State of the Center

National Science Foundation
Industry-University Collaborative Research Center in
Smart Vehicle Concepts – Phase III

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The Ohio State University

Presentation Outline

- NSF IUCRC Program, SVC mission, membership structure, and metrics
- Role of Industrial Advisory Board, research matrix, and list of projects
- General updates

NSF IUCRC Program

- Established in **1973**
- IUCRC centers conduct **industrially-relevant**, **pre-competitive research** via multi-member, sustained partnerships among industry, academe, and government
- The IUCRC Program provides a **financial and procedural framework** for center operations in addition to best practices learned over decades of fostering public/private partnerships that provide significant value to the nation, industry and university faculty and students
- IUCRC centers offer a platform for **significant leveraging** of financial investment by members to accelerate the knowledge base in emerging technological sectors and develop an industrially savvy workforce

https://www.nsf.gov/eng/iip/iucrc/home.jsp

IUCRC Facts – FY 2018/2019

Program Funding

- $19.2M in Program Funding (ENG, CISE)
- $79.8M in Total Center Funding; $1.2M per center
- 1:3.4 Leveraging of NSF funds
- 90% of membership fees go toward research

Centers Nationally

- 68 Centers with 182 University Sites
- 1164 Memberships: 196 new and 194 terminated
- 50% Large Business, 28% SB, 12% Federal Members

Students

- 1787 students engaged/27 students per center
- 575 graduated, 266 hired by industry, over 30% hired by members
- 176 PhDs, 242 MS & 157 UGs graduated in 2018, trained in Center research

Sustainability

- About 40 Graduated IUCRCs remain in operation true to model

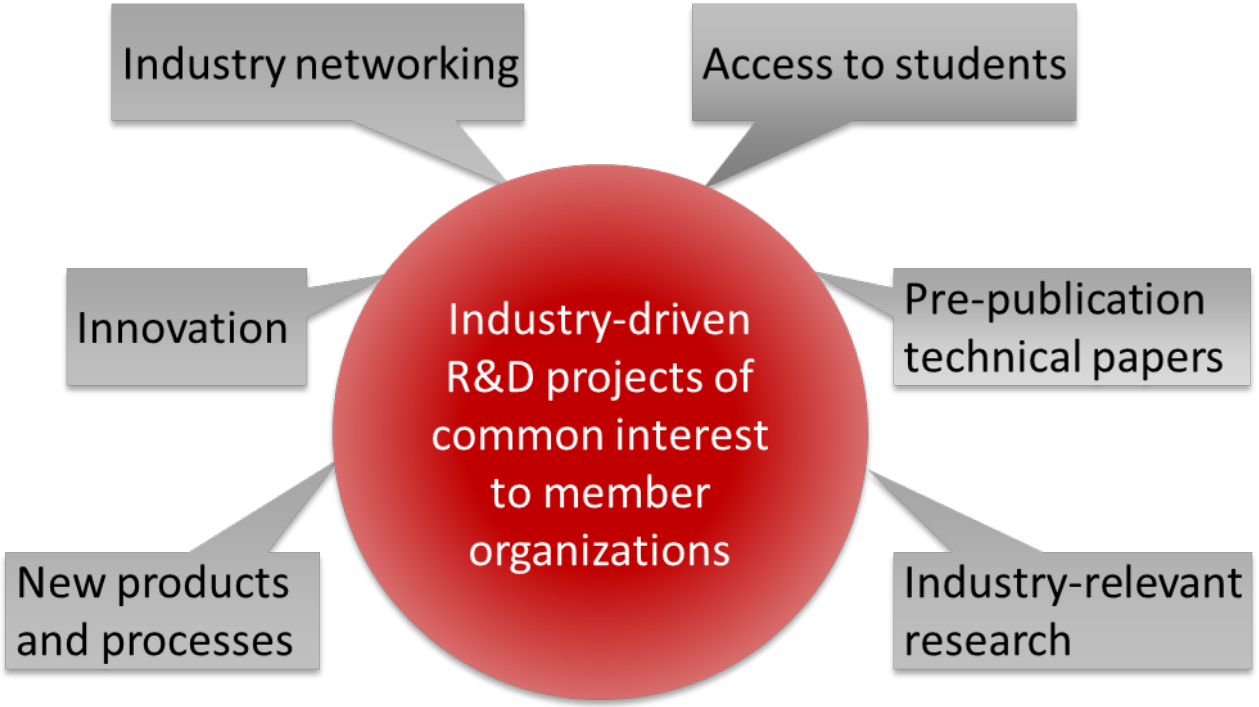
Data from FY 2017-18 IUCRC Center Director Report published in April 2019

Smart Vehicle Concepts Center History

Oct 2005 – July 2007	Planning grant (NSF) awarded to OSU, Planning Conference at OSU, membership sign-ups, etc. (OSU)
July 2007	Center launched at OSU with funding from the NSF and Industrial Members (Phase I: July 2007 to June 2012)
Feb 2007 – June 2008	Projects initiated by founding members (OSU)
July 2008	TAMU joins as an academic partner (July 2008 - June 2013)
March 2012	Center renewal proposal submitted to the NSF by OSU
June 2012	Phase II Center renewed by the NSF as a single site center (Phase II: July 2012 – June 2017)
Feb/March 2017	Phase III proposal submitted No cost extension to Phase II granted until December 2017
Annual Meetings	2 meetings held per year (Semi-annual meeting in winter/spring and annual meeting in summer/autumn)
August 2017	Phase III Center renewed by the NSF as a single-site center (Phase III: 2017-2022)

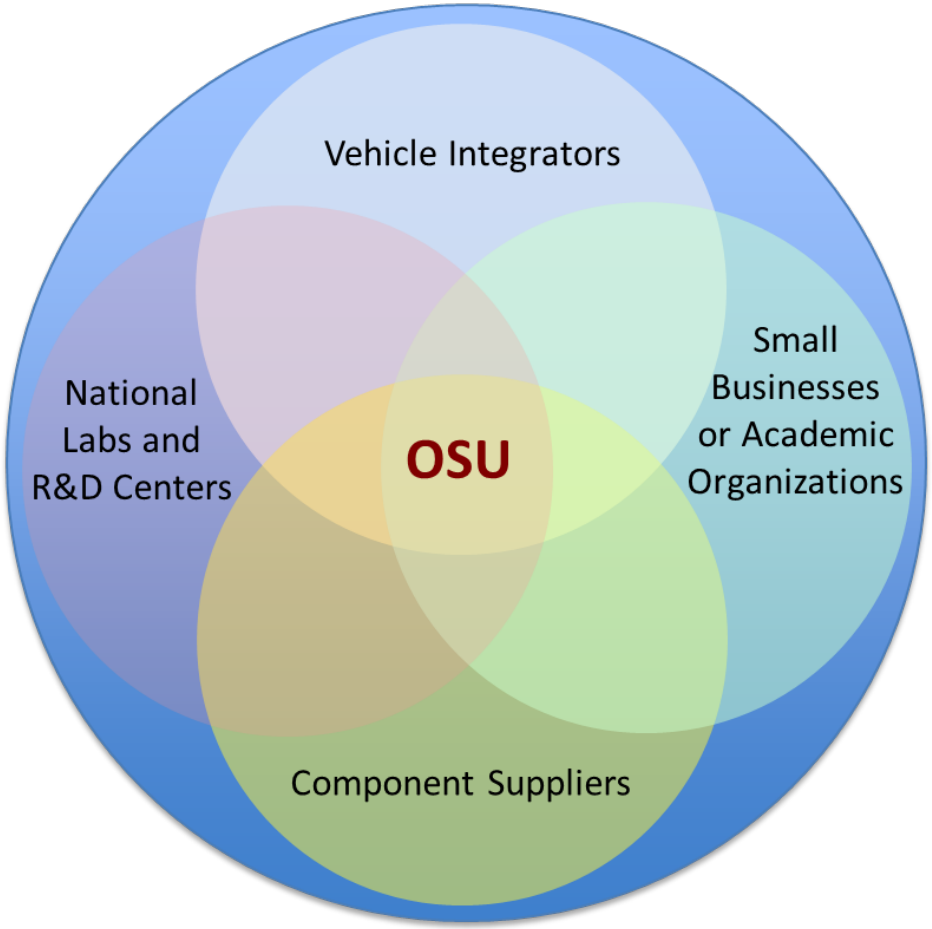
SVC Mission

- Conduct basic and applied research on **smart materials and structures** applied to ground and aerospace vehicles
- Build an **unmatched base of research**, engineering education, and technology transfer with emphasis on improved vehicle performance
- Prepare **next-generation engineers** who possess both theoretical and experimental expertise applicable to auto and aero vehicles



SVC Focus

- **Pre-competitive** technologies and research of common interest
- Smart vehicle **components, sub-systems, and systems** (ground and aerospace vehicles)
- New **smart material actuators and sensors**
- New devices and design tools for **vehicle development work**
- **Superior** dynamic response, plus quiet and smooth operation
- **Improved** performance and refined diagnostic methods
- **Enhanced** safety and energy efficiency



SVC Overall Membership Structure (Phase III)

Membership Type	Money per Year	Project Decisions	Vote	IP Access
Member	Per Membership Fee Schedule		1 per membership (limit 2)	Yes
Solo Guaranteed Project	Membership Fee + Project Fee + Admin Fee	Project is guaranteed		
Umbrella Project	Membership Fee + Admin Fee	Made by the IAB		
Affiliate	Same as Project Fee	No Say	0	Limited to one project only
Invited Observer	In-kind ($10K +)	No Say	0	No
Observer	In-kind (< $10K)	No Say	0	No

SVC provides companies with several membership options. All fees indicated are considered a minimum: Members and Affiliates are encouraged to provide supplemental funding to support the research activities associated with their project

Phase III Fee Schedule for Solo Projects

Center Year	2017	2018	2019	2020	2021-22
Membership Fee (a)	$40K	$40K	$40K	$40K	$40K
Project Fee (b)	$12K	$14K	$16K	$18K	$20K
Admin Fee (c)	$5.2K	$5.4K	$5.6K	$5.8K	$6K
Cost of Solo Membership (a + b + c)	$57.2K	$59.4K	$61.6K	$63.8K	$66K

- *Voted by the IAB*
- *If a member wishes to fund a solo (guaranteed, "non-umbrella" type project), that member must pay an additional "project fee." Alternatively, the member could bring in at least 1 Affiliate to their solo project.*
- *If the Affiliate option is exercised, the 2019 fee is $61.6K ($40K for the Membership + $5.6K for the Administrative Fee + $16K for the Affiliate). Member companies pay for the Membership Fee and Admin Fee; affiliate companies pay for the Affiliate Fee (project fee).*

Phase III Fee Schedule for Umbrella Projects

Center Year	2017	2018	2019	2020	2021-22
Membership Fee (a)	$40K	$40K	$40K	$40K	$40K
Admin Fee (c)	$4K	$4K	$4K	$4K	$4K
Cost of Umbrella Membership (a + c)	$44K	$44K	$44K	$44K	$44K

- *At least 2 membership fees are needed ($88K/year or greater)*

https://svc.osu.edu/membership

Affiliate, Invited Observer, Observer Memberships

Membership Type	Money per Year	Project Decisions	Vote	IP Access
Affiliate	Same as Project Fee	No Say	0	Limited to one project only

Affiliate Membership

- No IAB vote
- Invited to the semi-annual review meetings and given IP access to one project as well as recruitment access to the graduate and undergraduate students upon graduation from OSU
- Each Affiliate can join an ongoing or initiated project that is primarily sponsored by a full Member

https://svc.osu.edu/membership

Affiliate, Invited Observer, Observer Memberships

Membership Type	Money per Year	Project Decisions	Vote	IP Access
Invited Observer	In-kind ($10K +)	No Say	0	No

Invited Observer

- This category has been defined for companies that choose to actively collaborate with SVC and supply software, smart materials, equipment, and instrumentation of $10K value or more, as well as human support to accomplish the projects.
- Invited to the review meetings and given a window into the knowledge being generated and access to the graduate and undergraduate students upon graduation from OSU.
- Allowed to attend the closed (members-only) sessions, though they have limited access to project reports
- No intellectual property rights unless the IAB approves it on a case-by-case basis given the unique contributions made by a specific Invited Observer to a particular project

https://svc.osu.edu/membership

Affiliate, Invited Observer, Observer Memberships

Membership Type	Money per Year	Project Decisions	Vote	IP Access
Observer	In-kind (<$10K +)	No Say	0	No

Observer

- This category has been defined for those companies that provide in kind support of $10K value or less
- Invited only to the “open” sessions of semi-annual meetings
- No intellectual property rights within SVC and no IAB vote

https://svc.osu.edu/membership

SVC Industrial Advisory Board and Evaluation

Industrial Advisory Board (IAB)

- **One representative per full membership (at most 2 IAB representatives for any company)**
  - *Chair: Ryan Hahnlen, Honda R&D*
  - *Vice Chair: Jon Cartlidge, Battelle Memorial Institute*
- **Responsibility:**
  - *Approve center bylaws and procedures*
  - *Evaluate current research thrusts and projects*
  - *Suggest new opportunities*
  - *Evaluate center operations and suggest new partnerships*
  - *Match center capabilities with unfilled research needs*

NSF Assessment Coordinator (VentureWell / Victoria Hill)

- **Assigned by the NSF**
- **Evaluator's fees and expenses covered by the NSF**

Academic Advisory Committee

- **SVC project leaders and MAE Chair are consulted on important Center matters**

NSF Funding (Years 1 – 13) at OSU Site

Phase I	Phase II	Phase III (Committed)*	Phase III (Received)
$561,000	$404,625	$298,000	$198,000
Total NSF funding all phases			**Total received**
$1,263,625			$1,163,625

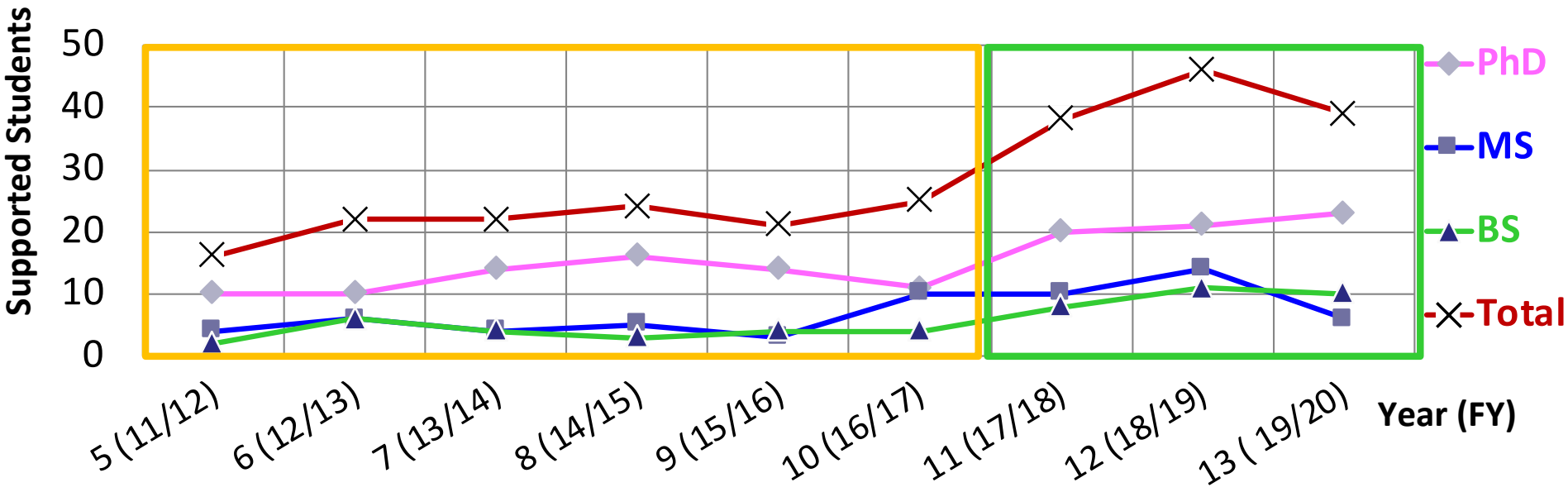
* Includes current REU funding

- Total industry funding received (years 1-13): **$6.7M**
- Ratio (industry/NSF): **5.73**

Status of Phase III Year II Reporting

Date Sent	Date Requested by	Report Type	Performance Period	Requester	Status
Year 1					
30 April 2018	30 April 2018	Assessment Coordinator Report	1 August 2017 – 30 April 2018	VentureWell	Approved
23 May 2018	31 May 2018	IUCRC Structural Report	1 August 2017 – 23 May 2018	IUCRC Evaluation Project @ NCSU	Approved
13 June 2018	30 June 2018	NSF Phase II Annual Report	1 July 2017 – 30 June 2018	NSF/Fastlane	Approved
25 June 2018	1 August 2018	NSF Phase III Annual Report	1 August 2017 – 31 July 2018	NSF/Fastlane	Approved
Year 2					
28 April 2018	29 April 2019	Assessment Coordinator Report	1 August 2018 – 30 April 2019	VentureWell	Approved
4 June 2019	1 July 2019	NSF Phase II Annual Report	1 July 2018 – 30 June 2019	NSF/Fastlane	Approved
10 June 2019	1 August 2019	NSF Phase III Annual Report	1 August 2018 – 31 July 2019	NSF/Fastlane	Approved
18 June 2019	28 June 2019	IUCRC Structural Report	1 August 2018 – 23 May 2019	IUCRC Evaluation Project @ NCSU	Approved

SVC Student Support (Years 1 – 13) at OSU Site



Fully or partially supported includesfellowship/scholarship students

	Supported by Center Research	Graduated from Center	Hired by Member Organizations	Supported by Center Research	Graduated from Center	Hired by Member Organizations
	Phase II 5-Year Data (Avg/Yr)			Phase III Data (Avg/Yr)		
PhD	13.0	4.6	2.6	21.3	4.5	1.5
MS	5.6	4.0	1.8	10	4.7	1.5
BS Thesis	4.2	2.0	0.4	9.7	3	0
TOTAL	22.8	10.6	4.8	41	12.2	3.0

Data as of Sept. 2019 (subject to change)

Phase II-III SVC Graduates and Current Employment

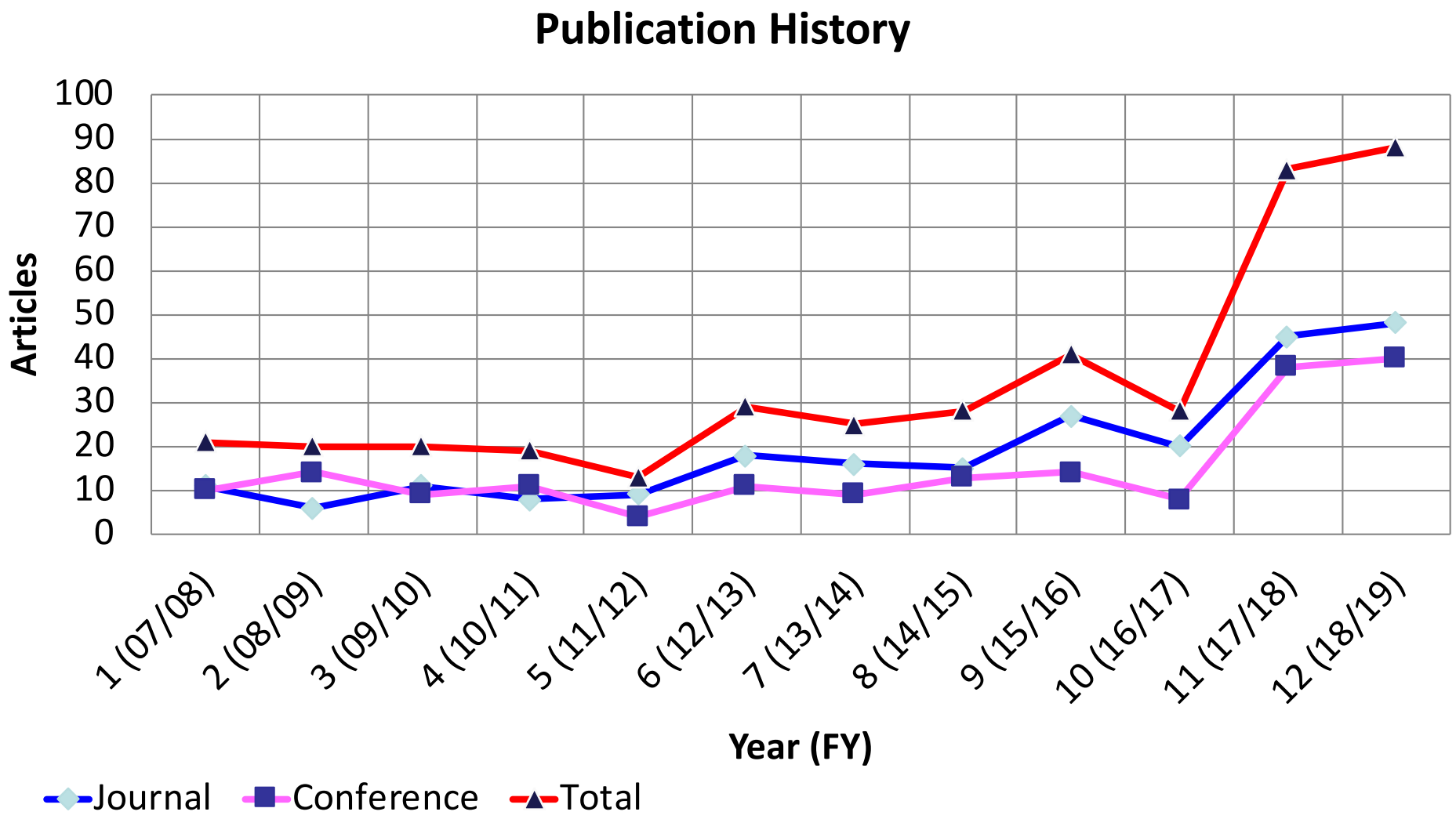
Former Students Employed by:	
Army Research Laboratory †	Made In Space
Bechtel	Magna Electronics
Bruel & Kjaer	Moog, Inc. †
China Automotive Systems, Inc.	NASA Glenn Research Center †
Cummins	NHK International Corp.
Edison Welding Institute †	Owens Corning †
F.tech R&D †	Procter and Gamble
Ford Motor Company †	Root Insurance
GE R&D	STERIS Corp.
General Motors	Toyota†
Goodyear †	TRW
Gorman Rupp	US Army (Aberdeen Proving Ground)
Honda R&D	
Former Students Employed by Academic Institutions:	
Boise State University	MIT Lincoln Laboratory †
IIT Bombay (India)	OSU (post-doctoral researcher)
IIT Delhi (India)	Southern Illinois University
IIT Tirupati (India)	

Graduate School:	
Ohio State	UCLA
Carnegie Mellon	University of Illinois
Georgia Tech	Purdue University

Graduates	Phase II (2012-17)	Phase III (2017-Now)
PhD	23	4
MS	20	16
BS	10	8

†SVC Member Organization during Phase II or III

Publication Record (Years 1 – 12)



New Research Matrix for Phase III

Thrust	Interfacial Mechanisms	Safety, Comfort, and Health Monitoring	Adaptive Noise, Vibration, and Harshness (NVH)	Emerging Vehicle Technologies
	Characterization, constitutive modeling, system integration (sensors, actuators, dynamic simulation)	Machine and material diagnostics, human-machine interface, strain energy management	Active noise and vibration control, adaptive structures, system integration	Vehicle electrification, autonomous vehicles, lightweighting
Relevant Projects	40A, 40E, 40F, 55	44, 46, 49, 53, 58	45, 47A, 52, 57	47B, 51A, 51B, 54, 56
Typical Sponsors	Honda R&D, TRC, R&D, Tenneco, Ford, NASA Glenn, Owens Corning	Bridgestone, Honda R&D, Moog, Eaton**	Honda R&D, TRC, Tenneco, NASA Glenn, Toyota, Parker Hannifin, CVG**	NASA Glenn, Honda R&D, Battelle, TRC

** Pending proposals

Current Topics, Sponsors, Leaders, and Synergies

Project Number and Topic		Sponsor	Project Leaders	Synergistic Projects
#40	Characterization and modeling of passive and adaptive bushings and mounts			#47B
	#40F: Nonlinear isolator dynamics	Ford	Singh	
#46	Mechanoluminescent paintable light sources in automotive lighting systems	Honda R&D	Sundaresan	#53, #58
#49	Embedded fiber optic sensors for structural health monitoring	Moog	Dapino	#51A, #51B, #51C
#51	Ultrasonic additive manufacturing for automotive structures		Dapino, Headings	#49, #52, #54
	#51B: UAM process modeling	Battelle		
	#51C: UAM for structural reinforcement	Honda R&D		
	#51D: UAM of steels	Honda R&D		

Current Topics, Sponsors, Leaders, and Synergies

Project Number and Topic		Sponsor	Project Leaders	Synergistic Projects
#52	Multifunctional structural polymer composites for vehicle electrification	Parker Hannifin	Sundaresan	#51
#54	Robust Integrated Magnetic Composites (RIMaC) for Magnetic Gears		Dapino	#51A, #51B
	#54A: Magnetic Additively-Manufactured Structural Hybrid (MASH)	NASA Glenn		
	#54B: magnetic gear drives (MGDs) for automotive applications	Honda R&D		
#57	Flexible piezoelectric sensors for vehicle applications	Toyota	Dapino	#33
#58	Optical multifunctional materials – Architectures for structural sensors		Sundaresan	#46
	#58A: Architecture for mechanoluminescent structural sensors and sensing platforms			
	#58B: Photoluminescent phosphors for visualizing thermomechanical stress in power electronic devices			

Phase III Sustainability

- A sustainability plan has been prepared **in consultation with the SVC IAB**, and proposed to the NSF in the Phase III renewal proposal

- The **sustainability strategy** of SVC beyond Phase III has 5 components:

  1. Expand the faculty base at OSU, especially junior faculty;

  2. Attract additional Original Equipment Manufacturers (OEMs) and suppliers (including component and material suppliers);

  3. Adapt the Center's research portfolio to evolving needs in the industry, especially in relation to vehicle electrification, autonomous driving, and structural lightweighting;

  4. Continue efforts to collaborate with other institutions and National Laboratories and attempt to attract additional sites as dictated by the technical needs of the IAB and the Center faculty;

  5. Retain the membership fee structure described in the bylaws as approved by the IAB.

Associated SVC Projects (Research Experiences for Undergraduates)

PI	Department	Project title	Amount	Start date	Source
Hanna Cho	MAE	Investigation of metal corrosion by in-situ electrochemical force microscopy	$8K	6/26/2018	NSF
Marcelo Dapino	MAE	Aeromechanic analysis and optimization of boundary layer ingestion turbomachinery	$8K	7/16/2019	NSF
Vicky Doan-Nguyen	MSE/MAE	Solution processing of thermochromic vanadium dioxide smart windows	$8K	7/16/2019	NSF
Ryan Harne	MAE	Integrated hyperdamping material systems for vibration, noise, and shock attenuation	$16K	7/16/2019	NSF
David Hoelzle	MAE	'Seeing' the temperature inside a 3D printed part	$8K	7/16/2019	NSF

Indicates newly received funding

2018-2019 Research Seed Program Update

- **Cash awards** in the amount of $15k each (discretionary university funds)
- Stimulate research collaborations between MAE researchers and industry to the point where a compelling proposal can be developed to **generate industry (or government lab) sponsorship within SVC**
- Program open to **MAE faculty, research staff, and post-docs**
- Brief proposals were due **April 2, 2018**
- **Proposals should include:**
  (a) Cover page (per SVC template)
  (b) Objectives of the proposed research project
  (c) Description and scope of the research (from both basic and applied research perspectives)
  (d) Expected outcomes (such as engagement with potential sponsors, publications, etc.)
  (e) Detailed description of potential companies or research organizations to which the research will be targeted for SVC membership
  (f) PI expertise and available facilities

Seed Program Awardees

PI	Department	Project title	Amount	Start date	Source
J.P. Chen	MAE	Aeromechanic analysis and optimization of boundary layer ingestion turbomachinery	$15k	5/1/2018	MAE
Vicky Doan-Nguyen	MSE/MAE	Solution processing of thermochromic vanadium dioxide smart windows	$15k	5/1/2018	MAE
Ryan Harne	MAE	Integrated hyperdamping material systems for vibration, noise, and shock attenuation	$15k	5/1/2018	MAE
David Hoelzle	MAE	'Seeing' the temperature inside a 3D printed part	$15k	5/1/2018	MAE

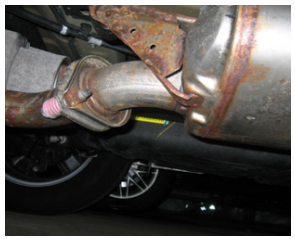
MAE = Mechanical and Aerospace Engineering
MSE = Materials Science and Engineering

NSF REU Project: Investigation of Metal Corrosion by In-situ Electrochemical Force Microscopy

THE OHIO STATE UNIVERSITY

Motivation

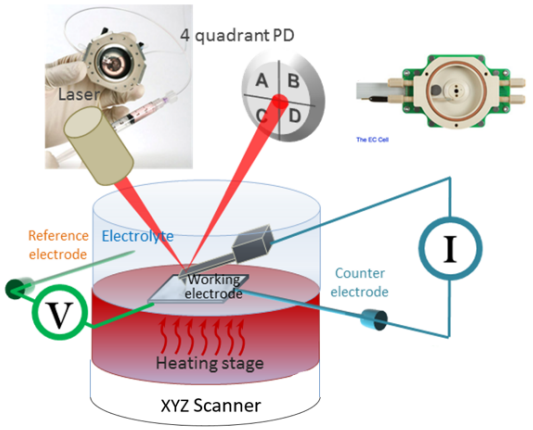
- Corrosion is a serious problem significantly affecting the lifetime of vehicles and thus automobile industry. For example, Toyota Motor Corporation has agreed to pay up to about $3.4 billion in 2016 to settle claims that certain of its trucks and sport-utility vehicles lacked proper rust protection, leading to premature corrosion of vehicle frames [1].



Rust in 2011 Toyota RAV 4 in muffler (carcomplaints.com)

- To date, the macro-scale electrochemical measurements have reveals the effect of electrochemical potentials, temperatures, solution conditions, timescales, and other factors on the global corrosion process for various metallic materials, while the local properties and conditions are trivialized.

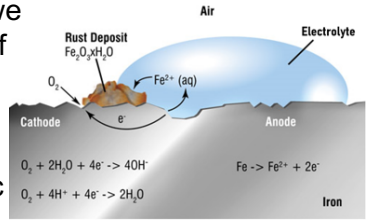
In-Situ Electrochemical Force Microscopy



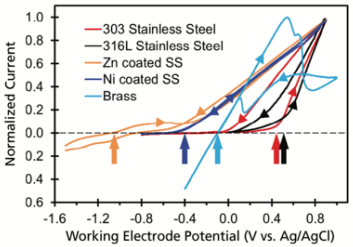
- ✓ Nanoscale characterization
- ✓ In-situ measurement:
  - In liquid; In electrolytes
  - Temperature control
  - Electrical input/output
- ✓ Measuring the potential dependence of corrosion current
- ✓ Local electrochemical behavior

Background and Objective

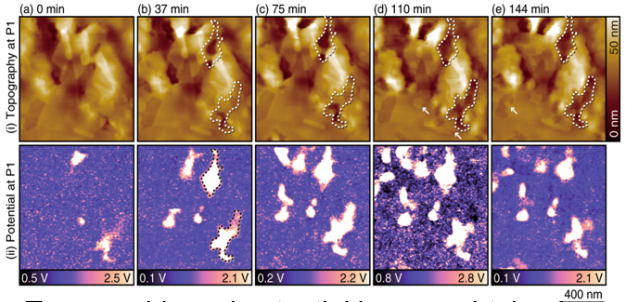
- Localized corrosion accounts for 70 percent of material failures, and these failures are catalyzed by varying particular abnormalities affecting the metallic surface [2].
- Water (electrolyte) comes in contact with the surface of metal, while in the presence of air. With these three parts in contact, the metal becomes polarized and electrons flow through the metal, ultimately creating a mas build up of iron oxide, commonly known as rust.
- Nanoscale corrosion studies depend on the ability to mimic the real-world conditions that promote corrosion in a shorter time scale.
- By leveraging the PI's expertise in AFM, we aim to investigate the corrosion process of various metallic alloys frequently used in automobile production by employing the state-of-the-art in-situ Electrochemical Force Microscopy (EFM) based on Atomic Force Microscopy (AFM).



Typical Data



Cyclic voltammograms of various metallic samples [3]



Topographic and potential images obtained on a stainless steel sample in a 10 mM NaCl solution via Electric Potential Microscopy [4]

[1] https://www.wsj.com/articles/toyota-in-3-4-billion-settlement-over-corrosion-in-some-trucks-and-suvs-1478972740
[2] http://www.npl.co.uk/upload/pdf/beginners_guide_to_corrosion.pdf
[3] https://www.oxford-instruments.com
[4] Honbo, K., Ogata, S., Kitagawa, T., Okamoto, T., Kobayashi, N., Sugimoto, I., Shima, S., Fukunaga, A., Takatoh, C., and Fukuma, T., Visualizing Nanoscale Distribution of Corrosion Cells by Open-Loop Electric Potential Microscopy, ACS Nano 10 (2), 2575-2583 (2016).

Project Leader: Hanna Cho (cho.867@osu.edu)

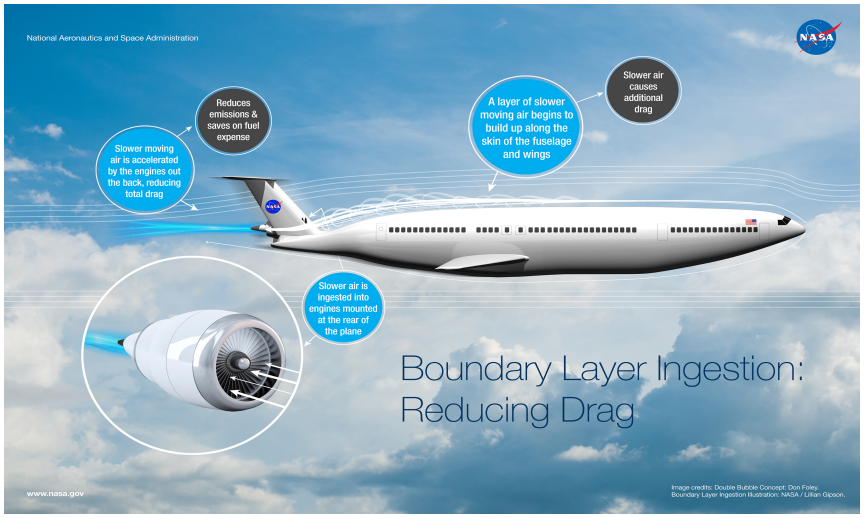
www.SmartVehicleCenter.org

SVC Seed Grant: Aeromechanic Analysis and Optimization of Boundary Layer Ingestion Turbomachinery

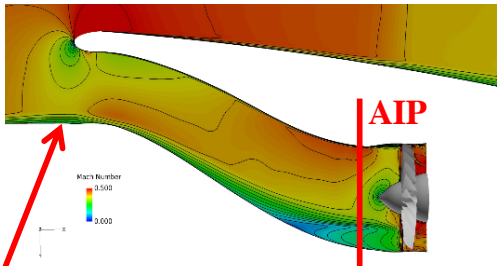
THE OHIO STATE UNIVERSITY

Motivation

- NASA subsonic transport system metrics: Fuel Burn Reduction N+1 (2015) 33%, N+2 (2020) 50%, N+3 (2025+) 70%
- 3-5% fuel reduction by ingesting boundary layer (BL) flow
- Non-uniform BL ingestion and inlet geometry create flow distortions that negatively impact engine performance and structural integrity
- A need to study inlet/fan interaction through CFD simulation to understand fan response to inlet distortion to mitigate aero and aeroelastic challenges

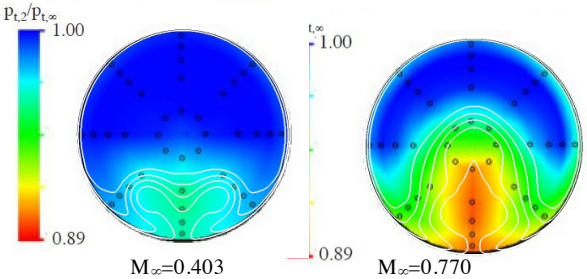


Accurate computational simulation coupled with inlet and blade optimization is necessary to bring this technology to production level

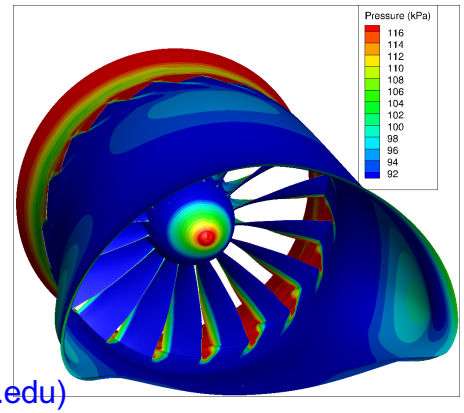


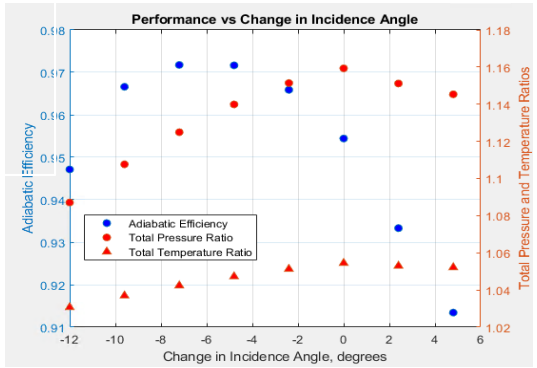
25% to 30% of inlet flow is low momentum BL flow

Total pressure distortion upstream of compressor



- Highly 3D swirling flow enters the inlet and interacts with the fan
- The fan experiences large changes in Angle of Attack





- Optimizing the geometry of the blade allows for increased overall performance and longer life for the blade

www.SmartVehicleCenter.org

Project Leader: Jen-Ping Chen (chen.1210@osu.edu)

Twelfth Annual Meeting, Ohio State, 19-20 September 2019

SVC Seed Grant: Solution Processing of Thermochromic Vanadium Dioxide Smart Windows

Industry Need, Context, Relevance

- Need to efficiently regulate temperature of internal environments with smart windows
- Impact on energy efficiency can be up to 42%[1] of total energy consumption for residential cooling and heating
- Need rapid synthesis methods to reduce processing time
- Need control over optical transmittance for smart windows applications

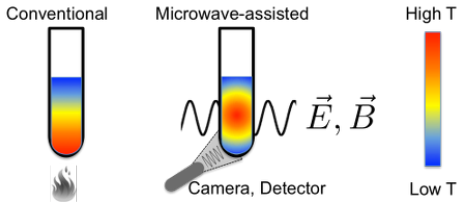
[1] S. Selkowitz 2010

Project Objectives

- Reduce typical synthesis of bulk materials from *days* to *minutes*
- Develop solution-processable low-temperature method for coating procedure

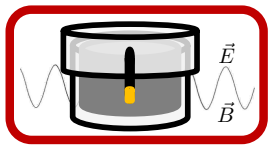
Research Plan

- Control microwave-assisted heating conditions to achieve phase purity of targeted materials

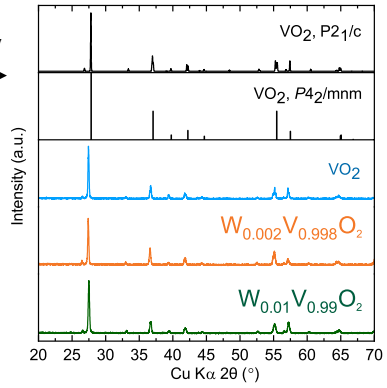


- Characterize phase purity of products and transition temperature
- Translate microwave-assisted heating conditions to solution-phase synthetic methods to control nanostructured morphology

Preliminary Results/Applications



Achieved phase purity



Preliminary results show phase purity of bulk smart materials. Next steps include film deposition and controlling opacity.

$A_xV_{1-x}O_2$

Vary x to control transition temperature

Project Leader: Vicky Doan-Nguyen (doan-nguyen.1@osu.edu)

SVC Seed Grant: Integrated hyperdamping material systems for vibration, noise, and shock attenuation

THE OHIO STATE UNIVERSITY

LSVR:
Advancing basic and applied science in vibrations, acoustics, mechanics, and smart materials.

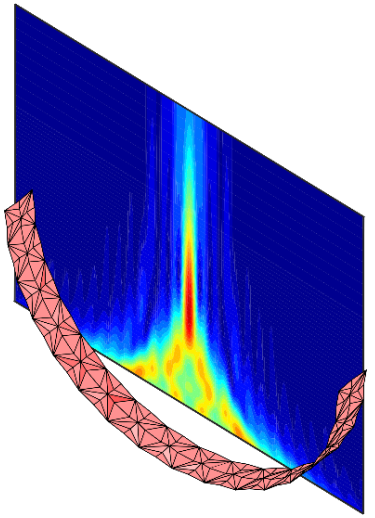
Director:
Prof. Ryan L. Harne

Thanks to our many industry, federal, and defense sponsors!

Research Student Team

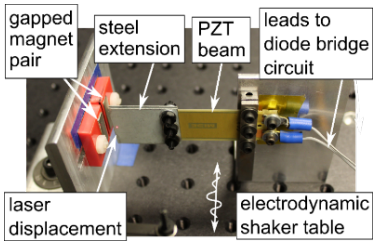
Origami-Inspired, Foldable Acoustic Arrays for Deployable Medical Ultrasound Devices:

Acoustics, wave physics, mechanics, design



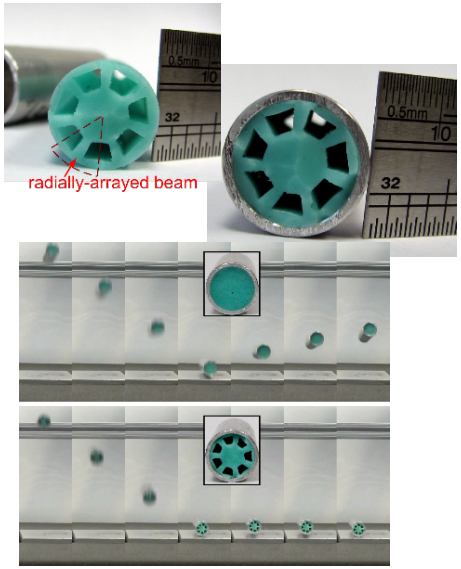
Understanding, Predicting Response of Multistable Structures Operating in Extreme Environments:

Analytical dynamics, energy harvesting, hypersonic multiphysics



Lightweight Material Systems to Control Shock, Vibration, and Sound:

Structural mechanics, materials science, design and manufacturing



www.SmartVehicleCenter.org

Project Leader: Ryan Harne (harne.1@osu.edu)

SVC Seed Grant: 'Seeing' the temperature inside a 3D printed part

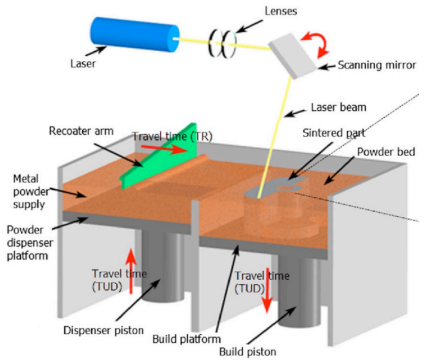
THE OHIO STATE UNIVERSITY

Background and Objectives

- Metal Powder Bed Fusion (PBF) is an additive manufacturing (AM) process that fabricates 3D parts from powdered metal feedstock
- Emerging manufacturing process for low-volume, high value-added parts and tooling
- There remain significant thermal management problems that reduce part quality and yield

Objective: Develop a state estimator framework to estimate unmeasurable temperature states inside a part that is being built.

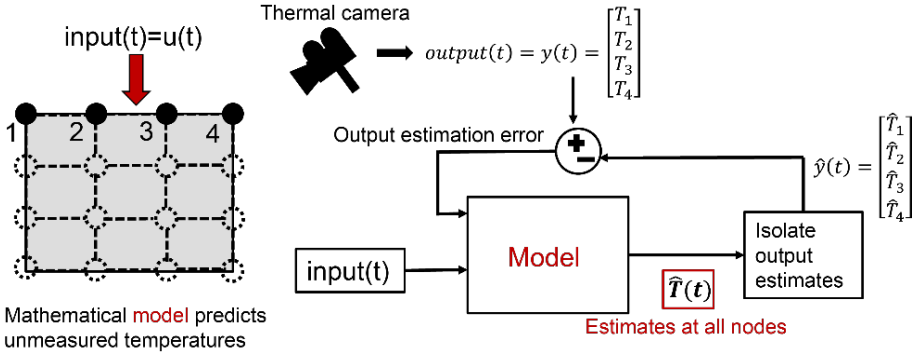
Metal PBF Process



(Verna, et al., *Int. J. Adv. Manuf. Tech.*, 2015)

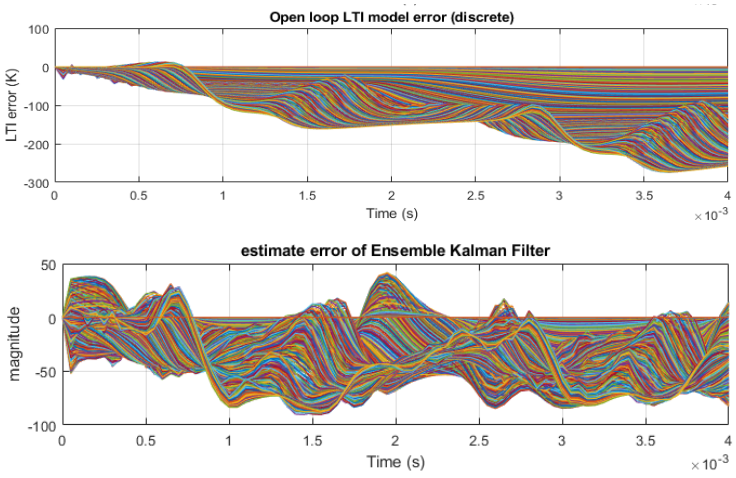
Inputs: Laser energy at coordinate (*x*,*y*) and boundary conditions
System: Complex geometry thermal domain dominated by conduction
Output: Temperature field on the top surface

Methods



Merge experimental data with process model: provides internal temperature states and estimate covariance statistics: Extended Kalman Filter

Simulation Results



Estimates diverge for standard computational models

Estimates remain bounded using an extended Kalman filter

Project Leader: David Hoelzle (hoelzle.1@osu.edu)

Twelfth Annual Meeting, Ohio State, 19-20 September 2019

www.SmartVehicleCenter.org

SVC Faculty and Research Staff

MARCELO DAPINO
Honda R&D Americas Chair;
Professor; Director of SVC
Expertise: Smart materials; Nonlinear coupled systems; Design; Control

J.P. CHEN
Associate Professor
Expertise: Computational fluid dynamics; CFD simulation and coding; Turbulence modeling; Turbomachinery

HANNA CHO
Assistant Professor
Expertise: Nonlinear NEMS/MEMS; AFM cantilever dynamics; Multi-functional ferroelectric material energy systems; Nano- and bio-science

VICKY DOAN-NGUYEN
Assistant Professor
Expertise: Synthesis; In-situ structural characterization; Smart materials; Advanced materials for energy storage/conversion

M. BRYANT GINGERICH
Research Associate
Expertise: UAM; Experimental testing; Design

RYAN HARNE
Assistant Professor
Expertise: Structural acoustics; Vibration energy harvesting; Nonlinear dynamics

LEON HEADINGS
Senior Research Associate
Expertise: Energy Systems; Mechatronic Systems; Intelligent Control Smart Materials

DAVID HOELZLE
Associate Professor
Expertise: Learning/adaptive control systems; Additive manufacturing processes; Microsystems for mechanobiology research; Dynamics systems analysis

SCOTT NOLL
Research Assistant Professor
Expertise: Structural dynamics; Jointed assemblies; Design; Inverse methods

RAJ SINGH
Emeritus Professor
Expertise: Noise & vibration control; Geared systems; Nonlinear dynamics; DSP

SOHEIL SOGHRATI
Associate Professor
Expertise: Advanced FEM; Modeling multiscale response of advanced/bio-materials and structures

VISHNU SUNDARESAN
Associate Professor
Expertise: Piezoelectric materials; Active polymers; Bio-derived materials

Center Publicity

Center Newsletters

- Annual newsletters (online as of 2014), December annually
- Latest Newsletter published December 2018

Web Sites (regularly updated)

- SVC Main Website: http://SmartVehicleCenter.org, (also under https://svc.engineering.osu.edu/)
- NSF Fact Sheet: http://www.iucrc.org/center/smart-vehicle-concepts
- NSF Events: http://www.nsf.gov/events/
- SVC Newsletter https://svc.osu.edu/sites/svc.osu.edu/files/uploads/december_2018_svc_newsletter_12.10.2018.pdf

Main Mechanisms

- Open Sessions in SVC meetings
- Meetings with Potential Sponsors
- Personal Interactions
- Papers at Technical Conferences
- Student Paper Contests
- Faculty Seminars & Invited Talks
- Brochures and Quad Charts
- NSF Meetings
- Web Sites and Newsletters

Magazine Articles

- *Smart Materials: Steering innovation in vehicle design,* OSU College of Eng., News in Engineering, 2007
- *Smart Vehicle Concept Center – Research for Industry,* OSU Mechanical Engineering Newsletter, October 2008
- *Smart and Small*, Machine Design, 2008
- *Building smarter materials*, Automotive Engineering International (SAE), 2009
- *Smart Vehicle Concepts Center – Research for Industry*, ASME/AIAA newsletter, 2009

Institutional Publications

Article in Industry-Nominated Technology Breakthroughs of NSF Industry-University Cooperative Research Centers

- *Design Concept for Smart, Adaptive Seatbelts* in 2014

Article in Ohio State University's MAE Department Research News

- *A Noise, Vibration, & Harshness Technology Success Story*, in 2013

Article in Ohio State University's MAE Undergraduate News

- *An Innovative Capstone Design Experience Based on Simulation Pilot Program Made Possible by GM Foundation*, in 2014

Selected Accomplishments

Prof. Vicky Doan-Nguyen awarded $40K through OSU Materials Research Seed Grant Program

August 7, 2019

The Ohio State University this week announced seven innovative materials research projects will receive a total of $300,000 in funding through the OSU Materials Research Seed Grant Program.

The program seeds and advances excellence in materials research of varying scopes. It is jointly funded and managed by the Institute for Materials Research (IMR), Center for Emergent Materials (CEM) and Center for Exploration of Novel Complex Materials (ENCOMM).

The program furthers IMR's mission to nurture, grow and support excellence in materials research. The enhanced OSU Materials Research Seed Grant Program became available to the Ohio State materials community in Winter 2011.

This year, one Multidisciplinary Team Building Grant (MTBG) and **six Exploratory Materials Research Grant (EMRG)** awards were selected after a thorough internal and external review

This grant assists in enabling nascent and innovative materials research to emerge to the point of being competitive for external funding. Each award is $40,000.

Design and Local Structure Identification of Stable Electrode-Electrolyte Interfaces

- **Prof. Vicky Doan-Nguyen**, Department of Materials Science and Engineering

Harne selected as Air Force Research Lab summer 2019 Fellow and recipient of the ASME Gary Anderson Early Achievement Award

AFRL Summer Faculty Fellowship study of gallium-indium-based liquid metal composites as tools for new flexible electronic soft matter with his Zack Nick and Charles El-Helou

From gears to blood vessels: Indian scholars excel during their summer at Ohio State

Posted: August 1, 2019

For the fifth consecutive year, the Research Internship for Young Academics (RIYA) program provided comprehensive research experiences for undergraduate mechanical engineering students from India. Four high-achieving students joined laboratories in The Ohio State University Department of Mechanical and Aerospace Engineering, where they took part in real-world investigations.

2019 RIYA Scholars"This is a very unique program," commented program founder and director, Professor Emeritus **Raj Singh**. "The students start with a passion for research, but without significant experience. We pair them with laboratories of interest where they quickly learn problem-solving skills in an active research environment."

This year's research projects focused on the subjects of nonlinear vibration, vehicle seat isolation, planetary gears and blood vessel permeability.

Team effort

Mentorship is a key component of the highly sought after program. Not only are students paired with mentors in their assigned laboratories, they also attend a weekly group session with Singh. Topics include ethics, research process, making presentations and planning for graduate school.

"The RIYA program has offered me an opportunity to improve and apply the fundamental concepts that I have learnt throughout my undergraduate curriculum," said participant **Ajinka Pawar**. "It has also given me a chance to understand the importance of academics, research [and] entrepreneurship via group sessions with other RIYA scholars and professor Singh, and allowed me to grow professionally."

The program's success wouldn't be possible without the commitment of faculty and research staff. "Over the years the number of labs participating in the program has increased," said Singh. "Faculty and researchers have seen the work ethic and analytical capabilities of the top-ranked interns from elite institutions and realize what a benefit they can be to their labs."

RIYA scholar **Harshit Bansal** appreciated the support he received in the Acoustics and Dynamics Laboratory. "I liked the overall structure of the RIYA program that perfectly introduce[d] me to the basics of qualitative research [and] provide[d] me with the opportunity to interact with personalities varying from academics to the industrial background," he said.

Selected Accomplishments

Passionate professor shares love of science with kids

Posted: May 22, 2019

Vicky Doan-Nguyen taps into kids' innate curiosity to get them excited about science.

An assistant professor of materials science and engineering, Doan-Nguyen spends a lot of time thinking about how to spark kids' interest in science and maintain it. She also wants every child—especially girls—to know that anyone can be a scientist or engineer.

Since joining the Ohio State faculty in August 2017, Doan-Nguyen has not only been recognized for her research accomplishments, she's also spearheading two outreach programs that are successfully engaging central Ohio kids in STEM.

Unlike those kids, Doan-Nguyen was introduced to engineering relatively late in life.

Professor Vicky Doan-Nguyen holds molecular models while talking to middle-schoolers about phosphorescent materials.

Prof. Doan-Nguyen helps a Girl Scout build a battery-operated model car.

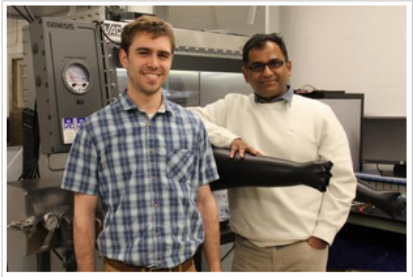
Catrina Wilson, a materials science and engineering graduate student, helps middle-schoolers make glow-in-the-dark bracelets at Gladden Community House.

Another step forward for a promising new battery to store clean energy

Posted: May 15, 2019

Researchers have built a more efficient, more reliable potassium-oxygen battery, a step toward a potential solution for energy storage on the nation's power grid and longer-lasting batteries in cell phones and laptops.

In a study published this month in the journal Batteries and Supercaps, researchers from The Ohio State University detailed their findings centering around the construction of the battery's cathode, which stores the energy produced by a chemical reaction in a metal-oxygen or metal-air battery. The finding, the researchers say, could make renewable energy sources like solar and wind more viable options for the power grid through cheaper, more efficient energy storage.



Paul Gilmore, left, and Vishnu-Baba Sundaresan

"If you want to go to an all-renewable option for the power grid, you need economical energy storage devices that can store excess power and give that power back out when you don't have the source ready or working," said **Vishnu-Baba Sundaresan**, co-author of the study and professor of mechanical and aerospace engineering at Ohio State. "Technology like this is key, because it is cheap, it doesn't use any exotic materials, and it can be made anywhere and promote the local economy."

Renewable energy sources don't emit carbon dioxide, so they don't contribute to global warming—but they provide energy only when the sun is shining or the wind is blowing. In order for them to be reliable sources of power for a region's energy grid, there needs to be a way to store excess energy gathered from sunshine and wind.

Companies, scientists and governments around the world are working on storage solutions, ranging from lithium-ion batteries—bigger versions of those in many electric vehicles—to giant batteries the size of a big-box store made using the metal vanadium.

Potassium-oxygen batteries have been a potential alternative for energy storage since they were invented in 2013. A team of researchers from Ohio State, led by chemistry professor Yiying Wu, showed that the batteries could be more efficient than lithium-oxygen batteries while simultaneously storing about twice the energy as existing lithium-ion batteries. But potassium-oxygen batteries have not been widely used for energy storage because, so far, they haven't been able to recharge enough times to be cost-effective.

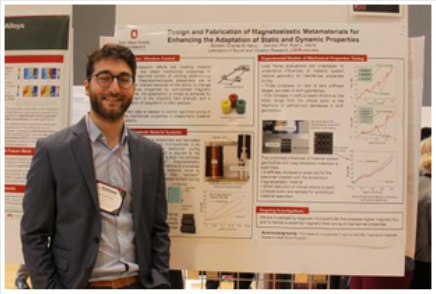
As teams tried to create a potassium-oxygen battery that could be a viable storage solution, they kept running into a roadblock: The battery degraded with each charge, never lasting longer than five or 10 charging cycles—far from enough to make the battery a cost-effective solution for storing power. That degradation happened because oxygen crept into the battery's anode—the place that allows electrons to charge a device, be it a cell phone or a power grid. The oxygen caused the anode to break down, making it so the battery itself could no longer supply a charge.

Selected Accomplishments

Charles El-helou Earns Third Place at Denman Undergraduate Research Forum

Posted: March 25, 2019

Undergraduate students from across campus were celebrated at the 24th annual Denman Undergraduate Research Forum.

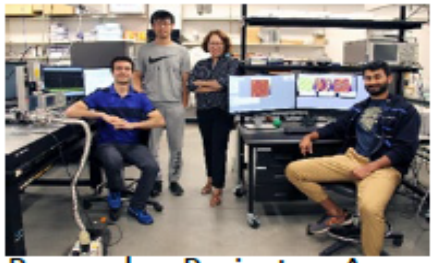


Charles El-helou

Four department students were among the 30 students representing the College of Engineering at the distinguished event. Each student produced a standout project as a result of their hard work and dedication.

Mechanical engineering major Charles El-helou won third place in the structural and material fabrication and design category for his project, "Design and Fabrication of Magnetoelastic Metamaterials for Enhancing the Adaptation of Static and Dynamic Properties." El-helou was mentored by Assistant Professor **Ryan Harne**.

Cho expands research initiatives with prestigious funding awards – August 2018

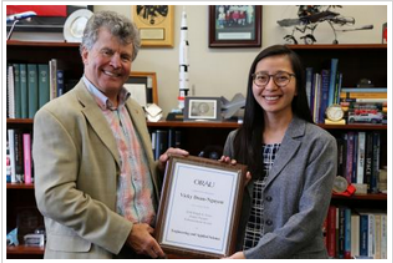


Assistant Professor Hanna Cho was awarded funding from the National Science Foundation (NSF) Partnership for Innovation and her previous Defense Advanced Research Projects Agency (DARPA) Young Faculty designation was converted to a prestigious Director's Fellowship. Click here for the full article. Prof. Cho is also recipient of an NSF Research Undergraduate Experience grant through SVC.

Engineering's Vicky Doan-Nguyen earns ORAU Powe Award recognizing early career research

Posted: July 3, 2018

Vicky Doan-Nguyen, an assistant professor in the Departments of Materials Science and Engineering and Mechanical and Aerospace Engineering, has earned a 2018 Ralph E. Powe Junior Faculty Enhancement Award from Oak Ridge Associated Universities (ORAU) in recognition of her research accomplishments and career potential.



Dean David B. Williams presents Assistant Professor Vicky Doan-Nguyen with her award plaque from ORAU.

Doan-Nguyen is one of just 36 recipients nationwide to earn the prestigious award, which provides seed funding to enhance the research and professional growth of junior faculty at ORAU member institutions. Each winner receives a one-year, $5,000 research grant from ORAU, which is matched by the faculty member's institution. Winners were competitively selected from among 159 faculty applications.

Doan-Nguyen joined Ohio State in 2017 as part of the Discovery Themes' Materials and Manufacturing for Sustainability Initiative. As part of the Center for Electron Microscopy and Analysis, her cross-cutting research includes synthesis, in-situ structural characterization and functional testing of smart materials as well as advanced materials for energy storage and conversion.

For her Powe Award project, Doan-Nguyen will collaborate with researchers from the Oak Ridge National Laboratory and Argonne National Laboratory to examine controlled rapid synthesis, advanced characterization across multiple length scales and functional testing of sulfide-based solid electrolytes for safer batteries.

"We are targeting solid-state superionic conductors that are competitive with current liquid electrolytes. The solid-state electrolytes are less flammable and can maintain high ionic conductivity over a wider range of temperatures," she said.

Her research group aims to use their expertise in materials synthesis and characterization to explain structure-property relations for a new class of superionic conductors that consists of sustainable, earth-abundant elements.

"By controlling chemical composition and structure of the solid electrolytes, we can design next generation safer batteries with longer cycle life," said Doan-Nguyen.

Selected Accomplishments

The College of Engineering recognizes the research contributions and productivity over the last five years of faculty and research scientists***. The 2019 College of Engineering Lumley Research Awards*** are presented to a select group of outstanding researchers who have shown exceptional activity and success in pursuing new knowledge of a fundamental or applied nature. This year's recipients include one of SVCs faculty, ***Prof. David Hoelzle.***

Patent Status	Invention	Inventors
Patent Pending	**Programmable Chemical Actuators**	**R. Northcutt,** *V. Sundaresan*
Patent pending 62/543,471	**Design Features of Dissimilar Material-Reinforced Blanks and Extrusions for Forming**	**M. Dapino**, D. Detwiler, *M.B. Gingerich,* R. Hahnlen, *L. Headings*, M Scheidt, A. Sheldon
Patent pending 62/676,191	**Continuous Ultrasonic Additive Manufacturing System**	**M. Dapino,** *M.B. Gingerich*, R. Hahnlen, *L. Headings*
Patent pending	**Electrically Triggered Rapid Exothermic Reaction in 3D Printed Ionomer Composites**	**V. Sundaresan**
Patent pending 15/760,095	**Active Member with Controlled Ion Transport**	**V. Sundaresan,** T. Hery, *R. Northcutt*, V. Venugopal
Patent pending 15/896,199	**New Cantilever Design for Measurement of Multi-Physical Properties using Atomic Force Microscopy**	**H. Cho**, L.A. Bergman, *S. Dharmasena,* S. Kim, A.F. Vakakis
Patent Pending 15/867,930	**Morphing Fender Skirt for a Steered Wheel**	**V.S.C. Chillara**, *M. Dapino*, U. Gandhi, *L. Headings*

Summary

- Emphasis of SVC is on **pre-competitive research** – exploratory and high-risk
- SVC creates research at the intersection of **smart material technologies** and **mobility applications** (automotive, aircraft, rotorcraft)
- The Center is in **Year 2 of Phase III (2017-2022)** with OSU as a single site
- Phase III accepted in August 2017 with about **$1.5M committed** (for years 11 and 12) from 10 distinct members
- OSU cost share (reduction in indirect cost rate and staff support) is used to leverage resources, though the support from OSU and NSF **has decreased dramatically** for Phase III
- Strong **education and placement** outcomes:
  - 81 students graduated with PhD/MS/BS degrees in Phases II and III
  - Many of our graduates have joined sponsors
  - Some of the SVC alumni serve on the IAB

IAB Meetings and Spring 2020 Meeting

IAB Meetings

- September 19– Updates and action items
- September 20 – L.I.F.E. feedback, etc.

Spring (13th Semi-Annual) Meeting

Dates TBD for March

Location: Ohio State University

- *Open session (for guests and sponsors) on Day 1*
- *Project reviews (sponsors only) on Day 2*
- *IAB meeting(s)*
- *Student poster display on Day 1*