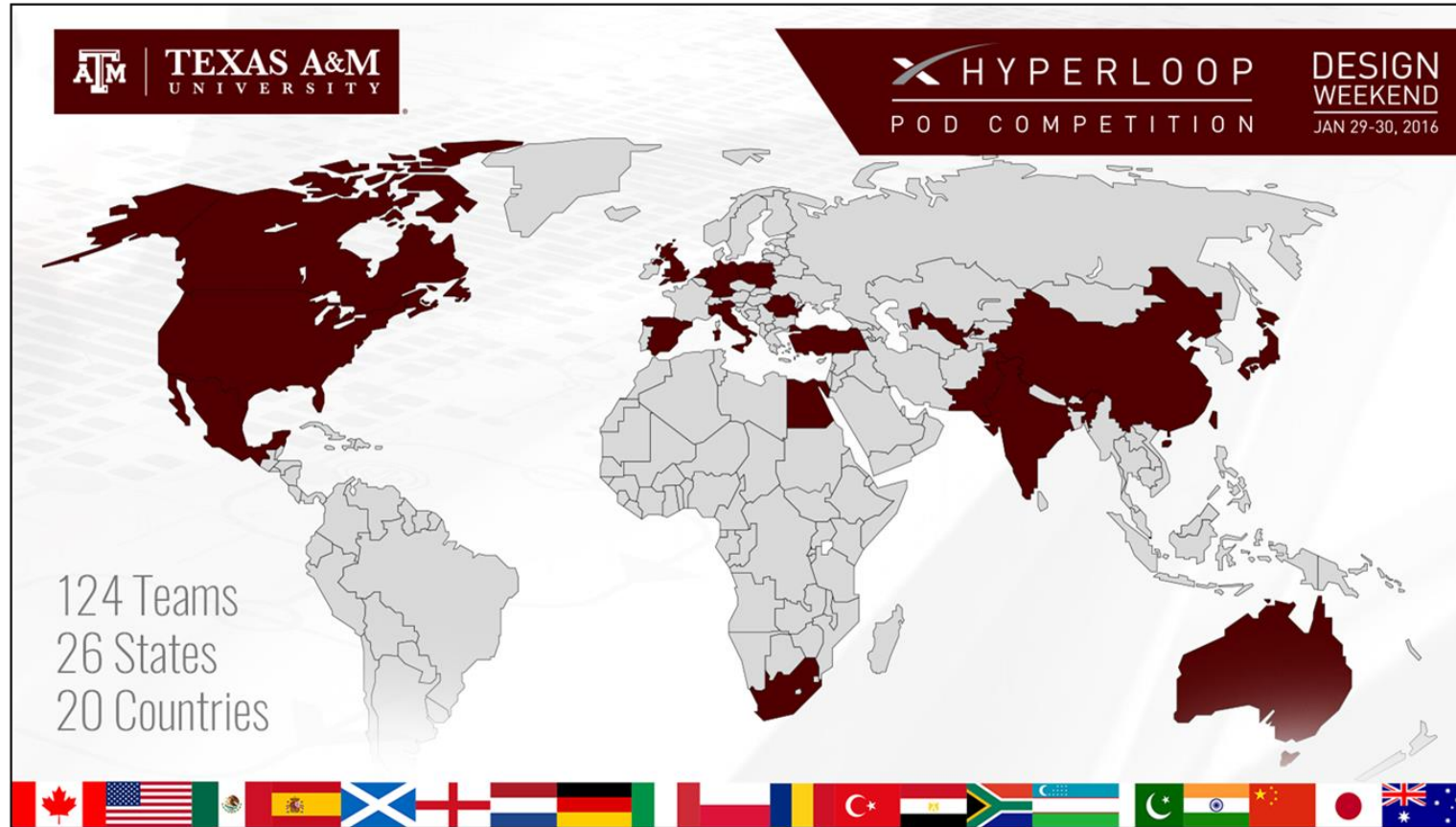


Image Courtesy of Texas A&M, Competition Weekend I, 2016



Ryerson's International Hyperloop Team

- ∞ Inspired by a line of text:

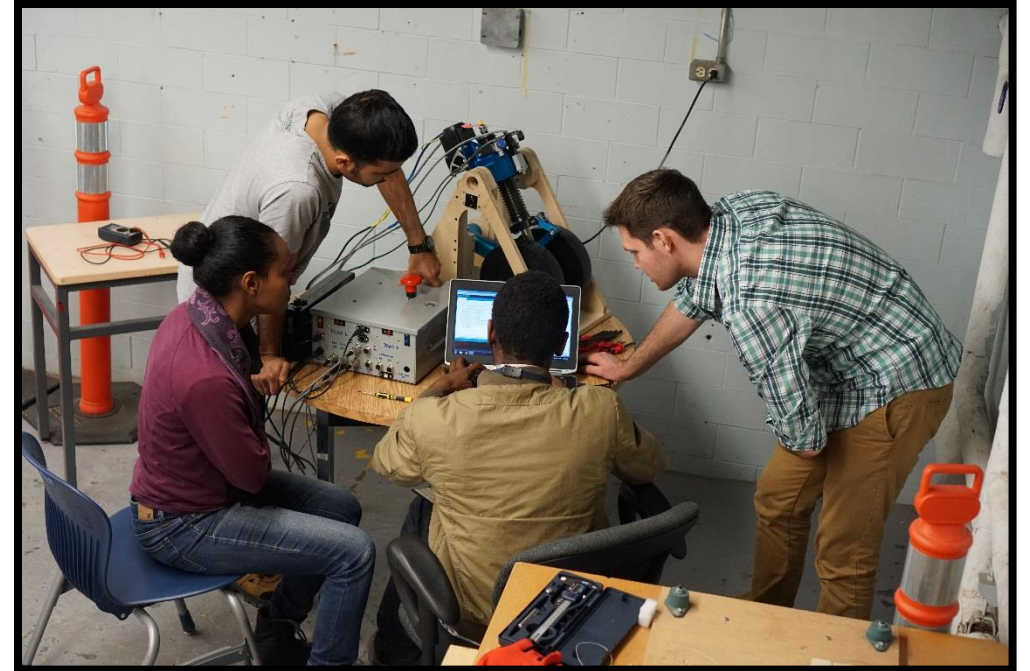
“The capsule may also include traditional deployable wheels similar to aircraft landing gear for ease of movement at speeds under 100 mph (160 kph) and as a component of the overall safety system.”

- Hyperloop Alpha Document

- ∞ Founded by 3 members within Safran Landing Systems (Student, VIE, Senior Design Engineer)

By the numbers:

- ∞ 6 passionate students
- ∞ 5 advisors (academic & industrial)
- ∞ 20 sponsors

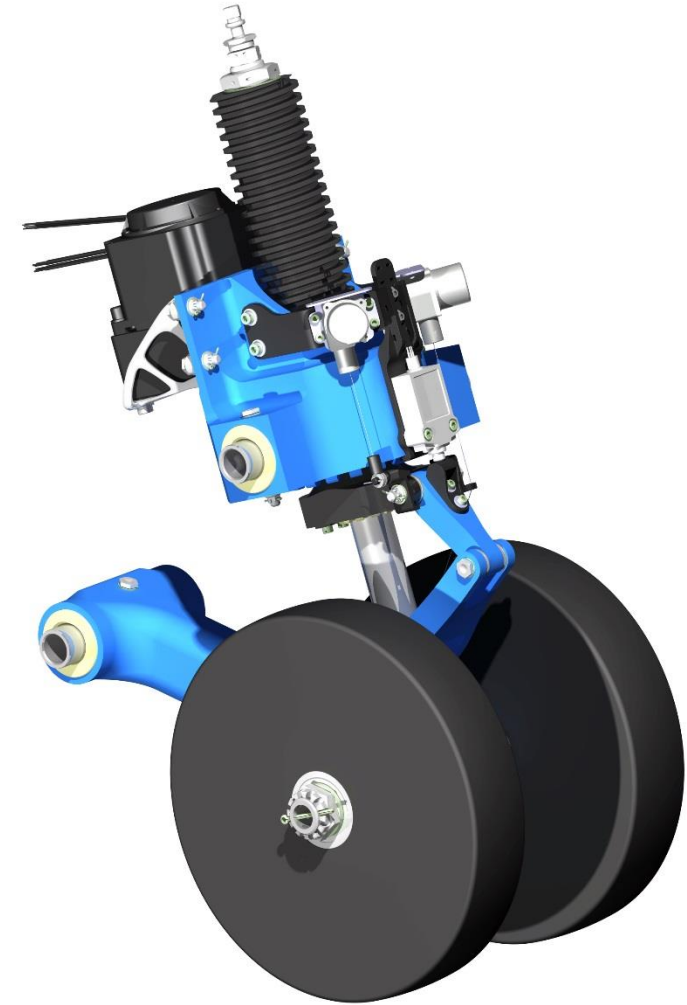




The Hyperloop Deployable Wheel System

The Hyperloop Deployable Wheel System (HDWS) is:

- ∞ Designed for **low-speed** (up to 180MPH) and **emergency travel** conditions
- ∞ Inspired by a traditional trailing arm **landing gear**
- ∞ Designed for the intense **space constraints**
- ∞ **Scalable** by design
- ∞ Follows an easy integration “**plug and pin approach**” with reference to its electric power systems and simple pin connections

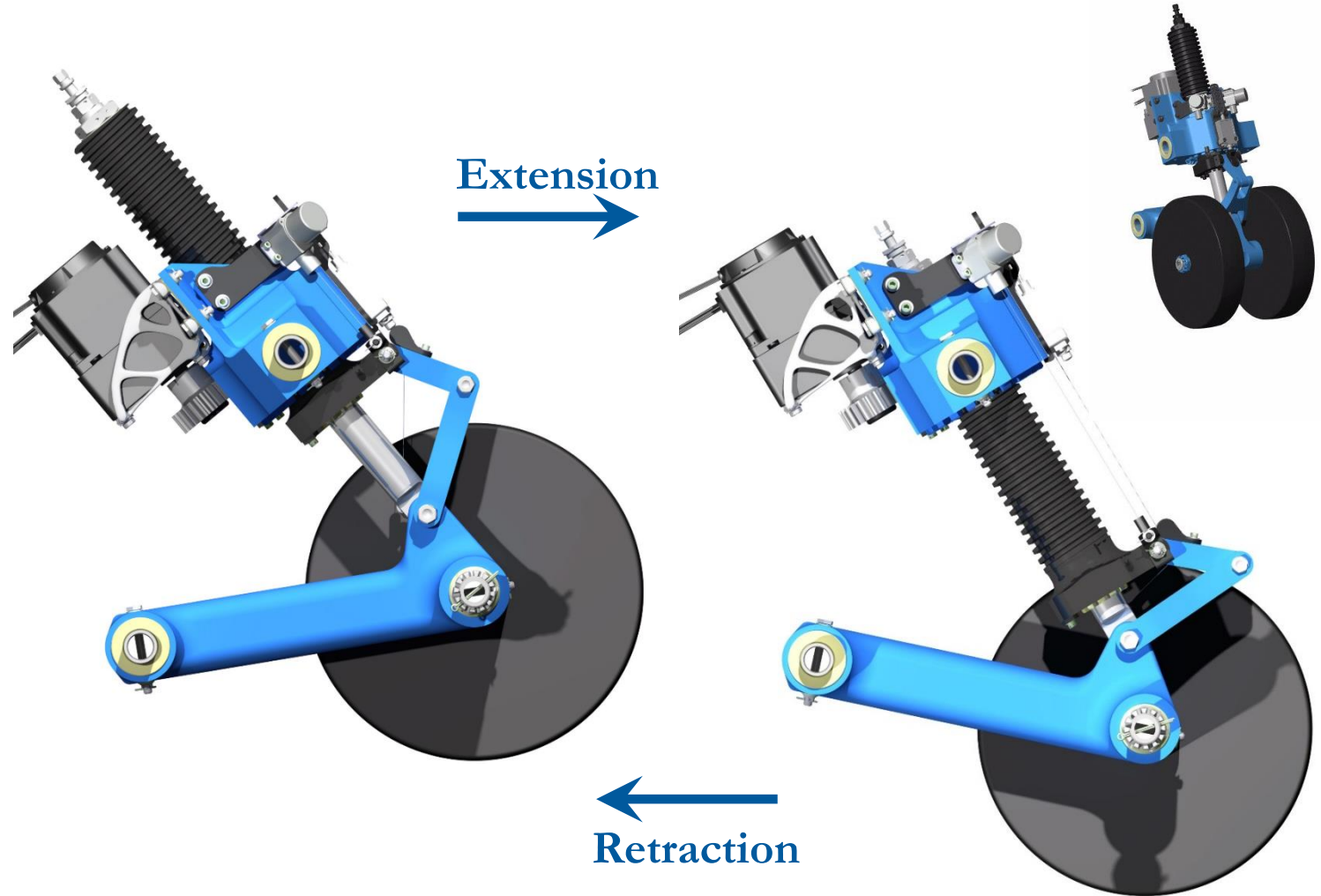




The Hyperloop Deployable Wheel System (cont'd.)

Key Features:

- ∞ Retract into pod when not in use
- ∞ Fully extend in < 2.5 seconds
- ∞ Uses Additive Metal Manufacturing (AMM)
- ∞ Active feedback sensors allow for active height stabilization control
- ∞ Uses industry standard hardware
- ∞ Shock absorption system

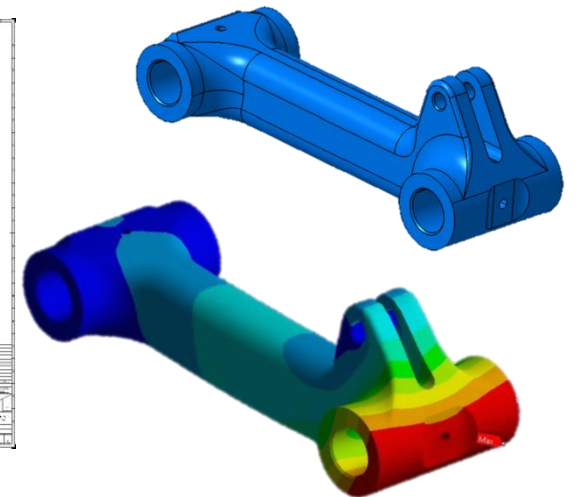
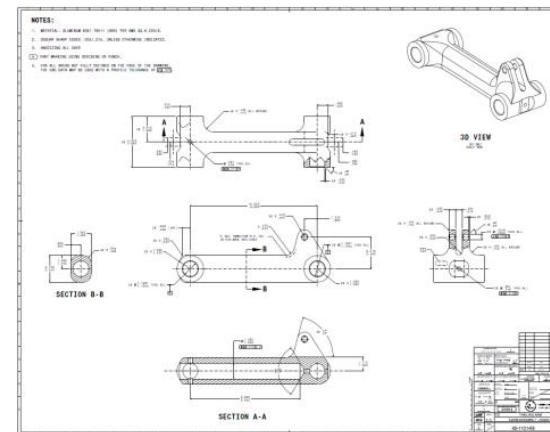
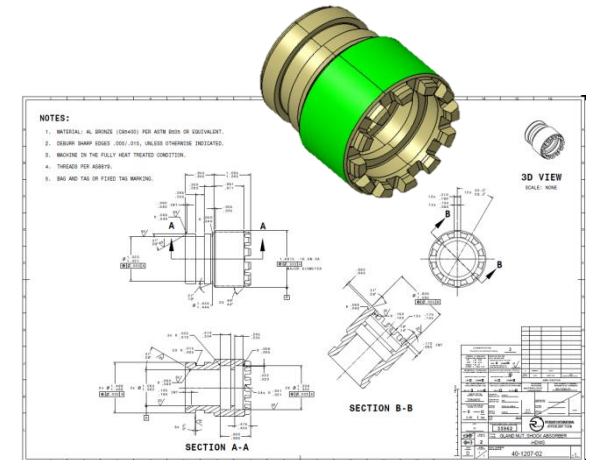




Developing the HDWS

Subsystem Development:

- ∞ Focusing on a single system gave opportunity to dive into detail
- ∞ Part drawings, assembly drawings to be generated using Dassault Systèmes CATIA®
- ∞ Part and assembly analysis performed (classical hand calculations, FEA, etc.)
- ∞ Custom manufactured parts were designed using industry best practices (e.g. SAE gland specs, thread specs)
- ∞ Use of certified aerospace hardware (NAS, MS)





Why CADENAS PARTsolutions?

- ∞ RIHT's team lead learned about the importance of aerospace standards for design and certification while on internship
- ∞ Sought to improve the level of detail in the design, contacted the Aerospace Industries Association (AIA) for help
- ∞ AIA provided access to their library of authorized digital 3D NAS parts and specs
- ∞ CATIA® 3D CAD models of AIA National Aerospace Standard (NAS) components were used
- ∞ AIA connected us with CADENAS and IHS Markit





3D Digital Database Applications

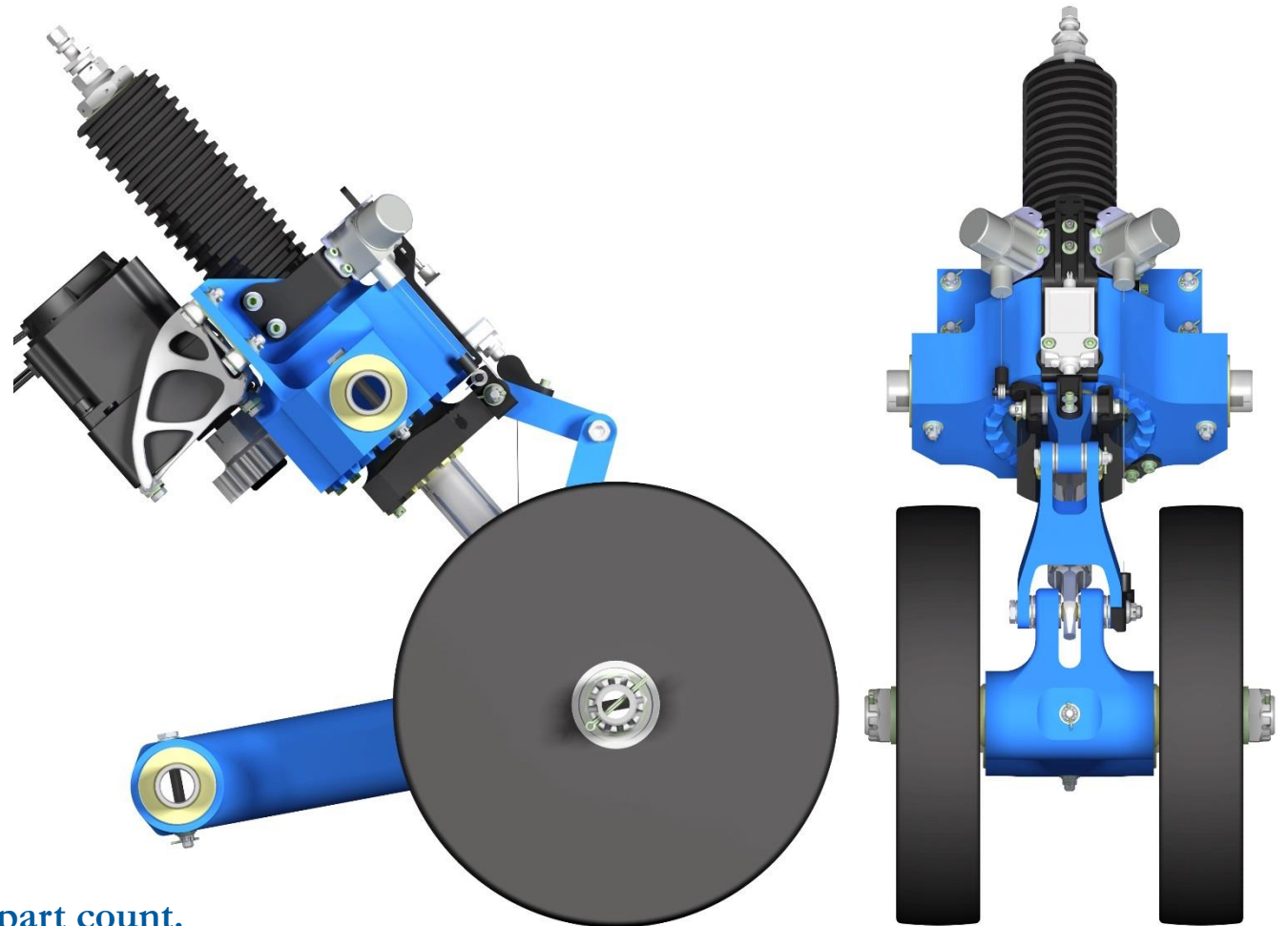
The numbers:

- ∞ 1 Hyperloop Deployable Wheel System
- ∞ 8 Subassemblies
- ∞ 42 Custom Designed Parts
- ∞ 82 Unique Parts
- ∞ 162 Standard Parts
- ∞ 204 Total Parts

AIA/NAS standard part breakdown:

- ∞ 11 Hex Bolts
- ∞ 14 Nuts
- ∞ 15 Cotter Pins
- ∞ 22 Cap Screws
- ∞ 58 Washers
- ∞ 120 Total AIA/NAS

AIA/NAS standard parts represent 58% of the total part count.





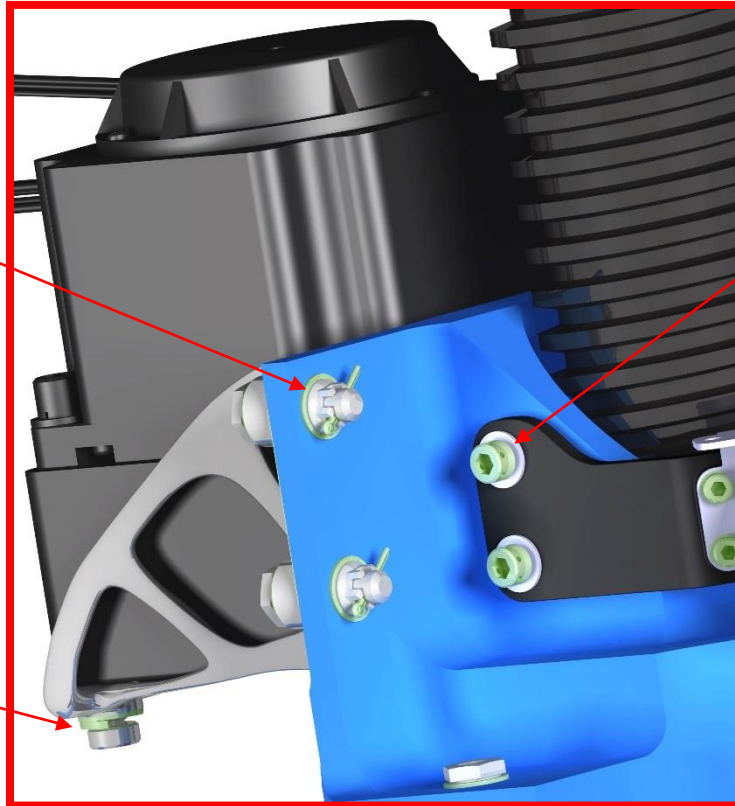
3D Digital Database Applications (cont'd.)



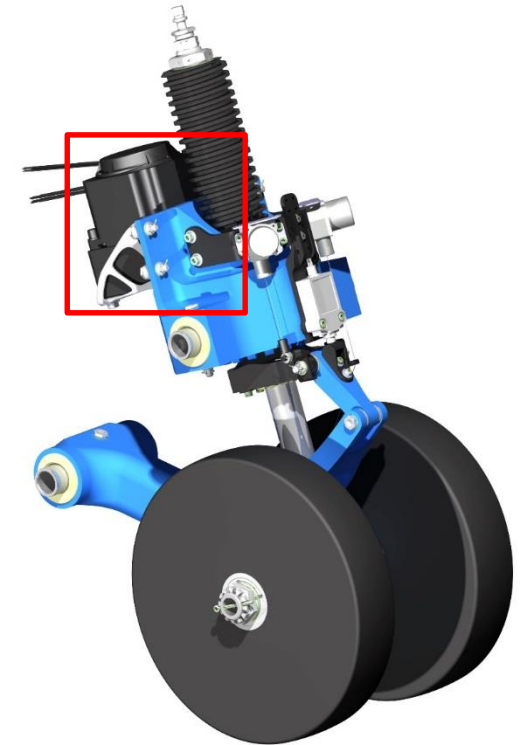
NASM14145
Self Locking Nut,
Castellated



NASM35338
Lock Spring Washer



NAS1351
Cap Screw,
Drilled Head

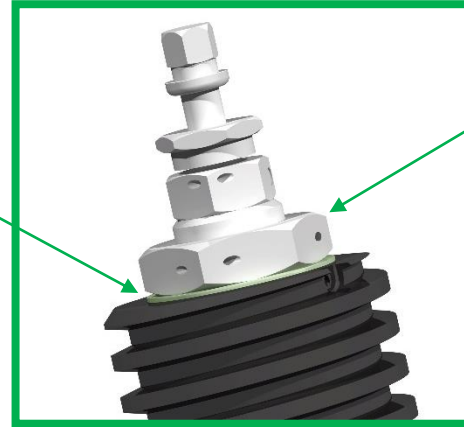




3D Digital Database Applications (cont'd.)



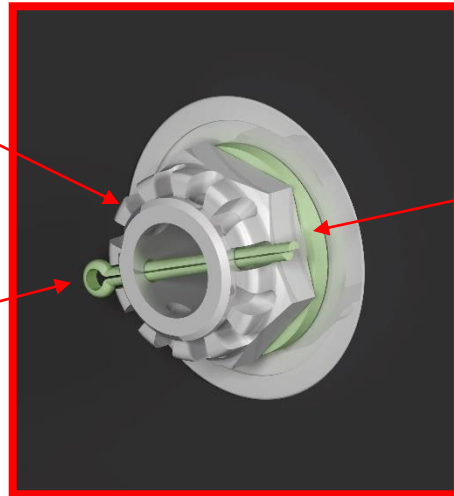
NAS1149
Washer



NAS1423
Drilled Jam Nut



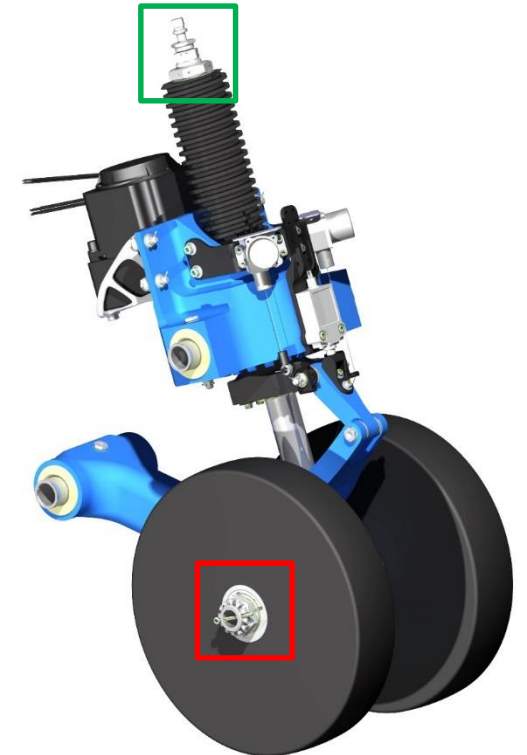
NASM21025
Castellated Hex Nut



NASM21258
Key Washer

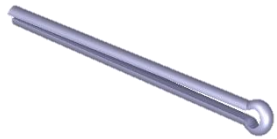


NASM24665
Cotter Pin

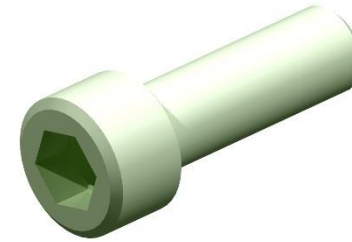
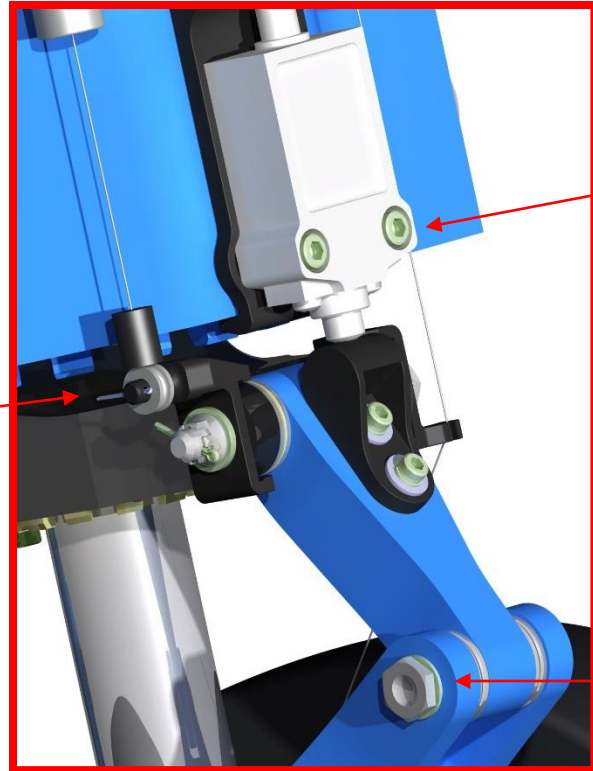




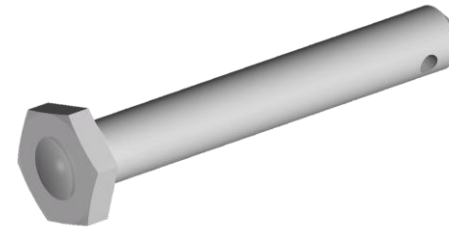
3D Digital Database Applications (cont'd.)



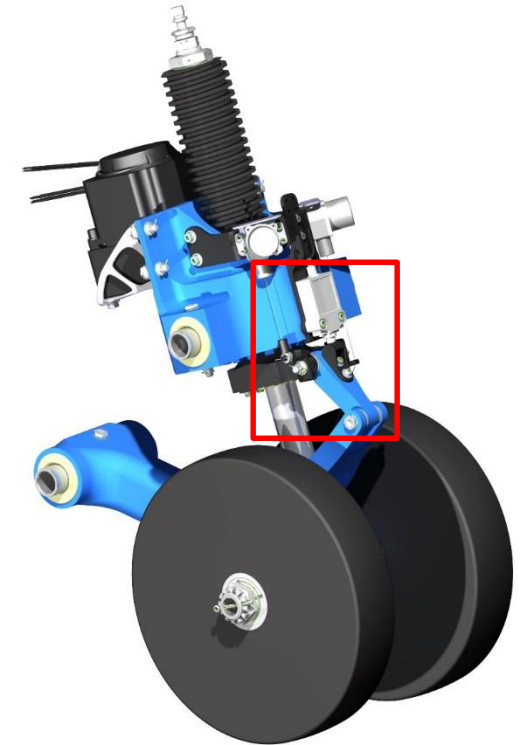
NASM24665
Cotter Pin



NAS1352
Cap Screw

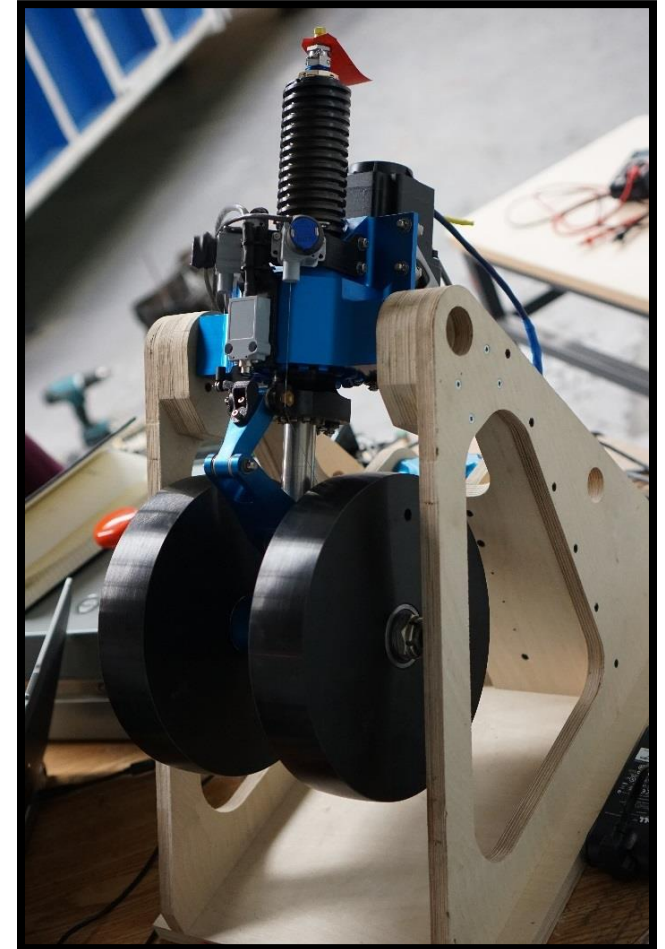


NAS6204
Hex Bolt,
Drilled Shank





Our Result

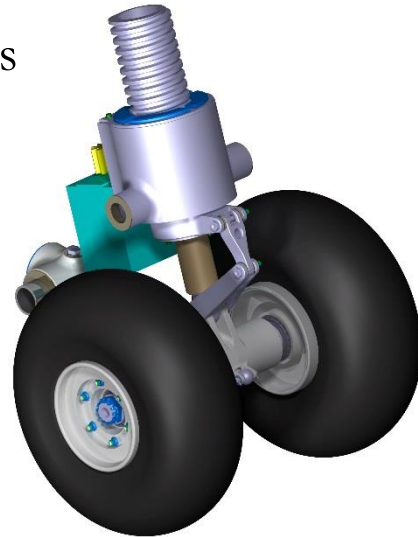




Winners of the Subsystem Innovation Award

Judging criteria based on:

- ∞ Innovation and uniqueness of subsystem design
- ∞ Scalability and economics
- ∞ Design detail
- ∞ Strength of supporting analysis
- ∞ Quality of presentation



Original HDWS, Design Weekend Submission



Image Courtesy of Texas A&M, Competition Weekend I, 2016

Only Canadian team awarded



Conclusions: RIHT and the HDWS

- ∞ AIA/NAS 3D digital standards significantly accelerated the pace of our initial and final design process
- ∞ Lets innovators focus on the key design components, rather than re-creating standard parts
- ∞ Enabled our team to create a design which competed very well against much larger teams
- ∞ We recommend the use of 3D CAD standards to any team looking to streamline their design process





Conclusions: 3D Digital Database

Summary

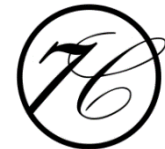
- ∞ Access to the 3D CAD database equates to:
 - Peace of mind (accurate & certified 3D models)
 - Increased consistency of parts
 - Improved engineering productivity
 - Quick visual sanity checks
 - Promotes experimentation (e.g. part combinations experimentation no longer time consuming)

Conclusion

- ∞ CADENAS PARTsolutions native 3D CAD database is an integral part of IHS Markit's AIA/NAS digital standard database
- ∞ Using the 3D CAD database in conjunction with AIA/NAS will help companies save time, reduce CAD model error risk, and better manage engineering resources



Project Sponsors





Appendix

The following slides contain images highlighting Ryerson's International Hyperloop Team's involvement in the SpaceX Hyperloop Competition I Design Weekend (January 2016) and Competition Weekend (January 2017).



SpaceX Hyperloop Competition I: Design Weekend 2016



Image Courtesy of Texas A&M, Competition Weekend I, 2016



Image Courtesy of Texas A&M, Competition Weekend I, 2016



SpaceX Hyperloop Competition I: Design Weekend 2016 (cont'd.)



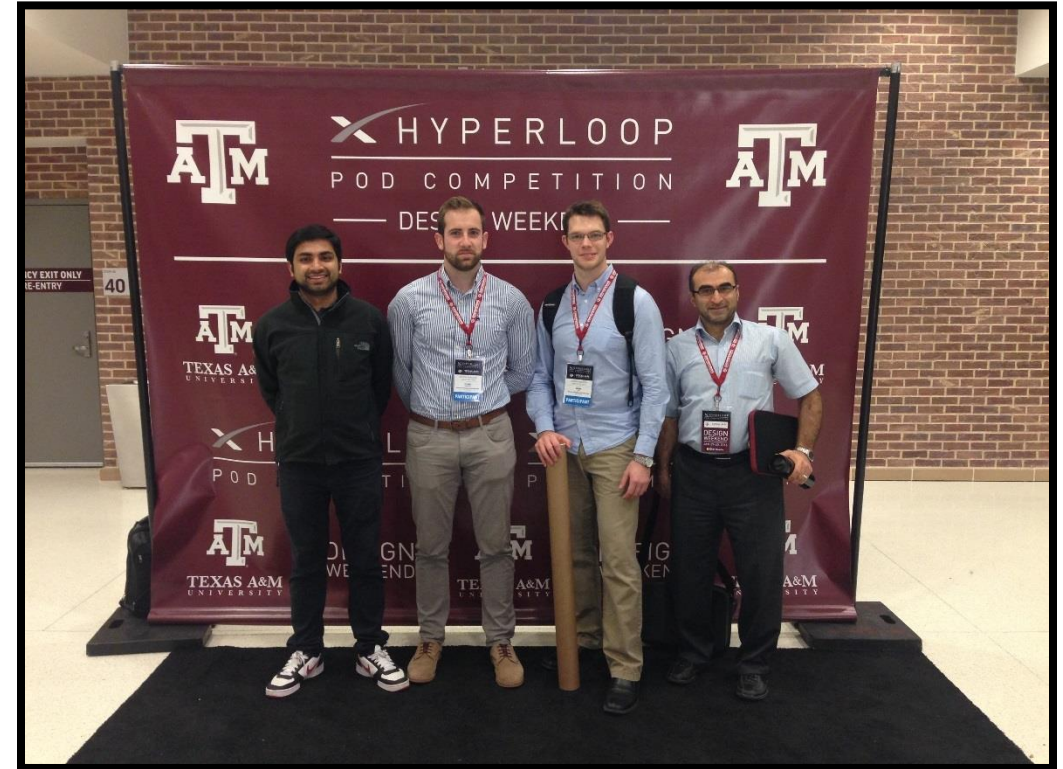
Image Courtesy of Texas A&M, Competition Weekend I, 2016



SpaceX Hyperloop Competition I: Design Weekend 2016 (cont'd.)



Image Courtesy of Texas A&M, Competition Weekend I, 2016





SpaceX Hyperloop Competition I Weekend 2017





SpaceX Hyperloop Competition I Weekend 2017 (cont'd.)



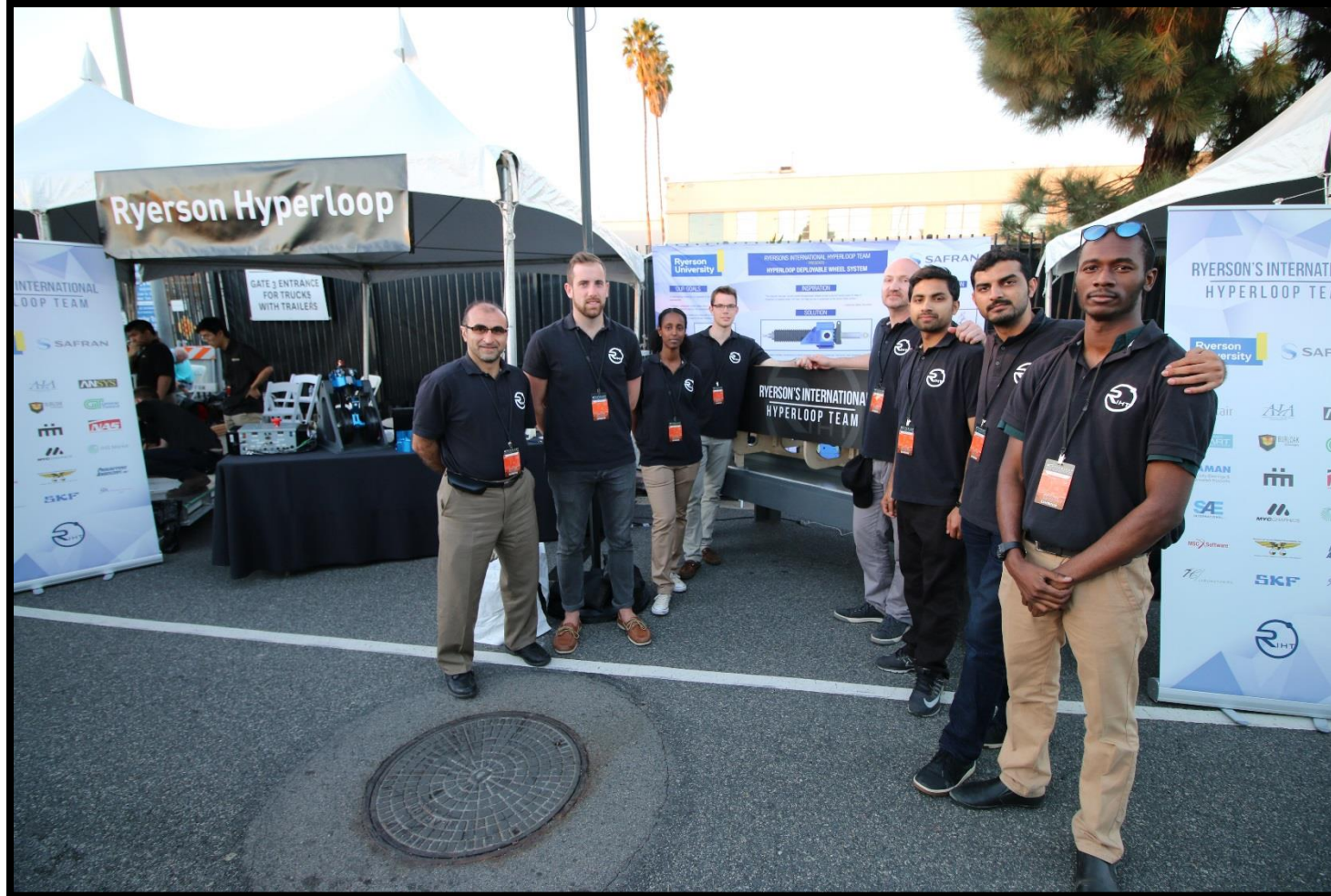


SpaceX Hyperloop Competition I Weekend 2017 (cont'd.)





SpaceX Hyperloop Competition I Weekend 2017 (cont'd.)





SpaceX Hyperloop Competition I Weekend 2017 (cont'd.)

