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**Thank you to my wonderful wife, Marwa, for everything you have done for me over the past 5 years! I would not be here today without you.**

**Nafati A.**



**My celebration wouldn't be completed without you mom, dad, sweetest Rori, Hason & friends. My lovely Dalol & Danon you are my everyday celebration.**

**Hussain A.**



**I would like to thank my lovely  
wife Ingvild-Jorna and my  
two kids Kristian and Nina  
Marie for their love and great  
support!**

**Geir A.**



**To my mom and dad, my mother  
and father figures, and all loved  
ones who have supported,  
encouraged, and inspired me  
throughout the years, thank you!**

**Adam D. A.**





**Thank you for coming.  
Hopefully I made you guys  
proud!**

**Arefeen A.**





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**Thanks all for your support.**

**Abdulrahman A.**



**Ghazai and Hadba, this  
wouldn't have been possible  
without you.**

**Ziyad A.**



**Thank you my family for the  
great support**

**Abdullah A.**



**To my parents, I cannot thank  
you enough for everything  
you have done for me to help  
me get to this point.**

**Mathew A.**



**My dream is to see my  
parents happy, thank you to  
both of you for making this  
possible.**

**Ahmed Mahdi A.**



**Congratulations. We made it!!**

**Abdulrahman A.**





**Thanks dad for investing and  
believing in me.**

**Mohammad A.**



**thank you**

**Faisal A.**



**“The strength of a nation  
derives from the integrity of  
the home.” –Confucius**

**I would not be here if not for  
my family’s support.**

**Robert A.**





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**Thank you Mom, Pops, Lindz,  
Oma and Opa for supporting  
me on this wonderful journey.  
I am blessed to have a family  
like you.**

**Luis A.**



**Mom, Dad, Grandma, Jer,  
Andrea, thank you for the  
motivation.**

**Gregory A.**



**Alyssa, you are an amazing wife and I love you! Thanks to my Azeka and Larson family for the support. My Master's is dedicated to you! Love**

**Bryan A.**





**Thanks mom, thanks dad, and  
thank you ASU Cyber Physical  
System Lab for showing me  
what it takes to be great!**

**Dave B.**



**Thank you to my beautiful  
wife, Erin, and my new baby  
boy, Weston!**

**William B.**



**Thank you for the love,  
support, and babysitting!**

**Tomas B.**



**Thank you mom, I love you.  
Thank you everyone at  
Freescale. I could not have  
done it without your support.**

**Adrian B.**



**Thank you so much for  
supporting me throughout  
my educational journey and  
helping me graduate!**

**Joshua B.**



**Thank you to my wife, family  
& friends for all the support.  
I will share this achievement  
with you all for the rest of my  
life! Gracias mama. Los amo!**

**Hiram B.**



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**I'm extremely proud to be a graduate of ASU for both of my degrees. Thank you family and friends for helping me through everything!**

**Elizabeth B.**







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CHI EPSILON<sup>®</sup>  
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HONOR SOCIETY

**I wish to thank my parents,  
my family, and everyone who  
has helped me knowingly or  
unknowingly in achieving this  
goal.**

**Aditya Vidyadhar B.**



**You made this possible ma.**

**Thank You**

**Vineeth B.**



**Thank you to my parents  
for doing whatever it took  
to ensure that I had the  
opportunity to receive a good  
education.**

**Dylan B.**



**Thank you for all your  
love and support over this  
CRAZY journey! I love you all  
~muah~**

**Holly B.**



**Thank you for your love and  
support!**

**Roberta B.**



**“What a Long Strange Trip It’s  
Been.” -Grateful Dead**

**Adam B.**

“”

**It may have taken me 8 years,  
but I never lost hope, and  
neither did you. Thanks Mom  
and Dad :D Love**

**Cory B.**





**Thank you for being both my  
anchor and the wind on my  
sails.**

**Girish Rao B.**



**Thank you to all my family  
and friends for believing in  
me. Special shout out to my  
mom, my true inspiration.**

**Zachary B.**



**There is absolutely no way  
this would be possible without  
the support of my family and  
most especially the rock solid  
dedication of my wife Amy**

**Patrick C.**



**Dear Mom and Pops, Thank  
you for everything. I couldn't  
have done it without you guys.  
Love, Selim**

**Yavuz C.**



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**Thanks mom & dad!! Hope I  
made you proud!**

**Lance C.**



**Thanks for everything!! Now  
what?**

**Bradley C.**



**Thanks to my Mom, Dad  
and my whole family for  
supporting me! I couldn't have  
done it without you! Love you  
guys!**

**Nicholas C.**





**Thank you Dad, Mom and Kev  
for all the support and love. Bob  
has become a graduate today  
and a proud engineer too! Shout  
out to all other graduates!**

**Robin C.**



**Thank you mom and dad for  
working so hard to give me  
the best education I could  
have ever imagined! Love you  
guys so much!**

**McKinsey C.**



**Dear Meredith, Dad, Steven,  
Allie, Gregg, Barbara, Ken, Ralph,  
Sarah, Justine and Lucas, Thank  
you for your unending support  
and encouragement. Love,**

**Jose C.**



**Thank you dear parents for  
supporting me studying  
abroad!**

**Chieh-an C.**





**Synthesis and Characterization of PDMS/CP-21 Alcohol-Modified Membranes for Permeation of Dilute L-Biotinyl Serum Solutions**  
Mehmet H. Ozkan, Chemical Engineering and Materials Science  
Arizona State University, Tempe, AZ 85287

**Introduction**  
The development of membranes for permeation of dilute L-biotinyl serum solutions is a critical step in the design of membranes for bioprocesses. The development of membranes with high permeability and low fouling is a key challenge. This study aims to synthesize and characterize PDMS/CP-21 alcohol-modified membranes for permeation of dilute L-biotinyl serum solutions. The membranes are synthesized using a two-step process: first, PDMS is synthesized and then CP-21 is grafted onto the PDMS surface. The membranes are characterized using various techniques, including SEM, TEM, FTIR, and XPS. The permeation properties of the membranes are evaluated using a permeation cell. The results show that the membranes have high permeability and low fouling. The membranes are also characterized by their mechanical properties and thermal stability.

**Synthesis and Material Characterization**

**Permeation Testing and Results**

**FURI**  
Future Urban Initiative

**ASU** Ira A. Fulton School of Engineering  
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**Dear Marcus, thank you for  
your unconditional support  
and love through the past four  
bumpy years. Without you,  
this would not be possible.**

**Yan C.**





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**I will be eternally thankful to  
Ma and Baba for all they have  
done for me....**

**Sabarna C.**





**Mummy Baba, I dreamt, you  
believed, therefore here I am!  
Thank You for everything..**

**Kedarnath Amarnath C.**



**Hey family and friends, I  
freaking love you guys.**

**Rebecca C.**



**I feel prepared for anything  
thanks to ASU! Giving special  
thanks to: Joe, Mom & Dad,  
Family, Professors: Czeranko,  
Lee, Balasooriya, both Calliss'**

**Jeffrey C.**



**A special thank you to my parents,  
who have encouraged and  
supported me throughout this  
program. I wouldn't be here without  
them. MULTUMESC DIN SUFLET**

**Bogdan C.**



**Many thanks to my parents,  
wife, daughter and professors  
for making this possible. I guess  
I have no excuses left to get out  
of cleaning the garage.**

**Philip C.**



**“Brian Crosswhite is the most awesome person you will ever meet.” –Everyone**

**Brian C.**

“”

**Thank you so much to my family without whom I never would have reached this point in my life. I love you all.**

**Ryan C.**





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**Thank you for putting up with  
me and my stress all these  
years! Love you!**

**Kathleen C.**



**Thank you Mom, Dad,  
Grandparents, and all my  
close friends. Your support  
helped the entire way.**

**Jai D.**



**Thanks mom and dad for all the love and support. Hope I'm setting a good example for my little brothers. You guys are next!**

**Claudio D.**



**I want to thank my family,  
friends and of course God for  
giving me the support and  
strength needed to obtain my  
Bachelor's Degree!!**

**Eduardo D.**



**Thank you friends and family  
for all your support.**

**Bhargav D.**



**Thank you to my husband  
and parents for supporting  
me! I am ready for my next  
challenge.**

**Linda D.**



**Connie, thank you for your  
patience and understanding as  
I worked through earning my  
degree. Your support has been  
paramount in my success.**

**Varun D.**



**“The most grateful of the people to Allah are those who are most grateful to others.”**

**Therefore, I am conveying my deepest gratitude.**

**Ibrahima D.**







### Optimal Generation of Solar and Wind Electricity

Advanced Energy Engineering  
Senior Project by Paul Thompson  
Electrical and Computer Engineering

**Conclusion**  
The analysis of the system has been done based on available data of 2004. Because of the lack of available data for that specific region, the study has been conducted for a time span of one year. In order to further validate this methodology, it is important to do the study over a period of 20 to 30 years.

**Future Work**  
Using generated electricity output over a 24-hr period by combining the power produced from solar panels and wind turbines, the next and most important step is to get real time electricity demand of our region of study. Once we have that information, algorithmic models can be created to meet the region electricity demand by then combining the two systems. In the future, in perspective, we can consider solar and wind energy as stand alone power sources which will make them more...

The poster contains several data visualizations:

- Hourly Power Generation:** A line graph showing power output over a 24-hour period. The solar component (green) peaks during the day, while the wind component (blue) shows more variability throughout the day.
- Monthly Power Generation:** A bar chart showing power output for each month of the year. The solar component (green) shows a clear seasonal peak in the summer months.
- Hourly Power Demand:** A line graph showing electricity demand over a 24-hour period, with a peak during the day.
- Monthly Power Demand:** A bar chart showing electricity demand for each month, with a peak in the summer months.

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**I would like to thank my family and my friends for everything! I will never be able to repay my parents for all the support they offered me!**

**Vlad D.**



**I want to thank my friends  
and family for supporting me  
through this journey! Mama y  
Papa son mis heroes!**

**Daniel D.**



**I would like to thank my entire family for the support and encouragement.**

**Victor D.**



**Dad (Richard Dorricott),  
Mom (Sharon Dorricott),  
My girlfriend (Alex Prassas),  
Professors Niemczyk,  
Kimberely, Sukhrev, West.**

**Nicholas D.**



**I want to thank my family and friends for their support and a special thanks to my fellow classmates for accepting the old guy in class.**

**Gregory D.**



**I want to thank my parents,  
Greg and Erin Dunn for all  
their love and support. I truly  
want to thank my dad, Greg for  
completing this dream with me.**

**Chase D.**





**Papa, Nana, Dad and Mom  
thank you for giving me a  
bright future! I love you!**

**Haley E.**



**Thank you to everyone who  
has been a part of my life and  
supported me during my time at  
Arizona State University. Thanks  
for sharing this day with me.**

**John F.**



**I could not have  
accomplished this without the  
motivation, love, and support  
from my parents, sister, and  
husband. Love you guys!**

**Helene F.**



**Saludos a los Flores-  
Juörez! Los quiero mucho! -  
Carlangas**

**Carlos F.**



**A great deal of gratitude goes out to my family, especially my husband Tony, for helping me survive and supporting all my late night studies!**

**Lisa F.E.**



**Thank you, Mom, Dad, and  
Kristen. I would not be here  
without you!**

**Rachel F.**



**Thanks for all the support,  
love and encouragement  
throughout my years of  
schooling.**

**Brandon F.**



**Thanks for what you did for  
me, my father and mother**

**Lei F.**





**Thank you Chihiro and  
Takeshi Fujiwara for the  
support, I couldn't have done  
it without you.**

**Shimpei F.**



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**Thank all the professors and  
students that helped me.  
Thank all the events and  
services here I experienced. I  
am so proud to be a sun devil!**

**Jingyao G.**



**Padmini Gudipudi: This would  
not have been possible  
without you!**

**Venu G.**



**I'd like to thank my Mother.  
My supporters Roger and  
Robin Mercer. And my mentor  
Rob Roberts. I could not have  
done it without you.**

**Kyle G.**



**I'd like to thank my family  
for their support and  
encouragement in making  
this a successful endeavor for  
me.**

**Matthew G.**



**I've had an amazing experience at ASU. I want to thank my family and my beautiful fiancée Ginger for supporting me for the past four and a half years.**

**Kevin G.**





**Mom & Pat, Would not be  
here today without you guys.**

**Valerie G.**



**Thanks Mom, Dad, Sneha &  
my dear friends for making  
this happen.**

**Girish G.**





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**Thank you to the sun devil  
family, will always cherish my  
moments here.**

**Vaibhav G.**



**Thank you for putting up with  
my stressful journey! I love  
you guys!**

**Thomas G.**



**To my family and friends, thank you for all of your support throughout these years. This achievement would not have been possible without it.**

**Greg H.**



**Thank you Aya for your  
support and patience over  
the past year. I LOVE YOU SO  
MUCH**

**Moayyad H.**



**i had a great and exciting time  
here both educationally and  
socially. thank you**

**Firras H.**





**Thank you everyone who  
helped and supported me to  
get here.**

**Dwight H.**



**Thank You Mom and Dad! I  
wouldn't have been able to do  
it with out you! To my 6 month  
old daughter, may the fourth  
always be with you.**

**Joshua H.**





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**Marcos, Isis, Jammie, and  
Marco! Thanks for all the  
support!**

**Marcos H.**



**Thank you AAR. Love you AJ!**

**Juan H.S.**



**Mom and Dad Thanks for  
paying for school. You're  
welcome for getting a job  
and not moving into the  
basement! Love**

**Nicholas H.**



**I thank my family and friends  
for their support.**

**Prashanth H.S.**



## EXPLORING CUES FOR AUDIO-HAPTIC SENSORY SUBSTITUTION

Shantama Bala, B.S. Computer Science  
Mentor: Dr. Troy McDaniel, Associate Director of the Center for Cognitive Ubiquitous Computing  
School of Computing, Informatics, and Decision Systems Engineering

For tactile-audio, what is an intuitive mapping between acoustic and haptic space for speaker ID (i.e., who is speaking) and environmental sound? Considerations when building such a device—signal processing requirements, actuator type, and placement.



### Motivation: Social Interactions

To improve access to speech information for individuals with who are deaf, much research has explored tactile-audio substitution devices—technologies that convert speech and environmental sounds into a pattern of vibrating stimulation applied to the skin. The most well-known of such devices is the Tactile ID (TID). The Tactile ID is a portable and wearable tactile audio substitution electronic device with a flexible, attachable electronic display. This research attempts to explore more intuitive mappings between acoustic haptic space. For the first step, we propose to explore natural mappings between speaker identification (i.e., who is talking) and vibractile stimulation patterns.

### Design: The Haptic Feedback

The Haptic Feedback Display (HFD) consists of a flexible, attachable electronic display embedded with a vibractile display. The display is composed of two columns of eccentric rotating mass (ERM) actuators. The actuators and vibration motors are affixed to the outside of the display. The actuators are in direct contact with the user's skin. The device is powered and connected to a USB, and its components are built using the Arduino electronics platform.

The Haptic Feedback Display was designed to convey the effect and emotion of speech by an interaction partner in the middle of a conversation. For the research, we designed vibractile cues on the display to convey the details of human speech using a user's sense of touch.





**Familia, Gracias por todo su apoyo y sus porras durante estos dos años y medio...**

**Diego H.R.**



**“Second star to the right,  
and straight on til’ morning.”**

**-James Tiberius Kirk**

**Chelsea H.**

“”

**Thank You**

**Abelardo H.**



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**A special thank you to dad and mom for always being there and supporting me throughout this journey. Thank you to Uncle Bill and Aunt Jaynie.**

**Nicolas J.**



**Love you mom, Love you  
Sherry.**

**Ce J.**

“”

**Thanks for those who had  
helped me!**

**Jie J.**



**I am here because of the  
sacrifices made by my family.  
Especially my mom and Uncle  
Omar.**

**Darrell J.**





**To my biological family and my Mexican family. I have never known such love. It's time I give back. Thank you Jesus for blessing me with this day!**

**Michael J.**



**I Thank My Family & Friends  
For Their Support!!**

**Ravi Teja Reddy K.**



**Would not have been possible  
without you Mom & Dad.  
Hope you were here!**

**Kuldeep K.**



**Thanks to my amazing wife Sarah, my parents and brother, and to Dr. Tom Sugar. You all mean so very much to me and I appreciate all of your support!**

**Jason K.**



**I would like to thank my  
Family, Dr. Mary Niemczyk,  
and Gayla Marsh for the  
incredible support given to  
me. I Love You All**

**Kimberley K.**



**Thank you all for sticking with  
me throughout the ride!! It  
was worth it.**

**Shane K.**



**Thanks Mom and Dad for all the help getting me to this point in my life/career. Thanks Maham for putting up with my stress and drinking habits.**

**Mark K.**



**My loved ones, Thank you  
so much for supporting me  
through this journey. Love  
you!**

**Sharath K.**





**I can't thank my family enough  
for the everlasting support  
they showed me, even when  
passing grades seemed like a  
statistical anomaly.**

**Mackenzie K.**



**Thank you Mom, Dad and  
Aniket, for everything. I'm here  
today, just because of you.**

**Aniruddha Gajanan K.**



# Evaluating the cost efficiency of using molasses as an electron donor for *ex situ* bioremediation of chlorinated solvents

Emily Bondarik, Civil (Environmental) Engineering  
Mentor: Rosa Krajmalnik-Brown, Ph.D.  
School of Sustainable Engineering and the Built Environment

## Introduction

Trichloroethene (TCE) is a carcinogenic contaminant found in many aquifers in the US, and worldwide.



Bioremediation of TCE, utilizing genetically engineered dehalogenase-containing cultures is a successful remediation method, which might have the potential to become more cost effective through testing of alternative electron donors.

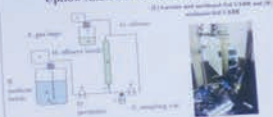
## Background

The unit cost of lactate-methanol is \$10.00/ML, while the unit cost of molasses is \$10.00/L. From a previous study, lactate and methanol could support 90% dechlorination to ethene in an HRT of 0.6 hours in a UABR.

Objective: Assess the cost-effectiveness of using molasses by evaluating dechlorination performance in a continuous flow bioreactor.

## Experimental Procedure

### Upflow Anaerobic Bioreactor (UABR)

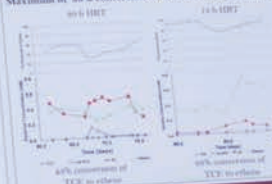


The reactor was operated continuously for 30 days and hydraulic retention time (HRT) was reduced from the initial 60 hours to 12 hours when percent conversion of TCE to ethene stabilized.

Gas Chromatography was used to measure TCE, cis-DCE, vinyl chloride, and ethene concentrations to monitor the rate of dechlorination.

## Dechlorination Performance

Maximum of 98% conversion of TCE to ethene achieved



## Conclusion

Molasses is not a viable alternative as electron donor because although it was able to support 98% conversion of TCE to ethene, practical considerations and challenges overcome cost benefits and steady state operation is difficult to achieve and maintain.

## Acknowledgements

Special thanks to Dr. Peter Fajana-Williams, Dr. Rosa Krajmalnik-Brown, and Dr. Josefa Delgado for their mentoring and support as well as the opportunity to work on this research project. I would also like to thank the FURI Program for this opportunity and the funding.

## Practical Considerations

- Lactate-Methanol**
  - Methanol is toxic in large quantities
- Molasses:**
  - Yeast formation of sugars remains 0% which lead to a low pH
  - Contamination is hard to avoid
  - Uncertainty causes clogging of lines and challenges delivery

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## 3D Modeling of Self-Sustaining Tower

Ben Haines, Civil Engineering  
Mentor: Dr. Justin Haines  
School of Sustainable Engineering & the Built Environment

## Can a Twenty Kilometer Tall

### Potential Inflation Descriptions

launch rockets and space shuttles  
lowers fuel costs / Reduces fuel emissions  
for airport near existing airports  
lowers fuel costs / Reduces fuel emissions  
solar energy in atmosphere  
to 0.5% of the tower to atmosphere  
valuable wind energy  
streams produce significant power output  
to produce potential energy  
utilizing the change in potential energy  
from top to bottom of tower  
immense scientific understanding

### Best Radius Design



Optimum tower height to be 6000m  
all other factors constant, this radius  
total weight of 6000m

### Power Design Data



This image shows the structure of the tower before the first iteration is complete and before the effect of wind loads have been taken into account

### Level Optimization



5 Sides: 22 levels  
4 Sides: 18 levels

**FURI**  
research program

**Thanks for the support of  
my parents, my brother, my  
professors and all my dear  
friends. That was one heck of  
a ride. Go Devils \m/**

**Sri Harsha K.**



**Thank you to all my friends  
and family for helping me  
graduate!**

**Kyle K.**



**Thank you Krishna!**

**Archana K.**



**As great and fulfilling as an achievement can be, the joy of sharing the moment with loved ones is even greater. Can't thank you enough for being here**

**Joseph K.**



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**Thank you amma & appa**

**Bragadishwaran K.**



**I have acquired many skills attending ASU, and they will be very useful in my career path. Helpful resources were also always very abundant.**

**Jonathan L.**



**Heartfelt thanks to my dearest  
Manish, my little daughter/  
princess Diti, my parents & in-  
laws for putting up with my  
conquest of achieving this dream!**

**Radhika L.**



**Dad, I took what you said to heart, “the world needs ditch diggers too,” and became an engineer, thanks for inspiring the dream.**

**Bryan L.**



**Mom and Dad, You have  
provided me with a solid  
foundation for success.**

**Thank you for your patience,  
guidance, encouragement, and  
unconditional love.**

**Matthew L.R.**



**Thank you to my family,  
friends, and my loving  
girlfriend for giving me the  
support I needed to succeed!  
Thank you for believing in me!**

**Cameron L.**





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**My experiences have been  
molded by your influence, and  
to that I am grateful.**

**Pimwadee L.**





**Thank you to my family,  
friends, and my loving  
girlfriend for giving me the  
support I needed to succeed!  
Thank you for believing in me!**

**Cameron L.**



**Thank you DAD!! Miss you  
here today!**

**Mounika L.**



**Thank you Mom, Dad, and my lovely wife Aimee for helping me get here. I couldn't have done it without you.**

**David L.**



**Thank you CircuiTailor Team!  
Thank you Ed and Cheryl ! It's  
my honor to have you guys  
here!**

**Zibai L.**



**Thank you for giving me the  
chance to study in such a  
great university! I love you!**

**Chang L.**





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**Thank you very much. I am graduating with a lot of knowledge in computer science. It wouldn't have been possible without the masters.**

**Dwaraka L.**



**A million thanks to my beautiful wife (Jessica Lunt) and wonderful children (Clayton, Darren, and Annie) for supporting me all these years, I love you**

**Byron L.**





**Mom and Hayley, thank you for encouraging me through my Master's degree. Dad, thank you for all the support and encouragement that helped me get here.**

**Beth M.**



**ASU, the place where I  
learned real Engineering!!! A  
proud Sun Devil!!**

**Raveesh M.R.**



**:-| -Maldo**

**Michael M.**

“”

**Thank you to my family and friends for the love, support, and encouragement. I could not have done it without you. I dedicate this to my father (RIP)**

**Dorine M.S.**



**don't forget to write**  
**fullcircle.asu.edu**  
**news for alumni**  
**and friends**



**Couldn't have done it without  
your help, thanks mom and  
dad!**

**Clayton M.**



**Thanks to my wife for inspiring me, encouraging me, and putting up with me, I love you. Thanks to my parents and family who mean the world to me.**

**Michael M.**





Planting Phase

Time	Phase 1	Phase 2	Phase 3
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**Thank you, mom and dad! I  
couldn't have done it without  
you! I love you, family! And  
thank you so much, Jesus, for  
carrying me through this! :)**

**Lauren McB.**



**“The first law of ecology is that everything is related to everything else.” -Barry Commoner**

**Tyler McC.**



**Do the Q, love you Vicky!**

**Max M.**



**The completion of my degree  
is 100% the product of  
unprecedented support and  
motivation from my wife and  
family. Thank you!**

**Maxwell M.**



**Life here has been full of ups and downs. Thank you, mom and dad, for being there for me. Thanks to all my friends for being there. I did it!!**

**Chitra M.**



**Thank you Mom and Dad.  
You're the real MVP's**

**Jose M.**



**Thank you mom and dad for  
working so hard to give me  
the best education I could  
have ever imagined! Love you  
guys so much!**

**McKinsey C.**



**Thank you mom, dad and Joe!  
It's finally all over! (:**

**Krista M.**





**Thanks Mom for all the encouragement, phone calls, and food! Thanks Dad for inspiring me and giving me hugs; I still want to be just like you!**

**Emilee M.**





**I would like to thank my  
parents and my brother for  
their extreme love and support  
they showed throughout my  
life. I love you all very much!!!**

**Sandeep M.**



**Thank you to all my friends  
and family that help me get  
here! GO DEVILS!**

**Alec M.**



**Thank you to Intel  
Corporation for supporting my  
education.**

**Ynes M.**



**I want to thank my parents  
Xochitl y Victor Mora Gamez  
for everything without them I  
wouldn't have been able to do  
it Papa Mama lo logre !!!**

**Jesus M.**



**I would like to thank my wife  
for all of her love and support  
in this process! She helped  
keep me going when the  
journey became difficult!**

**Herald M.**



**Thank you for all of your love  
and support, family! Couldn't  
have done it without you!**

**Brett N.**





**Thanks Ghouzoulah! I love  
you so much!!!**

**Mohammad N.**



**It's the best experience in my  
lifetime education.**

**Mohan Krishna N.**



**Thank you to my family,  
friends and ASU!**

**Krishna Tanmaya N.**



**Special Thanks to my family  
and friends. College would  
have been a very tough road  
without you being there for  
me and supporting me**

**Thach N.**



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**Thank you Aai Baba for your  
guidance and encouragement!**

**Puneet N.**



**Thank you friends and family  
for all of your support! I would  
not be here without you!**

**Sabrina O.**



**Thank you Nichole, Mom, Dad,  
Sandy, Sean, Grandparents  
for all your support. I needed  
all of it to get to this point.  
Love you all.**

**Jamie O.**





**Thank you Fadilia for all your  
support and encouragement.**

**Lindsay P.**



**Thank you my family for  
supporting me and loving me!  
Thank you my ASU friends for  
the memories I will cherish  
forever!**

**Zhanxiao P.**





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**I dedicate my degree to my beloved parents, my sister and my wife. I would also like to thank my advisors, mentors and friends for guidance & support.**

**Amrit P.**



**Thanks so much for your  
continued love and support  
Mom and Dad! I really don't  
deserve the care and kindness  
you continue to show me! Love**

**Nicholas P.**





## understanding making + making communities

electrical systems engineering + mentors dr. micah lande dr. shawn jordan the polytechnic school

### comparing making + engineering definitions

#### Collecting Definitions

Participants at multiple sites were asked to respond to "What is making?" and "What is engineering?" These responses were analyzed using word frequency to discover the similarities and differences between engineering and making.

#### Characteristics of Definitions

Both engineering and making responses used broad, ambiguous terms to describe actions and objects. Responses for Making suggested an informal trial-and-error approach while Engineering responses suggested a formalized design process.

### participants relate making + engineering

and in participants' definitions of Making and Engineering shared vocabulary

#### next steps

Additional data sets from engineering specific and/or audience will be collected. Comparisons of vocabulary across these additional sets will be undertaken.

#### ongoing work

The informal understanding of Making helps to guide the ongoing interviews of makers. About 2 dozen Adult Makers and Young



**Want to thank God, my parents,  
husband and lovely daughter  
“Keya.” Special thanks to my  
dear husband without him it  
wouldn’t be possible. love you**

**Avani P.**



**Thank you Lydia and Leo!**

**Chi-Han P.**





```
//I couldn't fit all your names
//in this limited space =( for(i
= 0; i < family.length; i++)
{ cout << "Thank you, " +
family[i].name + "!\n"; }
```

Lester P.





**graduation photos**

**flickr.com/photos/  
fultonengineering**

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**Thank You To my parents!  
Thank You to All my  
professors who made class  
interesting! I made it!**

**Oscar P.C.**



# MITTENS

**Brent P.**



**DR. PERRENOUD sends his  
love to his incredible family.  
THANK YOU!**

**Anthony P.**



**Speak your mind but ride a  
fast horse!**

**Matthew P.**



**Thank you for the love and  
support! Love,  
Meghan P.**



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**and friends**







### Alternative Energy Education

Michael A. Granato, Mechanical Engineering Technology  
Mentor: Dr. Nathan Johnson, Assistant Professor  
The Polytechnic School

...and hands-on labs in the field of alternative energies for the education of college students. As wind, solar, and hydroelectric become more popular, it is important that students are educated on the theories behind them. The development of the following labs, programs, will help to present these topics in an effective manner.

#### Wind Power



#### Hydropower



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research program

**Mom and Dad, thank you for  
all the love and support!**

**Matthew P.**



**Thank you for all the love and  
support**

**Kory P.**



**Thank you mom and dad.**

**Saransh P.**



**@ASU Been a wonderful  
experience, couldn't have  
hoped for a better start**

**Ashwin R.**



**Thank you Amma, Appa and  
Varsha! This wouldn't have  
been possible without your  
support!**

**Subramanian R.**



**Thanks a Ton!**

**Dilip R.**



**Thank you Mom and Dad for  
your constant support! Love  
you!**

**Balaji Solai R.**





**To my whole family thanks for  
your support. I couldnt have  
done it without you guys. Love  
you all!**

**Elvis R.**



**Thank you Mom, friends and  
family for all your support!  
Love you all!**

**Jessie R.**



**Thank you dad for being here.  
Means a lot!**

**Shikha R.**



**Thank you, Sweets, for your  
love and support.**

**Christopher R.**



**Thank you my awesome wife,  
kids, Nanay & Tatay!!**

**Allen R.**



**Thanks family, friends, and professors, for all your support through my many years at ASU. Especially you, MOM!!!**

**William R.**



**Gracias Mom y Dad por todos los sacrificios que hicieron por mi. Los quiero mucho!**

**Cinthia R.**



**“If you want to walk fast, walk alone; if you want to walk far, walk with others.” - proverb from Burkina Faso**

**Marcos R.**





**Thank you to everyone.**

**John R.**



**I would like to thank my friends  
and family for all their continued  
love and support through the  
years. You have all built me up  
to where I am today.**

**James R.**



**To my family, friends and  
lovely wife, thank you for  
always being there when I  
needed the extra support! I  
love you all!**

**Jacob R.**



**This wouldn't have been possible without the support and encouragement from my family. I'll be forever grateful.**

**Karl R.**



**Thanks for putting up with this whole college thing for the last 3.5 years. For always picking up the phone when I call. For loving me no matter what.**

**Bailey R.**





**Thanks St. Joseph of  
Cupertino, St. Thomas  
Aquinas, & St. Thomas Moore.  
Praise be to God!**

**Florencia R.**



**Thank you Mom, Dad and Sis  
:) And ASU rocks!**

**Priyanka Vinay R.**





**Thank you Mom and Dad!! Owe  
all this and so much more to  
you!! Special Thanks to Subir  
Sabharwal for pushing me  
better to myself (be nicer)!! :D**

**Sneha S.**



**Thank you Mom and Dad  
for all your support and  
encouragement.**

**Michael S.**



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**Thank you mom and dad for  
coming all the way from Saudi,  
without you I would not be  
standing in here. It's time for a  
new chapter to begin. I LV U ALL**

**Abdulaziz S.**



**I am really thankful for my mother  
who helped me to make my  
dreams come true. I am so grateful  
to my brother in law Dr. Emad  
Youssef and Dr. Nancy Yossef**

**Wessam S.**



**Thank you: Mom & Dad- For  
supporting & protecting me  
Sisters- For always watching out  
for me Brothers- For making me  
smile Kt- You da best Let's party  
Ever S.**



**I would like to thank my  
advisor Prof. Sangram Redkar,  
my friends, family and ALLAH  
for the unconditional support,  
care and blessings.**

**Rakhshanda Shahidakhtar S.**





**Share your victory**  
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**Thank you Mom, Dad, and the  
rest of my family and friends  
for all of the love and support.  
I love you guys more than  
anything!!**

**Dylan S.**



**My parents have been a constant source of love, encouragement, and support. None of this would be possible without them. Love you both, Mom and Dad.**

**Jacob S.**



**Thank You MOM and DAD.  
You made me realize this  
dream.**

**Arpit S.**



**During this celebration I  
honor my family for their  
sacrifices that made this  
achievement possible for me.**

**Wayne S.**





**graduation photos**

**flickr.com/photos/  
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**Thanks!**

**Andrew S.**



**“The one thing about trains, it doesn’t matter where you’re going, but what matters is deciding to get on...” Love you mom and dad!**

**Aaron S.**



**Dear Parents and  
Grandparents, Thanks for  
always believing in me and  
encouraging me to do my  
best. Time to celebrate!**

**Matthew S.**





**Thank you to my family for all  
the love and support you have  
given me while I completed  
this journey!**

**Amber S.**



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**and friends**



**Gracias Mama y Papa por  
guiarme por un buen camino.  
Gracias por todos sus  
esfuerzos y gracias por creer  
en mî. çLo logramos!**

**Brenda S.**



**My first thanks and gratitude to GOD, then to my family members, and all my close friends who supported me all along my journey.**

**Beshoy S.**



**Thank you to my parents,  
friends, and girlfriend for  
supporting me though all of  
my schooling!**

**Nicholas S.**



**Thank you to Mom, and my family for supporting me as I completed my degree.**

**Seth S.**



**Thanks mom and dad I  
couldn't have done this  
without your support!  
Congrats class of 2014!**

**Kristin S.**



**Thank you Grandpa and  
Grandma Strand! Thank you  
Grandpa and Grandma in  
Thailand! Thank you Mom and  
Dad!**

**Samuel S.**







**Thank you XI ZONG! Love  
you! Thank you mom and  
dad for your support and  
encouragement! Thank you LIN  
SUN! YOU ARE THE BEST!!!**

**Lin S.**



**Whoever said these were the  
best years of my life better be  
lying to me! Cheers! Go NAVY!  
Go Devils!**

**Michael S.**



**Thank you for being a motivational force to finish my education. I truly could not have done it without you all. I love you and this degree is for you**

**Devon S.**



**Thank you to my family for  
always being a constant light  
in my life. I owe you all more  
than I could ever give. Thanks  
for coming I love you all.**

**Pharon S.**



**Thanks to my beautiful wife,  
Lucie. You were my support  
during this adventure. I Love  
You**

**Joseph T.**



**Special shout out to my family:  
Nana, Anais, Naomi, Maria,  
Rosa, Dan, Grandma, Jaime,  
Joey, Alex, Jacob, Gabby y la  
Familia Tellez. Thank you!**

**Margarita T.**



**I want to thank my wife Geana  
and daughter Savannah for  
all of your support. I love you  
both very much!!!**

**Erick T.**





**Thank you all my friends and  
family couldn't have done  
without you!**

**Ankita T.**



**Thanks to the Almighty! It was indeed a great experience at ASU, great chapter of my life! Thanks to my parents who made it to the graduation :)**

**Rizwan T.A.**



**Thanks to my parents, family  
and friends**

**Shankar T.**



**Thompson's RULE! Thank you  
for all your support, I couldn't  
have done it without my  
family!**

**Samantha T.**



**Thank you Ron, Mom, Dad,  
and rest of the Family for your  
support. HI PARRISH! \*Love  
mommy\***

**Kristen T.**



**Thanks to my wife, Amber,  
for the constant support and  
encouragement. Thanks to my  
mom for constantly reinforcing  
the importance of education.**

**Lincoln T.**



**Thank you Mom and Dad for  
believing in me! I couldn't  
have done it without you!**

**Adriana U.**



**Dear Dad and Mom, I am blessed to have parents like you. You have been there through good times and bad ones. Thank you for everything you have done.**

**Hossein V.**





**When you dream sleeping on your mother's lap it will become true. It happened for me. I am living my dream now. This is for you my mom and dad.**

**Manikandan V.**



**I would like to thank my  
parents and my siblings for  
being there throughout my  
college experience; it means  
a lot to me. I love you all.**

**Alyza V.**



**Family and friends - you all  
are my roots. I can grow tall  
because you hold me firm. I  
would be nothing without you.**

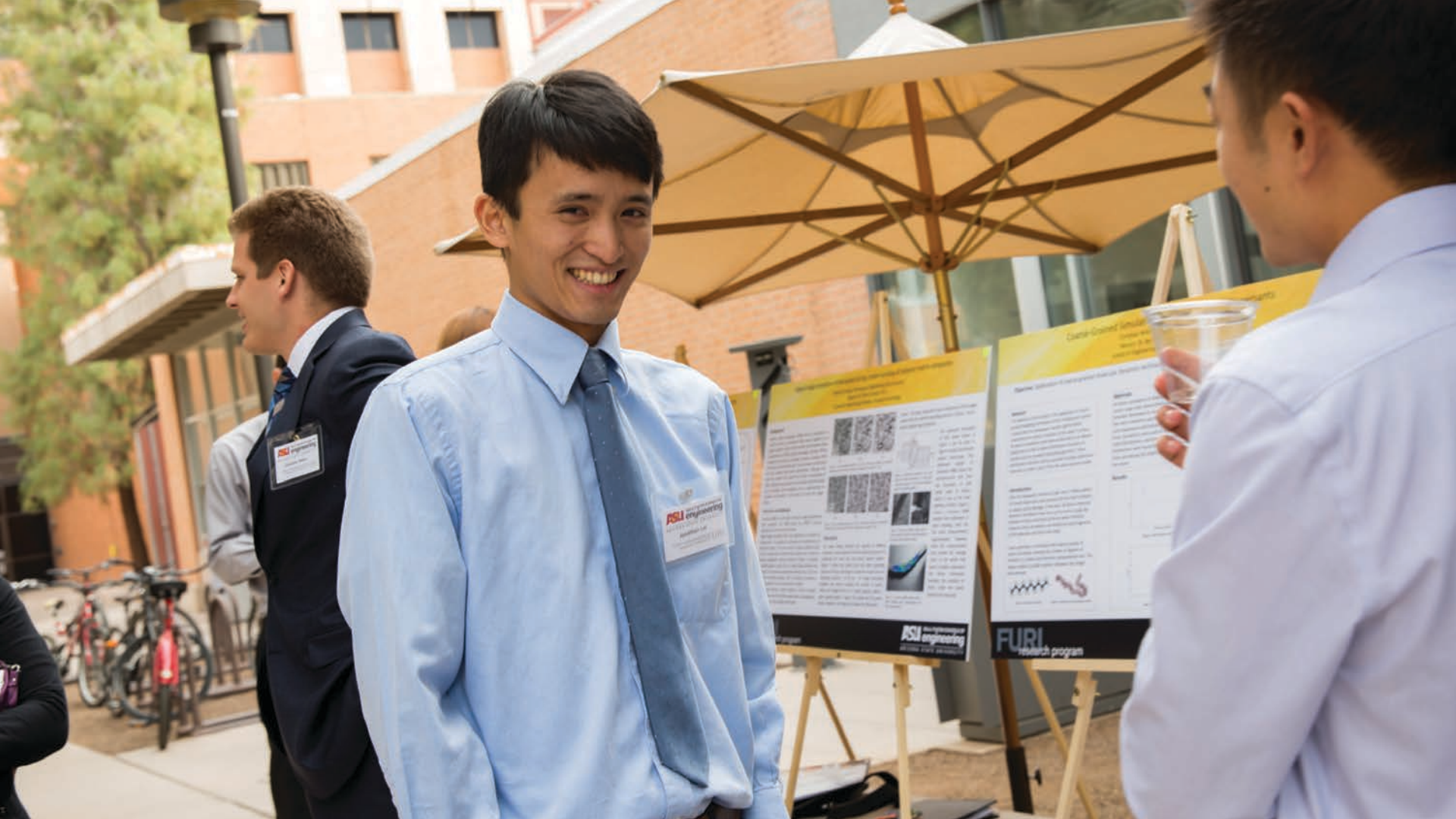
**Sarah V.**



**Thank you everyone for  
coming. LET'S PARTY!**

**Ryan W.**





**Thank you ASU. I am proud of  
you.**

**Xiaoxuan W.**



**Thank you for the support and encouragement. I could not have accomplished this goal without you all.**

**Keith W.**



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**I want to thank my family for always supporting me. I love you all! ASU has been an amazing experience and has shown me how to achieve greatness!**

**Brian W.**



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**Thanks, Daddy and Mummy.  
And all my friends and SOME  
professors. I love you. Mua~**

**Di W.**





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**#asugrad**

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**To my Dad, Craig Westerhoff,  
whom I miss very much every  
day...I'm having fun.**

**Steven W.**



**Thanks Steve and Glenda for  
traveling from Australia to see  
me graduate! Love you guys!**

**Jacob W.**



**Thank you Mom, Dad, and  
Katie. Love you guys!**

**Daniel W.**





**graduation photos**

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**Thank you Mom and Dad  
for all your support and  
inspiration to help me achieve  
my full potential.**

**James W.**



**It is only from the grace of  
God and from the help of my  
family that I am here today!**

**David W.**



**I wanted to thank you for supporting me in pursuing my college degree. It wasn't always easy but I always appreciated all your support. Thank you**

**Toby W.**



**Thank you for going out  
of your way to be here!  
“Trouble’s just the bits in  
between.” Allons-y!**

**Morgan W.**



**Parents. Qing Zhu.**

**Yunxi W.**



# YeLab Rocks!

Shuo X.



**Thank you mom, for your support  
during my whole student life,  
thank you Miss Y, for your  
understanding and support, and  
thanks for all of you!**

**Jianbo X.**



**This was wonderful learning  
experience about not only  
knowledge but also relationship  
with various persons who are  
from different countries at ASU.**

**Dae Hyun Y.**







ASU School of Engineering  
KYLE RISO  
FURI

### Residential Thermal Energy Control System with Storage

Kyle Risko, Engineering (Mechanical)  
Mentor: Dr. Nathan Johnson, Assistant Professor  
Polytechnic School

The optimal use of household-scale thermal energy storage (TES) to offset energy use and energy expenditures?

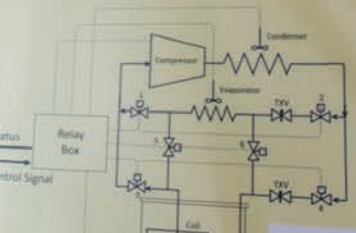
#### DESIGN SOLUTION



Thermostat  
Cooling Request  
(Low Voltage DC)



Status  
Control Signal



- Ramsond 37GW2:
- 1 Ton
  - 12,000 BTU
  - Mini-Split
  - Heat Pump

- Six Solenoid Valves:
- 1&2- Operate A/C
  - 3&4- Charge TES
  - 5&6- Discharge TES



FURI  
research program

**I like Ira A. Fulton Engineering  
school, I like ASU, I like  
Tempe and Arizona!**

**Qiang Z.**



**Let me begin by expressing sincere thanks to my amiable father Daiqing Zheng, my mother Meihua Xie, all my brothers, and lover Haoshu.**

**Zhipeng Z.**



**I would like to thank my wife  
Chenxue and my parents,  
parents-in-law for all the  
support during my Ph.D. study.  
I cannot do it without you!**

**Jiayu Z.**



**Hard to beat a small  
community within the  
largest university in America.  
Wouldn't be here without you  
Mom Love you!**

**Jeffrey Z.**



**Thank you Lin Sun! Thank you  
Mom and Dad! Thank you Dr.  
Towe! Thank you ASU!**

**Xi Z.**



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