

Major unmet need for knee prostheses in India



- 200,000 above-knee amputees in India [1]
- Over 40% of them live < \$1.25/day [2]
- Unemployed and suffer severe personal and societal consequences [2]
- Metabolically inefficient by up to 70% [3]

1. Narang 1982
 2. Hamner 2013
 3. Andrysek 2010

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Problem

Motivation

Prior Art

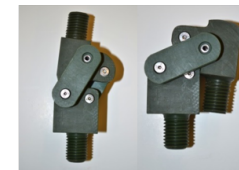
Research Objectives

Cost vs. Performance gap for passive knees

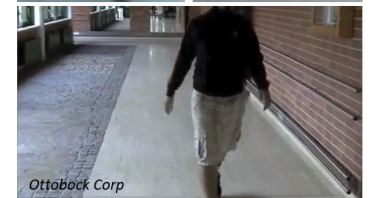
Jaipur Exoskeleton knee \$10



Jaipur-Stanford 4 bar knee \$25



Active knees ~ \$10,000-60,000



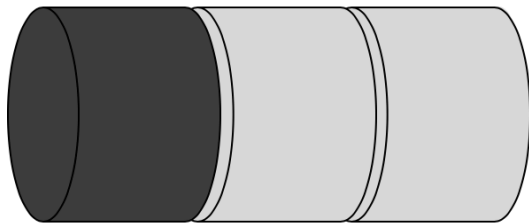
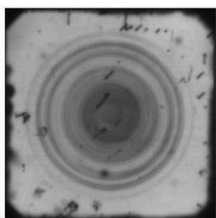
Lower-cost, higher performance Knee¹
\$100-150

1. In review, 2015: Narang, Y. S., Arelekatti, V. N. M., Austin-Breneman, J. & Winter, A. G. (2015). Using Human-Centered and Biomechanical Analysis to Determine Design Requirements for a Prosthetic Knee for Use in India

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Oxygen affects yield

- Efficiency loss: 5-20% relative drop
- Manufacturing yield loss: 25% - 30% of single crystal Si wafers



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Motivation

Problem

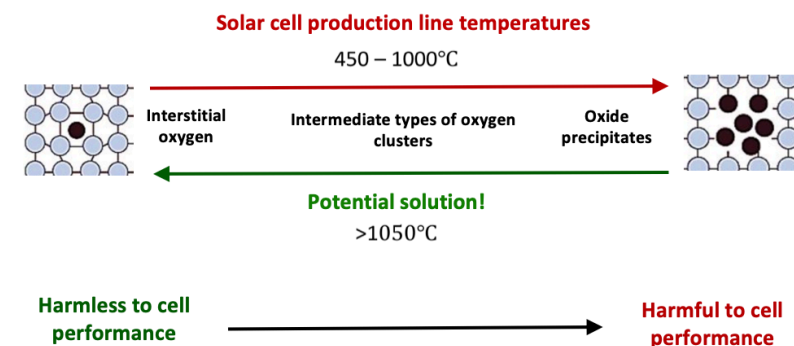
Research Questions

1. When all oxygen precipitates dissolve, how much efficiency can be recovered?
2. What is the limiting physical process (energy barrier) when dissolving the precipitates?
3. When does high temperature annealing to dissolve oxygen precipitates work?

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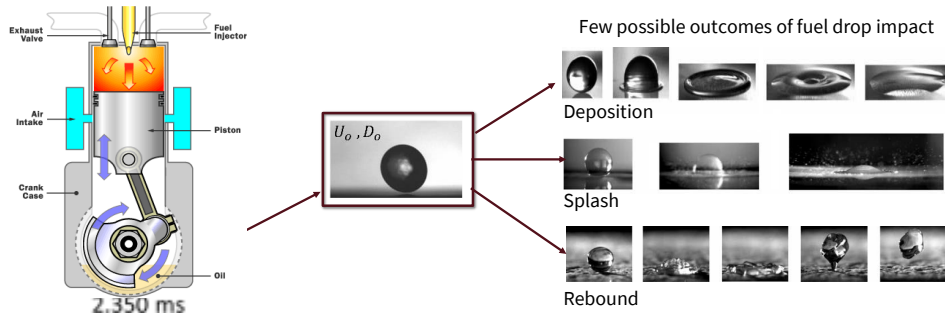
Research Objectives

Oxygen defects change during processing



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Fuel drop impact phenomenon: Why is it important?



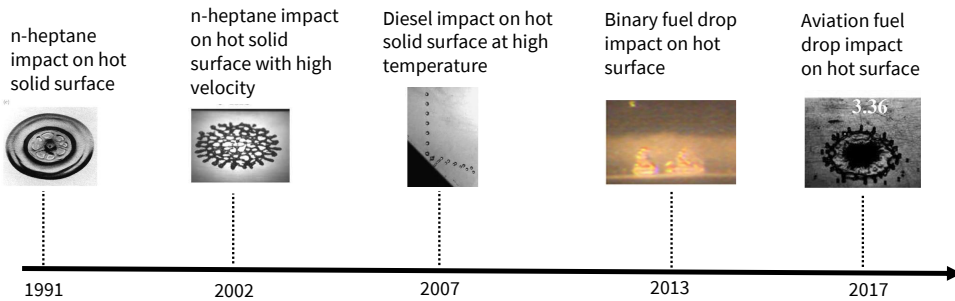
- Fuel spray impact morphology on the hot walls of the combustion chamber influences engine performance and emissions
- Fuel spray impact in engine combustors can be understood by breaking down the problem into single drop impacts

- Few possible outcomes of fuel drop impact
- Factors influencing drop spreading phenomenon:
- Droplet diameter
 - Distance between nozzle tip and surface
 - Properties of the impinging fuel
 - Surface temperature
 - Surface morphology

Viverjita U., MSc (Engg) Thesis, IISc (2017)
 Rioboo et al., Exp. in Fluids, 33 (2002)
 Zhao et al., SAE Int. J. Fuels Lubr. 10 (2017)

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Literature review of fuel drop impact on heated surfaces



- Literature review indicates most work on fuel drop impact on hot surface is focused on
- Understanding drop impact of a single fuel
 - Surface temperatures either below or above boiling point
- A comprehensive understanding of the effect of surface temperature and fuel properties on the drop spreading process is yet to be obtained**

Chandra and Avedisian, Proc. R. Soc. Lond. A, 432 (1991)
 Manzello and Yang, JHMT, 45 (2002)
 Chen et al., ETFS, 32 (2007)

Kompinsky et al., CES, 98 (2013)
 Sen et al., Int. J. Thermal Sci. 121 (2017)

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Motivation

Research Objectives

Objectives of the present work

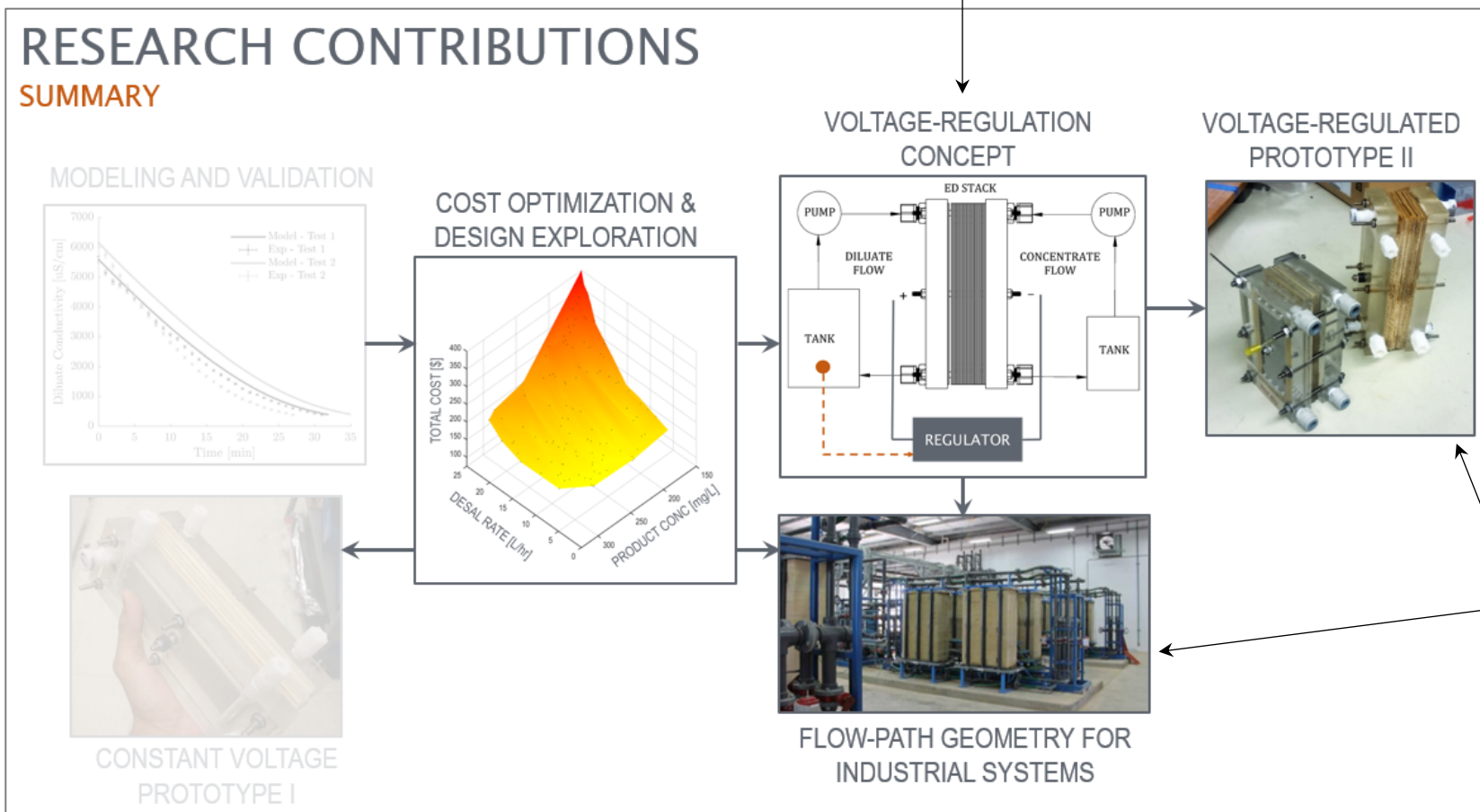
- To study the effect of surface temperature on the fuel drop spreading process
- To study the effect of fuel properties on the fuel drop spreading process
- To evolve a detailed understanding of the single fuel drop spreading process on a hot substrate that can be used for studying fuel spray impact processes in engines

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Problem

Roadmap Example 1:

Scopes the presentation while mentioning other work

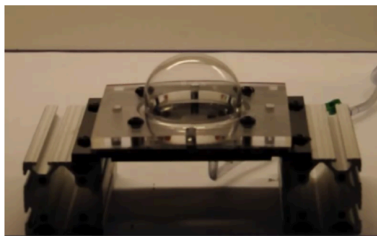


Highlights the 'creative' solution

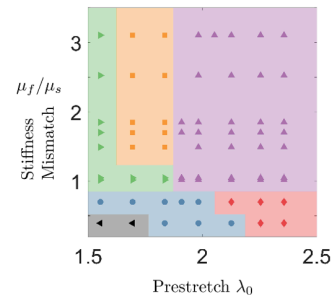
Features outcomes

Roadmap example

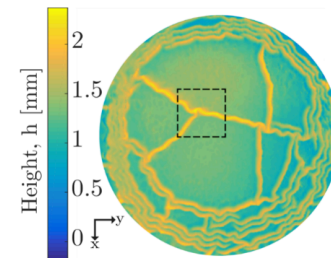
Outline



Developed novel experimental design to study bilayer buckling



Explored buckling pattern parameter space



Characterized propagation of ridge buckling mode

Publication: Al-Rashed et al, *Soft Matter* (2017).

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- States contributions beforehand, so audience knows where the story is going (no mystery story!)
- Introduces key images that will come back

Roadmap Example 2:

RESEARCH OUTCOMES


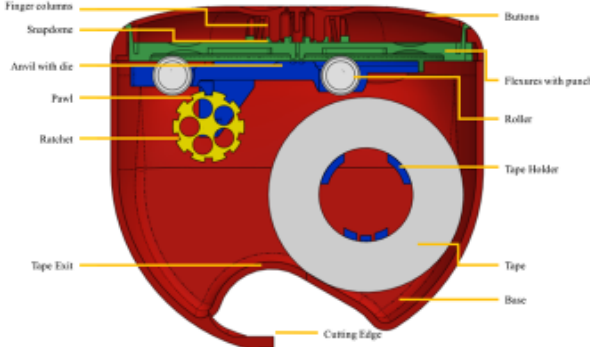
Braille-It: From Idea to Proven Solution

Mechanism Design

1. Repeatedly embosses Braille dots on Scotch tape
2. Braille characters meet global specifications
3. 15 micron repeatability elastically averaged anvil die interface

System Integration and Optimization

4. \$1.44 estimated manufacturing cost per device

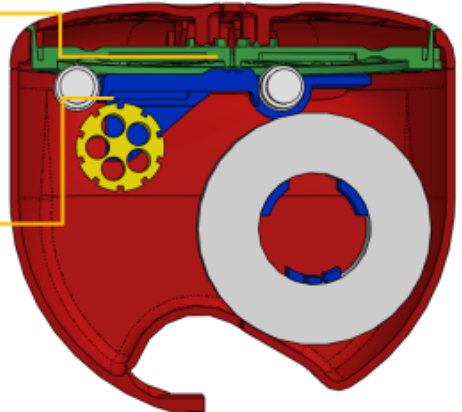



2 /

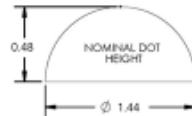
Enumerates key outcomes succinctly

APPROACH

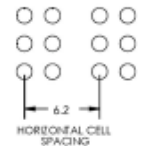
Core Mechanisms



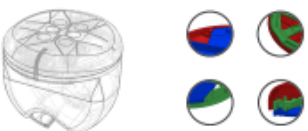
Embossing



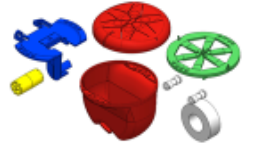
Indexing



Assembly



Design for Manufacturing



Background Design Embossing Indexing Assembly Conclusion

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Calls out four specific areas researcher will address later; gives broad, visual overviews of them

Roadmap Example 3:

Current work is motivated by the state of the field

Problem statement:

Despite 10 years of research, no Indian homes use electro dialysis.

Research Questions:

1. Have we identified all the customer **needs**?
2. What **opportunities** exist for designing a new point-of-use ED system?
3. How can we **compare** system concepts?
4. Is there an **ED concept** that meets all the requirements?

Visuals repeated throughout the presentation

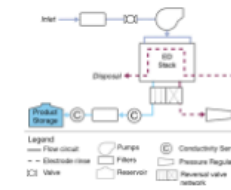
Scope and main contributions

Needs

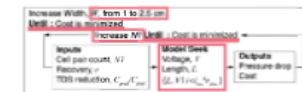


EUREKA FORBES
Your friend for life

Concept generation



Simulations



Proof of concept



Elucidated unmet integration needs from manufacturers


Invented new system concept for small scale ED

Demonstrated the novel concept better meets the market needs than previous concepts.


H. Varner, S.R. Shah, A.G. Winter, U.S. "Simplified Architecture for Desalination via Electrodialysis." *Patent application serial number 63/065,574*.
 H. Varner, S.R. Shah, and A.G. Winter. "The determination of a cost optimal design for a multiple stage continuous electro dialysis desalination device for use in domestic point of use water purification." *International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*, pages 1-8, St. Louis, 2020. ASME
 H. Varner, S R. Shah, and A G. Winter. "Architecture and unit design of a capital cost optimized, household electro dialysis desalination device with continuous flow." *In preparation*.

Contributions highlighted

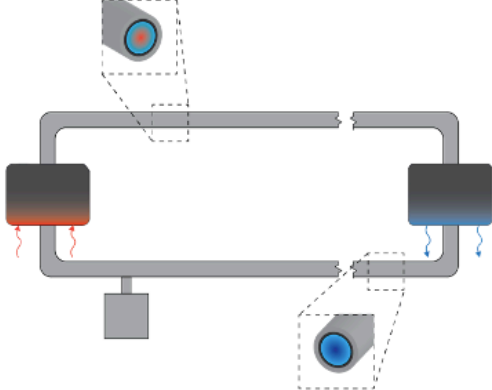
Close the loop with conclusions before discussing future work



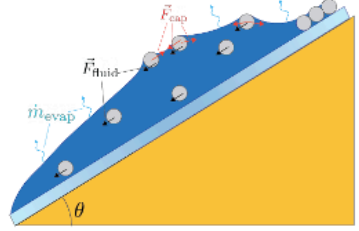
Conclusions



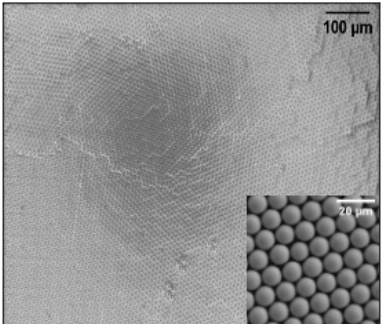
Developed model showing need for evaporator and condenser with **high permeability and HTC**



Developed model that enables **rational, ordered structures** across **wide range of sizes**



Generated insights of self-assembly enable structures with pores **10x bigger** than previous works



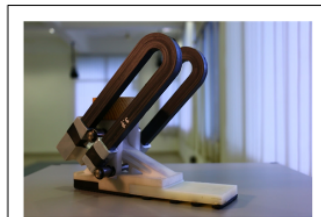
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- Summarizes work
- Jogs audience memory
- Prompts questions
- Emphasizes new contributions to the field

Use final slide to reiterate your contributions

Instead of asking “Questions?”, try...

SUMMARY OF THE PROJECT

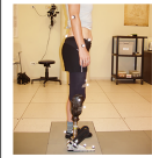


Experimental Prosthetic Foot to Test the Lower Leg Trajectory Error (LLTE) Design Framework

- Custom Interchangeable Springs
- High Stiffness & Range of Motion
- Lightweight

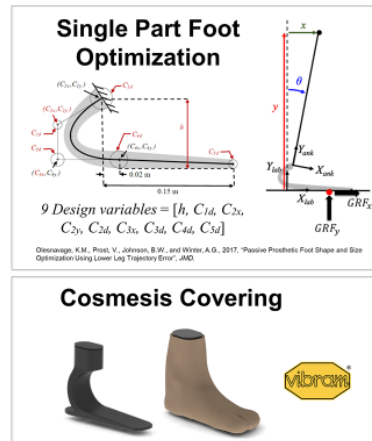


QUALITATIVE
Early User
Testing with
Prototype Foot



QUANTITATIVE
Initial Clinical
Testing and
Data Analysis

VALIDATION OF THE LLTE
DESIGN FRAMEWORK



JOURNAL PAPERS:

- Prost, V., Olesnavage, K. M., Johnson, B. W., Major, M.J. and Winter, A. G., 2017, "Design and Testing of a Prosthetic Foot Prototype With Custom Springs for Evaluating Lower Leg Trajectory Error, an Optimization Metric for Prosthetic Feet," *Journal of Mechanisms and Robotics*.
- Olesnavage, K.M., Prost, V., Johnson, B.W., Major, M.J. and Winter, A.G., 2017, "Clinical Validation of Predicting Lower Leg Trajectory for Passive Prosthetic Feet Using Physiological Data as Inputs", *IEEE Transactions on Neural Systems and Rehabilitation Engineering*. (Submitted)
- Olesnavage, K.M., Prost, V., Johnson, B.W., and Winter, A.G., 2017, "Passive Prosthetic Foot Shape and Size Optimization Using Lower Leg Trajectory Error", *JMD*. (Accepted)

CONFERENCE PAPER:

- Prost, V., Olesnavage, K. M., Winter, A. G., 2017 "Design and Testing of a Prosthetic Foot Prototype With Interchangeable Custom Rotational Springs to Adjust Ankle Stiffness for Evaluating Lower Leg Trajectory Error, an Optimization Metric for Prosthetic Feet". ASME IDETC/CIE Conference, 41st Mechanisms and Robotics Conference.

PATENT:

Uspring Design for Prosthetic Applications - Provisional Patent #19539.123484

AWARD:

MIT Mechanical Engineering Research Exhibition 2017 – Runner Up Award

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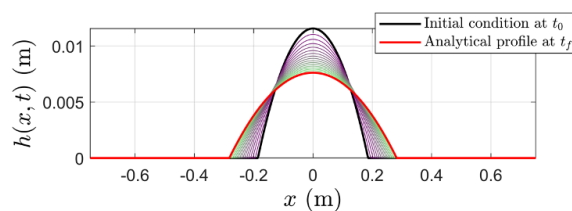
Lets you highlight publications, patents, and/or awards

Use final slide to reiterate your contributions

Instead of asking “Questions?”, try...

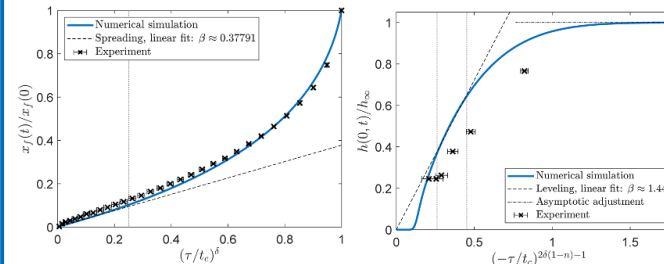
Contributions

Novel numerical scheme derived:



- 2nd order accuracy.
- Respect mass conservation on discrete level.
- Captures spreading and levelling.
- Can simulate wider variety of problems (rheology, geometry, porous media).

2nd kind self-similar problem:



- Simulations show good agreement with experiments and analytical solution.
- Quantified ‘adjustment’ time for self-similarity to begin.
- Validated levelling self-similarity rigorously.

- Summarizes work
- Jogs audience memory
- Prompts questions
- Emphasizes new contributions to the field

Another one!

Publications:

[1] Ghodgaonkar A.A., Christov I.C. (2019) Solving Nonlinear Parabolic Equations by a Strongly Implicit Finite Difference Scheme In: Applied Wave Mathematics II. Mathematics of Planet Earth, vol 6. Springer. ([link](#))

[2] Zheng Z., Ghodgaonkar A.A., Christov I.C. Shape of spreading and leveling gravity currents in a Hele-Shaw cell with flow-wise width variation, in preparation

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