USC Viterbi
School of Engineering

ENGINEERING A BETTER WORLD FOR ALL HUMANITY

STATE OF THE VITERBI SCHOOL

Yannis C. Yortsos
Dean

WHY ENGINEERING

Enabling Discipline of Our Times

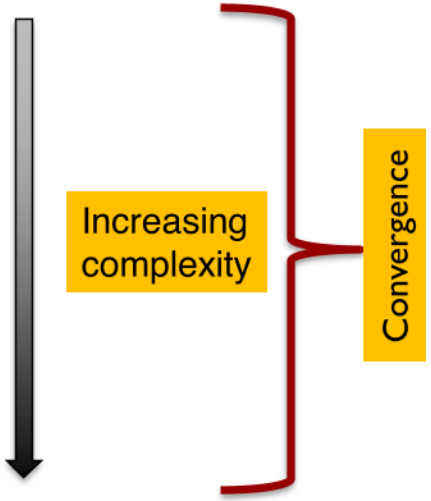
1. Exponentially Growing
2. Convergent

Human Nature does not Change Exponentially Fast!

TECHNOLOGY AND ENGINEERING

LEVERAGING *PHENOMENA** FOR *USEFUL* PURPOSES**

- **PHYSICAL** (e.g. Photoelectric Effect)
- **CHEMICAL** (e.g. Catalysis)
- **GEOLOGICAL** (e.g. Groundwater)
- **BIOLOGICAL** (e.g. Bioengineering)
- **SOCIAL-BEHAVIORAL**

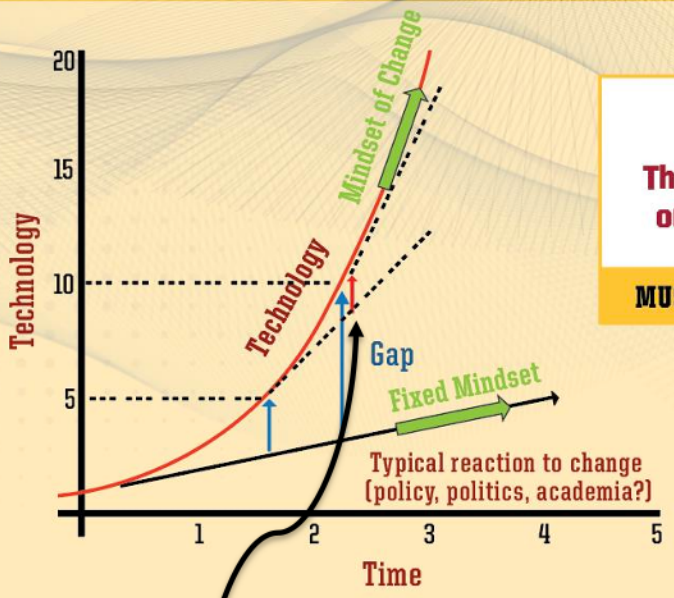


Paraphrased from Brian Arthur (2008)

*And systems, devices and tools- and combinations thereof
Including the **discovering of new phenomena

ERA OF CONSTANT ACCELERATIONS (FRIEDMAN, 2016)

THE EXPONENTIAL PACE OF TECHNOLOGY BRINGS CONSTANT DISRUPTION. THIS REQUIRES AGILITY AND ADAPTABILITY - AND *NEW MINDSETS*



EXPONENTIAL CHANGES
There are no longer steady states or even steady states in growth

MUST REINVENT OURSELVES EVERY YEAR

Exponential, if the technology speed is proportional to it

$A \rightarrow A$

$$\frac{\Delta A}{\Delta t} \approx \lambda A$$

Faster than exponential (*singularity*) if it is proportional to a higher power (n>1)

$A + A \rightarrow 2A$ (n=2)

$$\frac{\Delta A}{\Delta t} \approx \lambda A^n$$

Trust: The required ingredient to move fast along the exponential
Tax we pay when trust is absent

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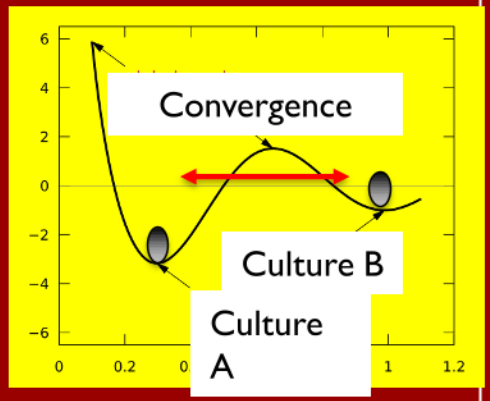
CONVERGENCE AND SILOS CHALLENGES

"Culture wants to be enduring and prevailing"

from Antonio *Damasio's "The strange world of things" (2018)*



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STRATEGIC PILLARS

Catalysts!

1. **Admin**

2. **Fundraising**

3. **Budget**

4. **Marcom**

1. Talent: students, faculty. staff- and environment to flourish

PEOPLE

2. Value: Continuously adding value to curriculum, programs

PROGRAMS

3. Thought Leadership: Research and discovery

PAPERS

4. Impact: Impact on society (Innovation, K-12 Outreach, Global

PRACTICES-PATENTS

USC Viterbi School of Engineering

Top 10 accomplishments

1. Reached gender parity in Fall 2019 entering class (historic)
2. Rocket Propulsion Laboratory reached Space -and breaks student world record
3. Increased faculty ranks with four new NAE members
4. Leads Engineering Education transformation (GCSP in London Global Summit; Competence *and* Character)
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9. Maintained robust enrollments and budget
10. Positioning for a new CS building

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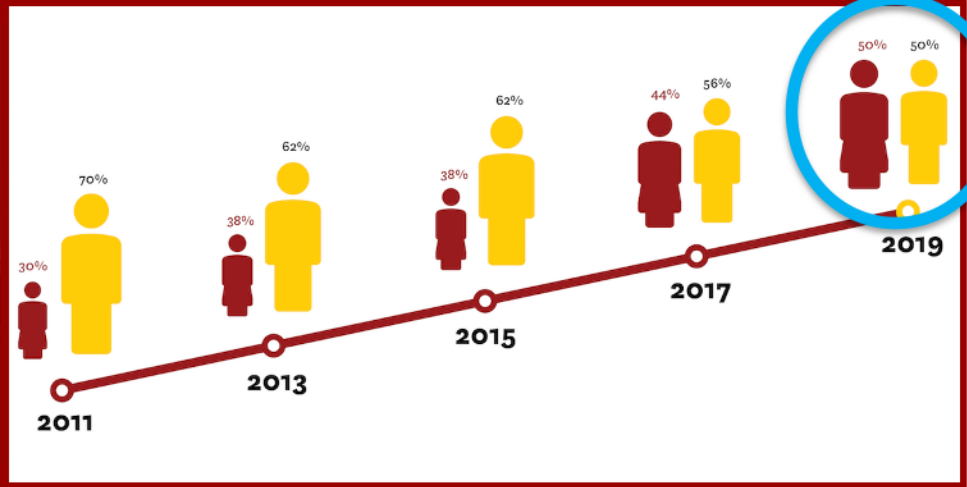
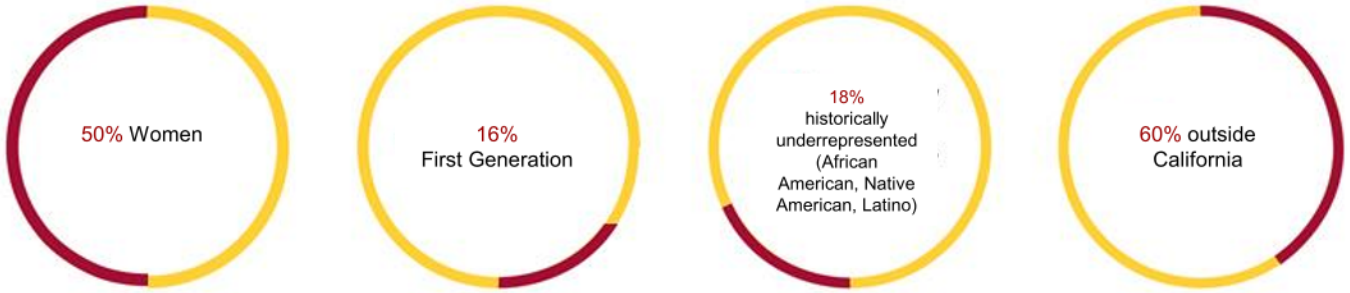
2019 ENTERING CLASS IS 50% FEMALE



Incoming freshman class

23 % perfect math SAT or ACT



A historic accomplishment for USC Viterbi

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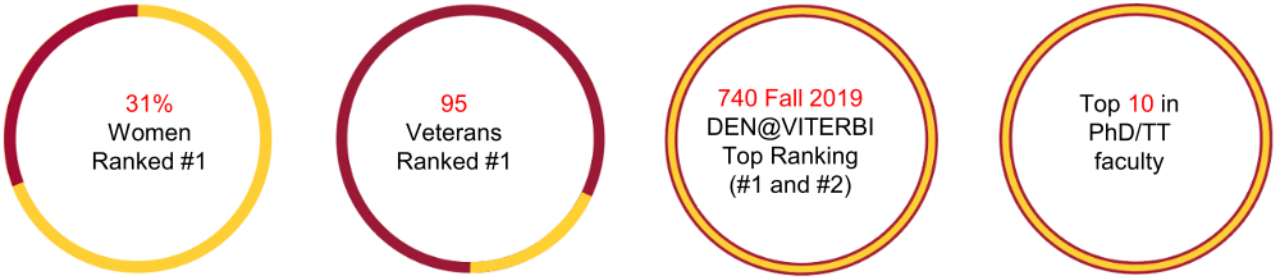
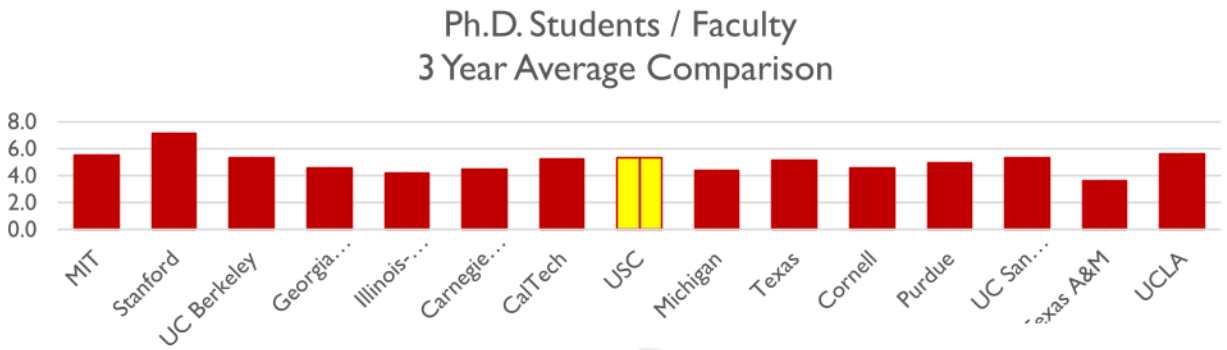
GRADUATE STUDENTS





Applicants from 98 countries

USC Viterbi School of Engineering

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RPL REACHES SPACE

The first undergraduate student team in history to design, build and successfully launch a rocket into space

https://www.bing.com/videos/search?q=usc+rpl+youtube&view=detail&mid=1EA0BD8FAC7FFA15C8E01EA0BD8FAC7FFA15C8E0&FORM=VIRE

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FROM RPL TO RELATIVITY

Tim Ellis and Jordan Noone

-USC Graduates and RPL leaders
-Blue Origin and Space X
-Relativity Startup: Incubated at the Y-Combinator; backed by Playground Global, Social Capital, Y Combinator, Mark Cuban, USC, and Stanford. Completed round C series with about $150M raised.

Tim serves on the World Economic Forum as a Technology Pioneer, and has been honored as an MIT 35 Innovators Under 35.

Jordan and Tim have been chosen for "30 Under 30" by Forbes, Business Insider, and Inc. Magazine.

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FIVE NEW NATIONAL ACADEMY OF ENGINEERING FACULTY MEMBERS

Dr. Charles F. Zukoski (USC Provost)

Dr. Pawlikowski (Lt. Gen. Ret.)

Dr. Mahta Moghaddam (ECE)

Dr. Mark Thompson (Chem)

Dr. Behrokh Khoshnevis (CEE)

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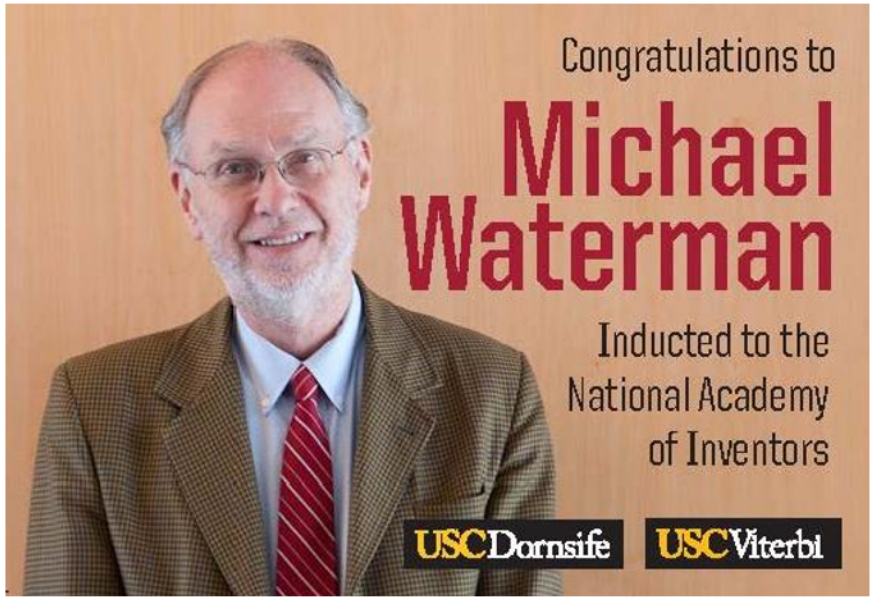
OTHER NOTABLE 2019 FACULTY AWARDS



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TRANSFORMATIVE FACULTY

12+2 MIT TR35 HONOREES IN LAST 9 YEARS

PhD students
Niki Bayat
Ghena Al Hanaee

USC Viterbi School of Engineering

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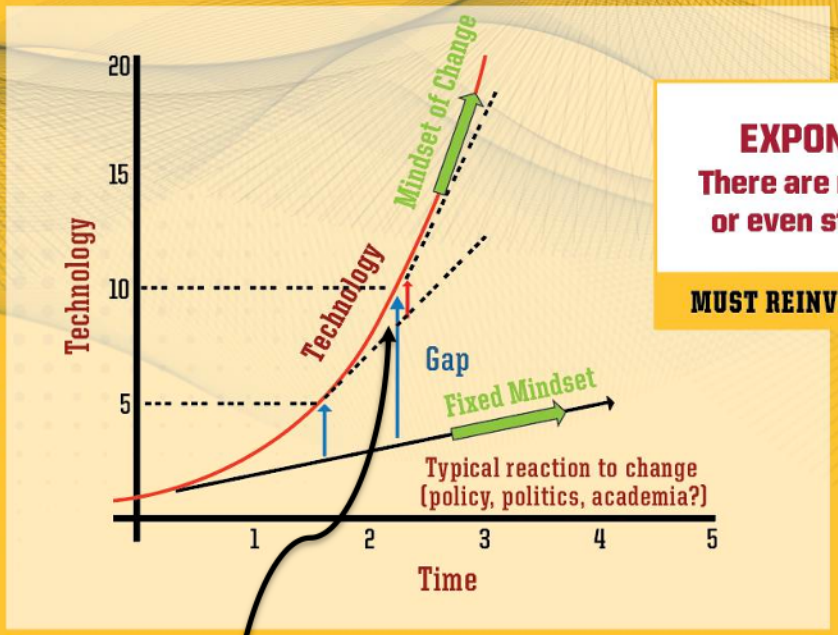

EXPONENTIAL CHANGES
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Trust: The required ingredient to move fast along the exponential
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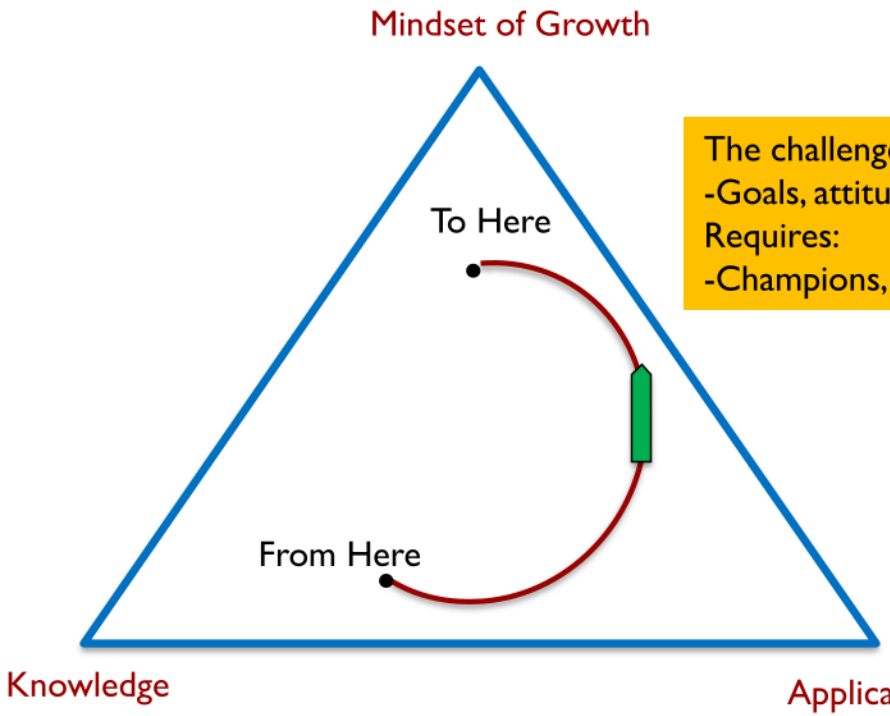
Mindsets In addition to Skills and Knowledge



The challenge to change culture:
-Goals, attitude, rewards and incentives
Requires:
-Champions, leadership, mindsets of growth

From Ortiz et al.

The Engineer of 2020

ATTRIBUTES OF THE ENGINEER OF 2020

- Analytical skills
- Practical ingenuity
- Creativity
- Communication & teamwork skills
- Business & management skills
- High ethical standards
- Professionalism
- Leadership, including bridging public policy and technology
- Dynamism/agility/resilience/flexibility
- Lifelong learners

Mostly competence.
Missing? Purpose, Character, Trustworthiness.

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EXPONENTIAL TECHNOLOGY BRINGS DISRUPTION REQUIRES AGILITY AND ADAPTABILITY – AND NEW MINDSETS

THE FIVE MINDSETS OF CHANGE TO THRIVE IN TODAY'S WORLD

1. **HUG THE EXPONENTIAL**
   Superb Technical Skills and Knowledge to Lead the Exponentially Changing Technology
2. **ENGINEERING +: CHANGE THE CONVERSATION ABOUT ENGINEERING**
   Engineering + X where X is anything (particularly, human-centric)
   Who we are, what we do and what we look like.

Competence

3. **INNOVATION IN THE BROADEST SENSE**
   Innovation and Entrepreneurship, to help create the new markets, the new jobs and to design the new self.
4. **THE CULTURAL MIND**
   Cultural Awareness (with culture broadly interpreted), to help thrive in today's fast changing world.
5. **HEROIC ENGINEERING**
   Awareness of the Impact of Engineering to Society (and the importance of technology ethics).

Character

Competence and Character= Trust

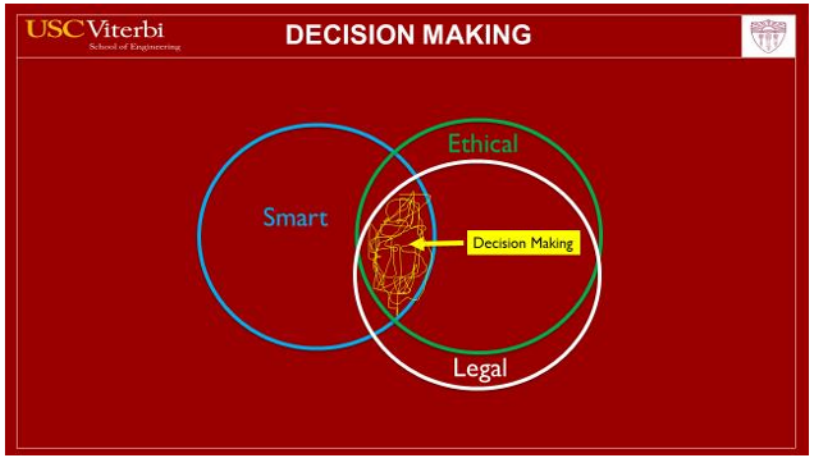
TRUST: FOUR CORES OF CREDIBILITY*

1. *Capabilities (talent, attitude, skills, knowledge, mindset)*
2. *Results (performance- past, current, anticipated)*

} Competence

3. *Integrity (humility, courage, congruence*
4. *Intent (motive, agenda, behavior)*

} Character



*From Covey, "The Speed of Trust"

Society will increasingly demand that our engineering graduates are trustworthy given the power of technology

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NAE GRAND CHALLENGES SCHOLARS PROGRAM

The Bridge, National Academy of Engineering, **43** (2), 53-57, (2013)

The Grand Challenge Scholars program gives students a better understanding of how their undergraduate work prepares them to face their careers and important societal challenges.

The NAE Grand Challenge Scholars Program

Tom Katsouleas, Richard Miller, and Yannis Yortsos

Tom Katsouleas

Richard Miller

Yannis Yortsos

In 2007 the National Academy of Engineering, with support from the National Science Foundation, convened a panel of leading thinkers from academia, policy, and business with the charge of identifying a small number of grand challenges for engineering in the 21st century. Their extraordinary list of 14 representative challenges (Box 1) spans the need for sustainability, health, security, and joy of living

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2015: Deans Commitment to the US President

2014: Global GCSP launched in GEDC meeting in Dubai
2014: MOU from 122 engineering schools signed in DC
2015 (March): Deans commitment presented to US President

120+ Deans committed to graduate more than 20,000 GCS over the next decade

NAE President Dan Mote (2013-2019)

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2016: NAE Coordination Office Created; Series of Annual Events Launched
2017: Third Global Summit- Washington DC
2019: Fourth Global Summit- London, UK

Rama, NAE Office Director

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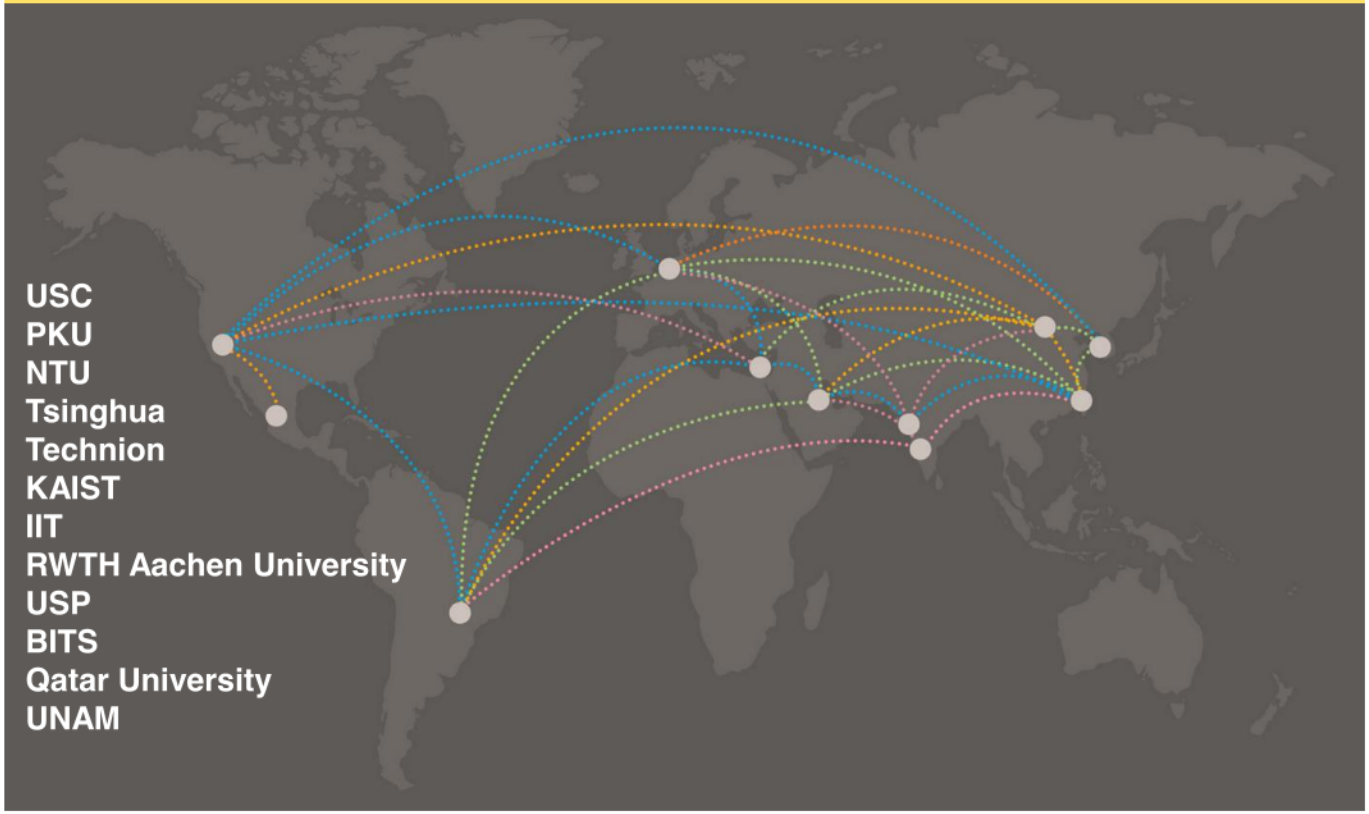
IPODIA STAR ALLIANCE

We would like every Viterbi UG to have at least one iPodia experience



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CHANGING THE CONVERSATION

USC Viterbi Recognized with the American Society for Engineering Education (ASEE) 2017 President's Award

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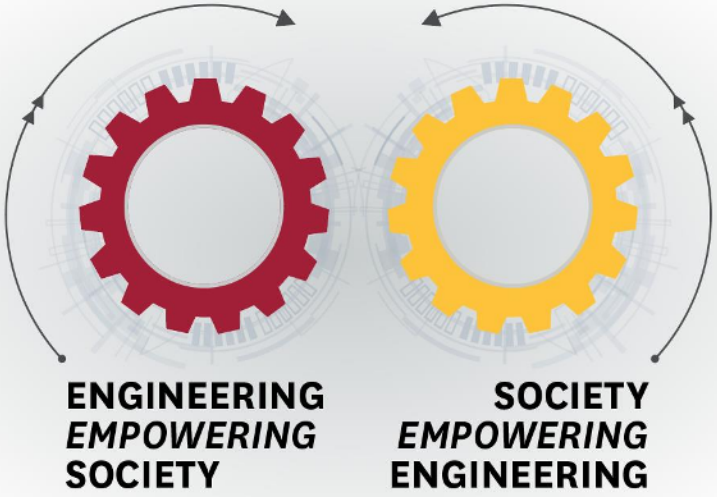
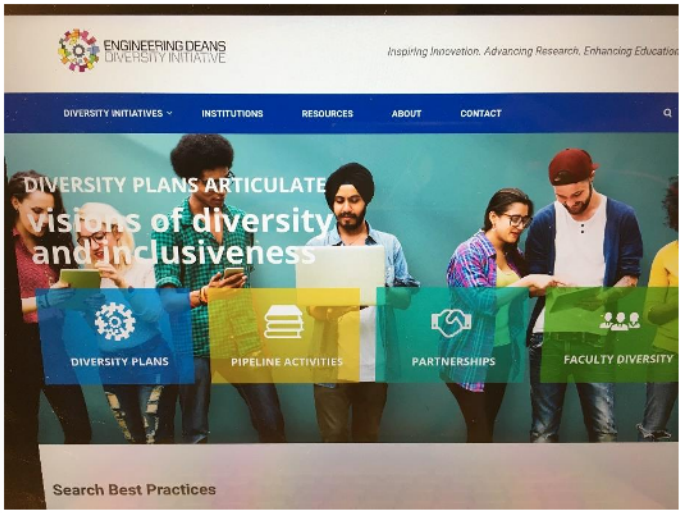
EMPOWERING ENGINEERING





NATIONAL (ASEE) DIVERSITY AND INCLUSION INITIATIVE (NOW SIGNED BY 210+ SCHOOLS NATIONALLY)

Exemplar status

USC Viterbi School of Engineering

STUDENT AWARDS 2019

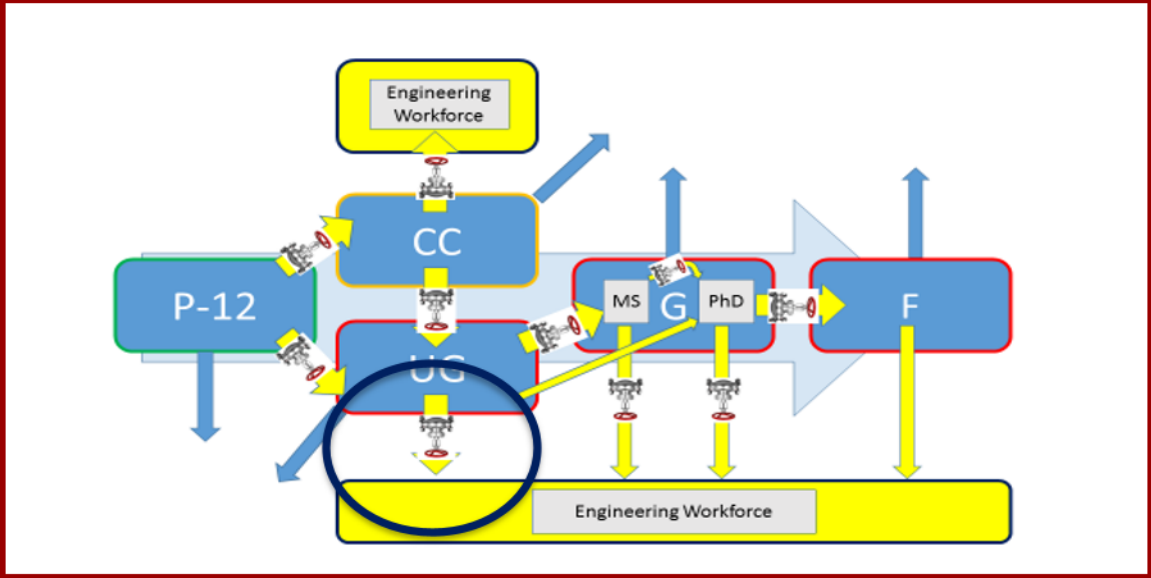
National Society of Black Engineers

- » 1st Place - Academic Technical Bowl
- » 1st Place – Debate

USC Society of Hispanic Professional Engineers

- » Outstanding Academic Development
- » Outstanding Chapter Development

Education as a Chemical Process



A Parity Objective

Maximizing efficiency in each control volume means achieving parity between input and output compositions. Namely, output demographics (e.g. undergraduate retention, graduation rates, etc.) must be statistically the same as those of the input.

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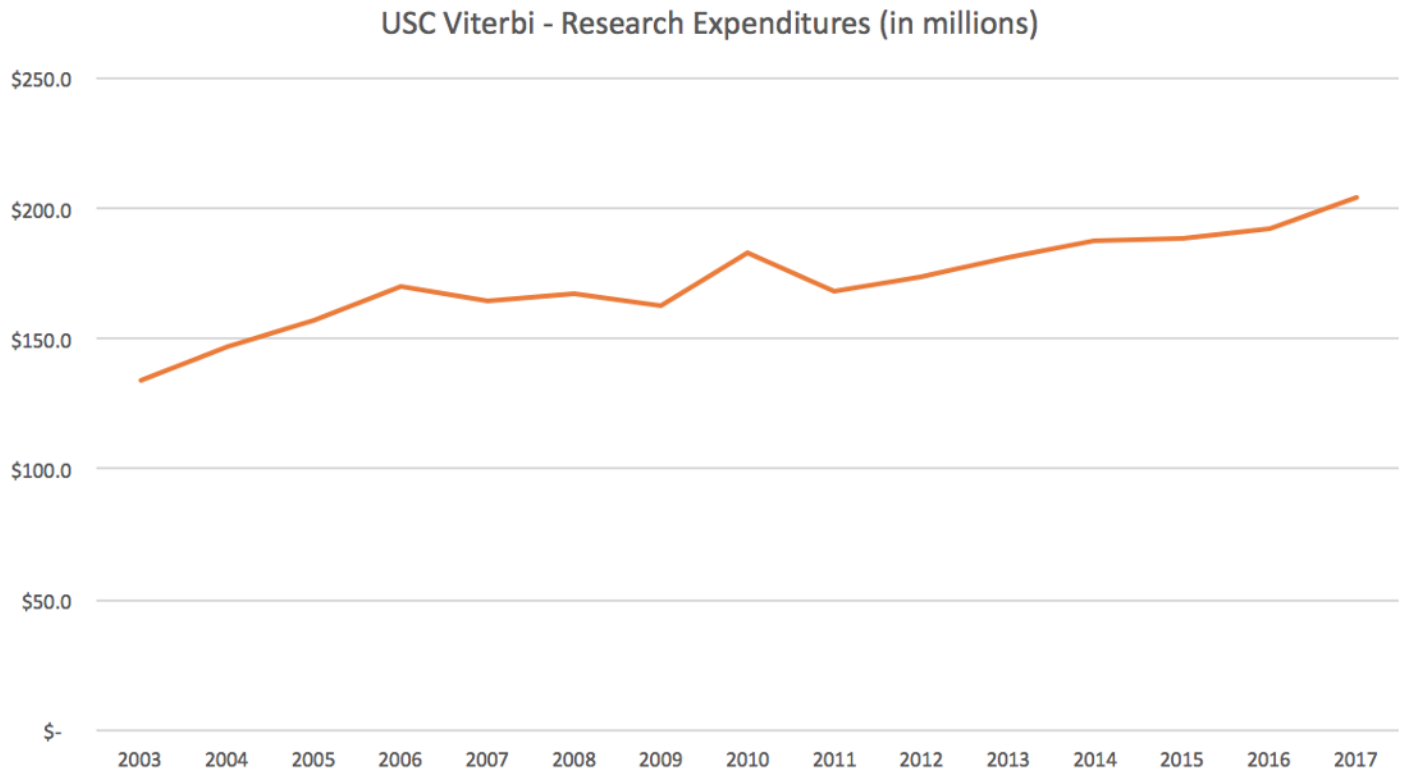
ENGINEERING SCHOOL RESEARCH EXPENDITURES (IN MILLIONS)



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WHY GRAND CHALLENGES?

Powerful, Fast Evolving, Convergent Technology Allows Us to Set Achievable Goals for all Humanity

Choosing Goals is an Ethical Question

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NAE Grand Challenges

SUSTAINABILITY

Make Solar Energy Economical, Provide Energy from Fusion, Develop Carbon Sequestration Methods, Manage the Nitrogen Cycle, Provide Access to Clean Water

SECURITY

Secure Cyberspace, Prevent Nuclear Terror, Restore and Improve Urban Infrastructure

HEALTH

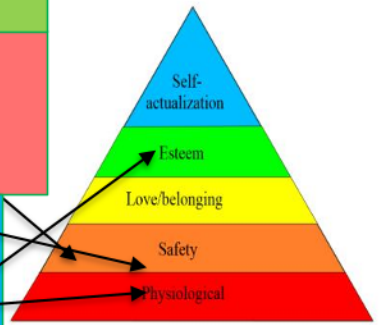
Engineer Better Medicines, Advance Health Informatics, Reverse Engineer the Brain

ENRICHING LIFE

Enhance Virtual Reality, Advance Personalized Learning, Engineer the Tools of Scientific Discovery

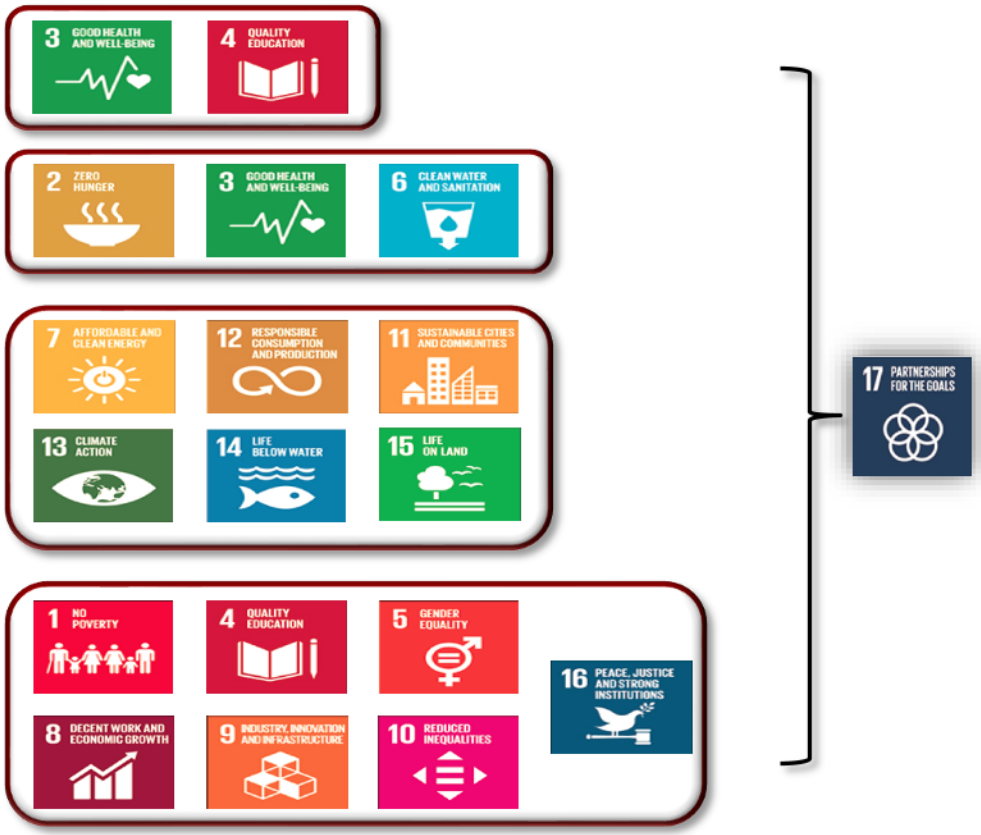
BEHAVIORAL AND SOCIETAL?

Social Phenomena (Through cyberphysical and data science)



Maslow's Hierarchy

UN Sustainable Development Goals



The Grand Challenges for Social Work

Individual and family well-being

- Ensure healthy development for all youth
- Close the health gap
- Stop family violence
- Advance long and productive lives

Stronger social fabric

- Eradicate social isolation
- End homelessness
- Create social responses to a changing environment
- Harness technology for social good

Just society

- Promote smart decarceration
- Build financial capability for all
- Reduce extreme economic inequality
- Achieve equal opportunity and justice

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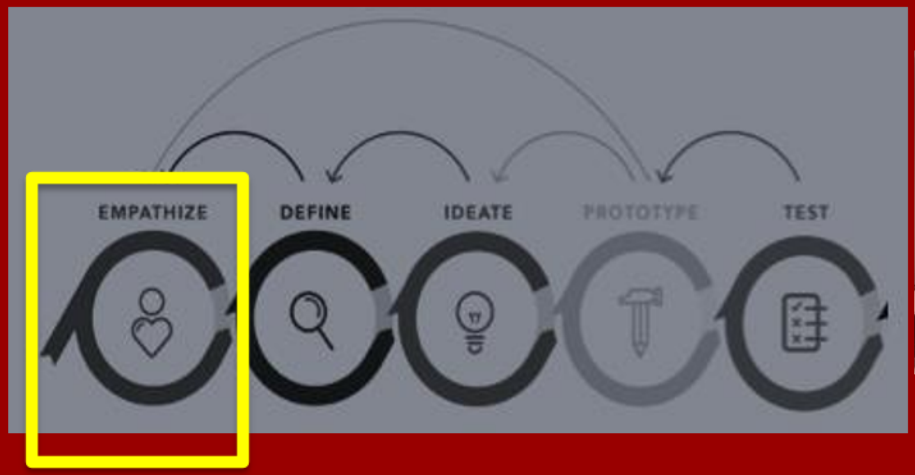
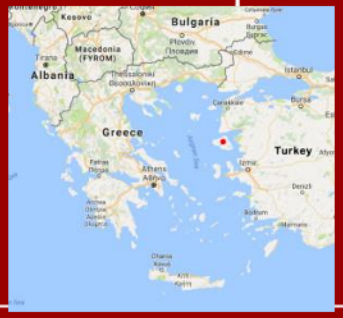
Wicked Problems

Engineering innovation critical in solving numerous human crises.
CE 499 Class: engineering innovation with focus on human crises.

CE499 theme: Engineering Innovations for Refugee Camp Challenges
(support from Min Family Challenge, established in 2017).



Involved two trips to the Greek Island of Lesvos, which hosts two large refugee camps.



5 Designs Studied

WATERWAY

duet

WeWash

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RESEARCH

- Over 50 USC faculty work on areas within AI
- Studying AI for health, energy, sustainability, and privacy and security, and developing novel machine learning, machine vision, robotics, and natural language understanding methods
- Two MS in Computer Science programs available – Data Science or Intelligent Robotics

For more information & news - https://ai.usc.edu/

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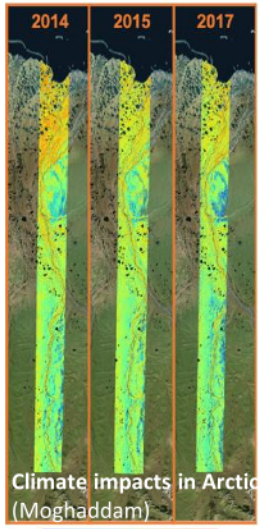
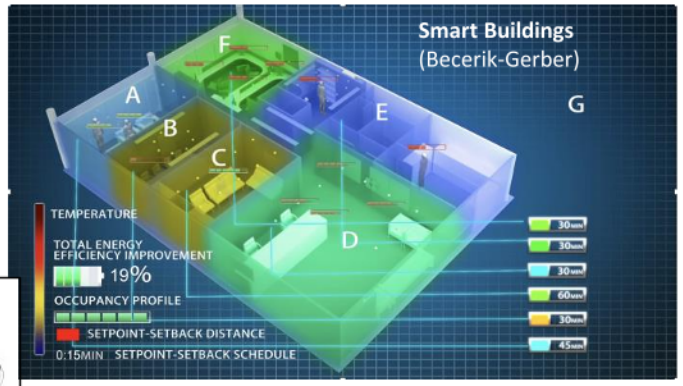
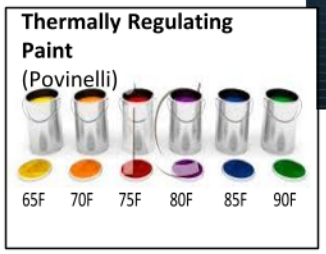
INITIATIVES TO FURTHER ENHANCE VITERBI RESEARCH AND ESTABLISH LARGE RESEARCH CENTERS

- Viterbi internal center incubators (VICIs)
  - seeded via a competitive proposal process administered by the Vice Dean for Research
- Research incentives to faculty
  - Discretionary return on GRA support
  - Discretionary return on externally funded AY salary
- Various other forms of support
  - Administrative help
  - Teaching relief
  - Discretionary funds for travel, tools, etc.
- Center-level proposal manager
  - Support for coordinating teams, managing timelines and budgets, contributing to content and editorial functions, etc.
- Corporate Council
  - New entity established to coordinate all corporate-related activities across school

USC Center for Sustainability Solutions

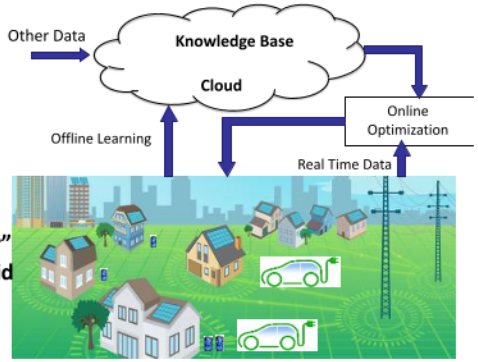




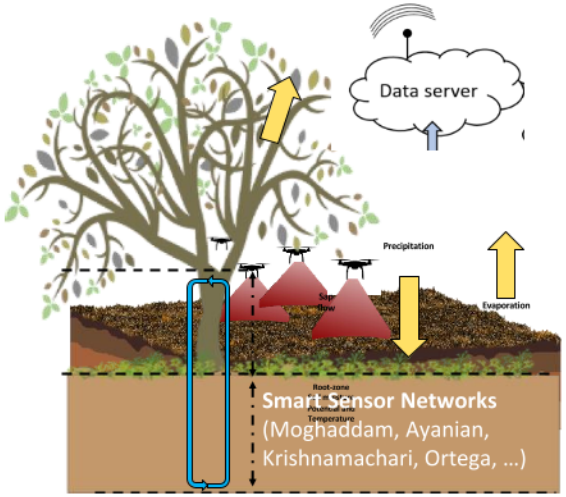


Viterbi is a hub of exponentially advancing technologies for sustainability

- Remote sensing of environment
- Sustainable water services
- Sustainable agriculture
- Ultra-efficient electronics
- Autonomous vehicles
- Smart buildings
- Carbon capture and storage
- Sustainable manufacturing
- Resilient infrastructure
- Smart energy grid
- Smart materials
- ….and many more



"Deep Solar" & Smart Grid
(Prasanna)



Sustainable Manufacturing
(Gupta)

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INFORMATION SCIENCES INSTITUTE

BICOASTAL PRESENCE

Marina Del Rey, CA

Arlington, VA

Boston, MA

FOUR GENERATIONS OF LEADERSHIP

Keith Uncapher –
Founding ISI Director

Herbert Schorr

Prem Natarajan
(On leave)

Craig Knoblock
(Interim Director)

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INFORMATION SCIENCES INSTITUTE

ISI-LED PROJECTS RECEIVING MAJOR GOVERNMENT FUNDING IN UFY19

$12.7M	$5M
USC FaceBase III: Craniofacial Development and Dysmorpholoy Data Management and Integration Hub	Accurate and Precise Recognition of Obscured Payloads in Operational Systems
$3.8M	**$3M**
PIRANHA: Preventing Information Removal and Nabbing Harmful Actors	NSF Cyberinfrastructure Center of Excellence Pilot Study

SUCCESS BY THE NUMBERS

$111.5M	23	52	39	93
FY19 revenue – a new record for research support	Government funding sources and corporations	New employees in 2018	New employees Jan – Aug 2019	Graduate Research Assistant (PhD students)
170	**70**			**23**
Overall publications	Publications in journals or books			Government funding sources and corporations

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INFORMATION SCIENCES INSTITUTE

Informatics Systems Research

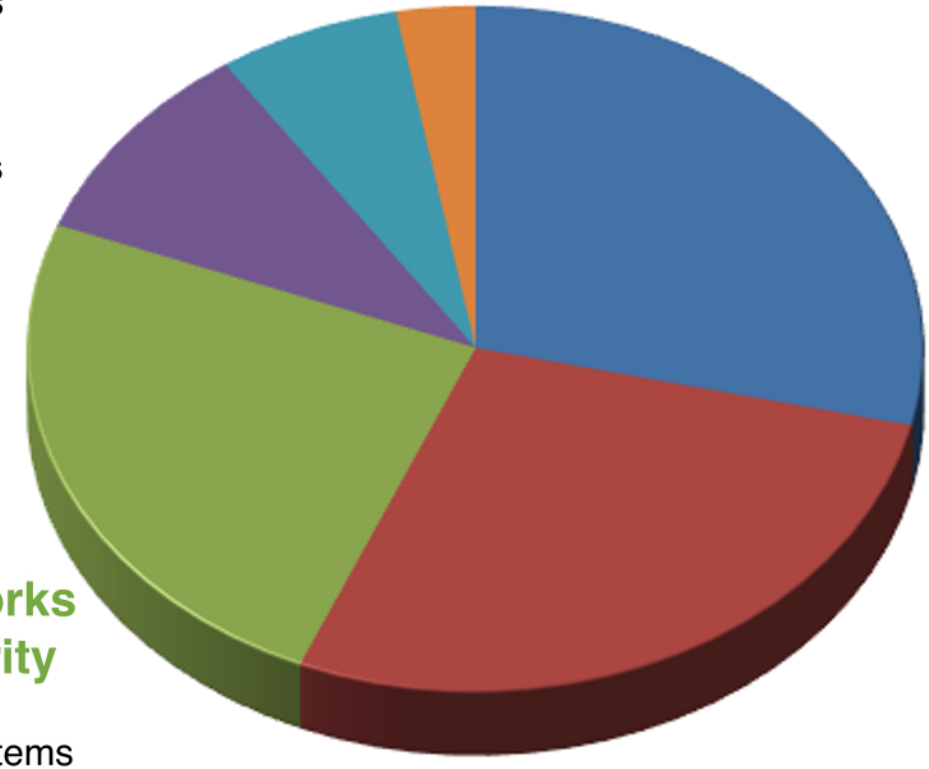
- Informatics cyberinfrastructure
- Medical Informatics

MOSIS

- Multi-project wafers
- Chip fabrication brokerage
- Trusted electronics

Computer Networks and Cyber Security

- Cyber security
- Cyber-physical systems
- Internet measurement
- Sensor nets
- Experimental Research Methodologies



High Performance and Quantum Computing and Electronics

- Secure, robust, and trusted electronics
- Heterogeneous and cloud computing
- High performance computing architectures and software
- Science automation technologies
- Reconfigurable computing
- Quantum computing

Artificial Intelligence

- Machine learning
- Natural Language Processing
- Information extraction
- Social networks, analysis & dynamics
- Bioinformatics
- Knowledge graphs
- Knowledge capture

INNOVATION AND ENTREPRENEURSHIP

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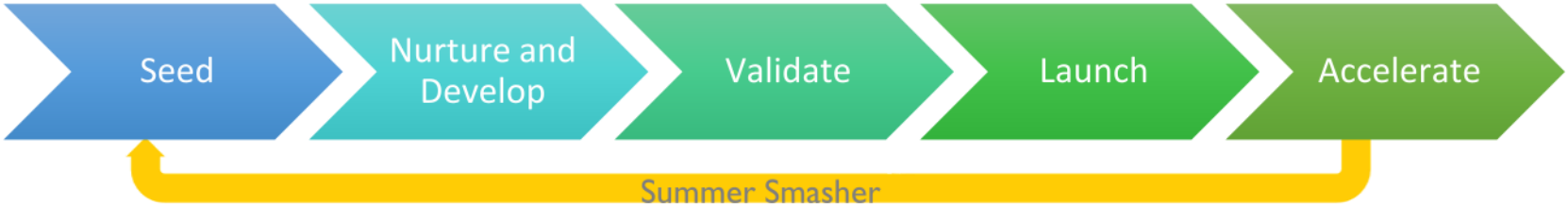
INNOVATION PIPELINE



- VSEE: entrepreneurial mindset in Freshman Academy
- ENGR 461, ISE 585, H4D, and other courses
- Summer Smasher: immersive experience with start-ups
- Info Sessions
- TIE Summer Program

- Hackathons
- Competitions (MEPC, MFC, ABC Prize, NAE GCSP)
- Mousetrap Fund
- Engineering Honors Program – Innovation Track
- Networking Mixers
- Office Hours

- NSF I-Corps Programing (ZAP, BOOM, LAUNCH, BLITZ, National I-Corps)

- Synchrotron accelerator program
- Technology Scouting Workshop

- Full-time residency at the Viterbi Start-up Garage
- Viterbi Venture Fund

Diversity and Inclusion across all activities

USC Viterbi School of Engineering

INCUBATION PROCESSES

- Maseeh Entrepreneurship Prize Competition
  - Several ventures launched by winners and top-placed teams (Abtum, Aescula Tech, Embark, InBrace, Second Spectrum)
  - Celebrating its 10th year
- Min Family Challenge
  - 2019 Challenge: Health challenges in the air and water in our low-income communities: Engineering solutions needed for a sustainable future for all
- Undergraduate ABC (atoms, bits, and cells) prizes to be offered
- New Amazon partnership at Viterbi Startup Garage for ventures in voice-enabled applications
- All freshmen see engineering entrepreneurship in Freshman Academy
- New Engineering Honors Program – Innovation Track

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I-CORPS

Innovation Node-Los Angeles: IN-LA

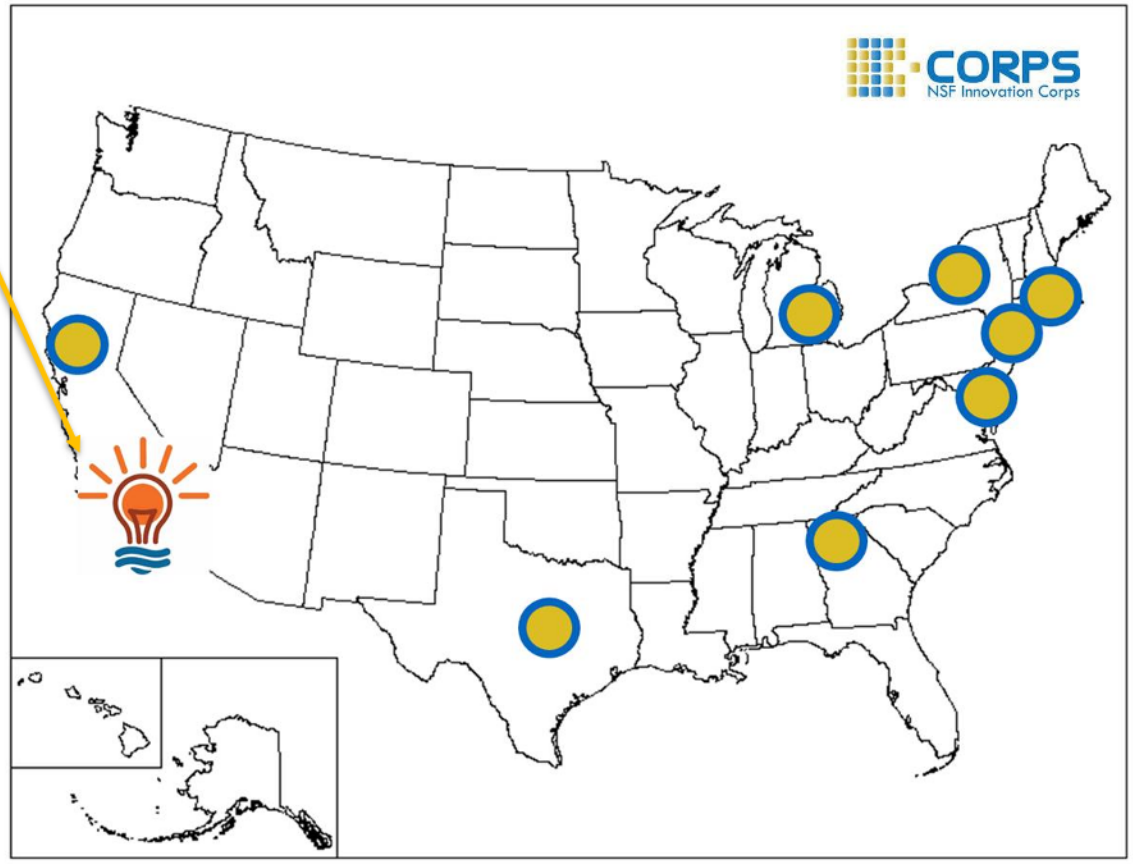
A collaboration between:

USC University of Southern California

Caltech

UCLA

15 members
500+ teams
>$100M raised



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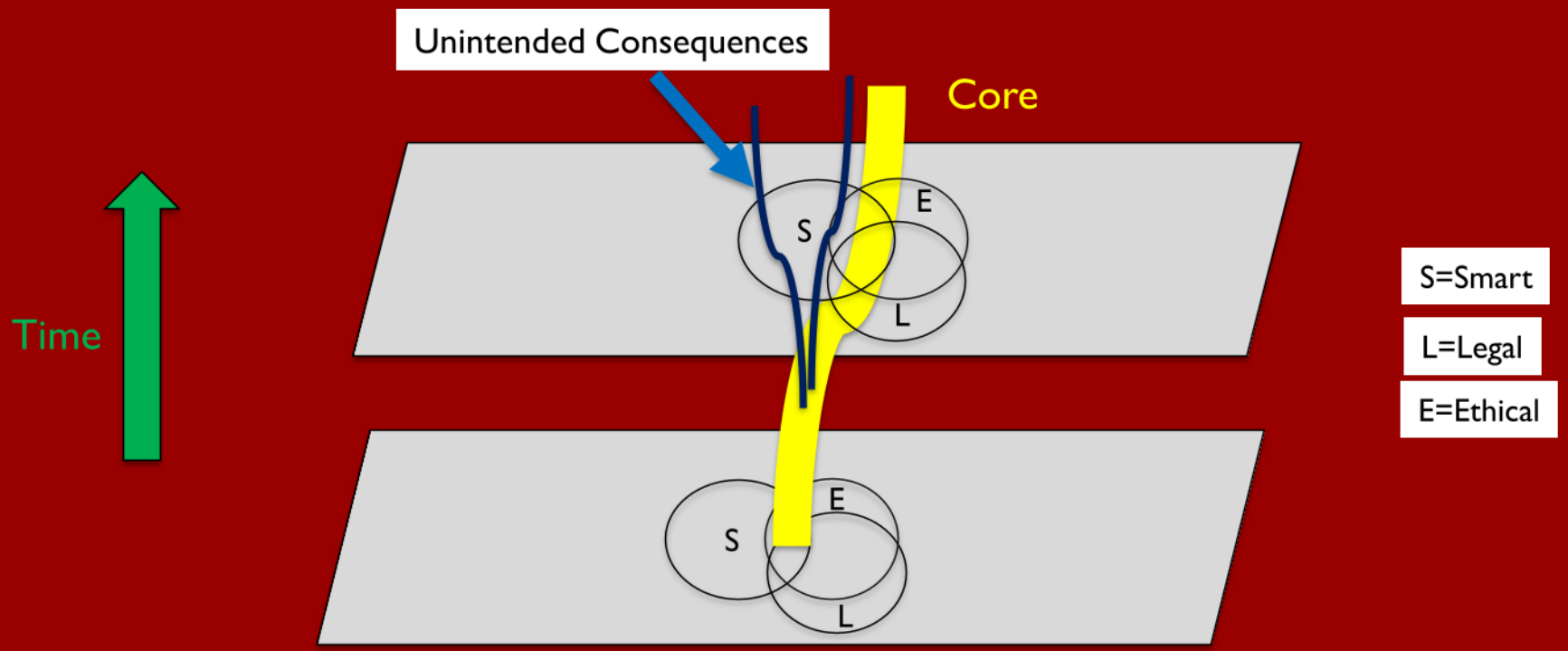
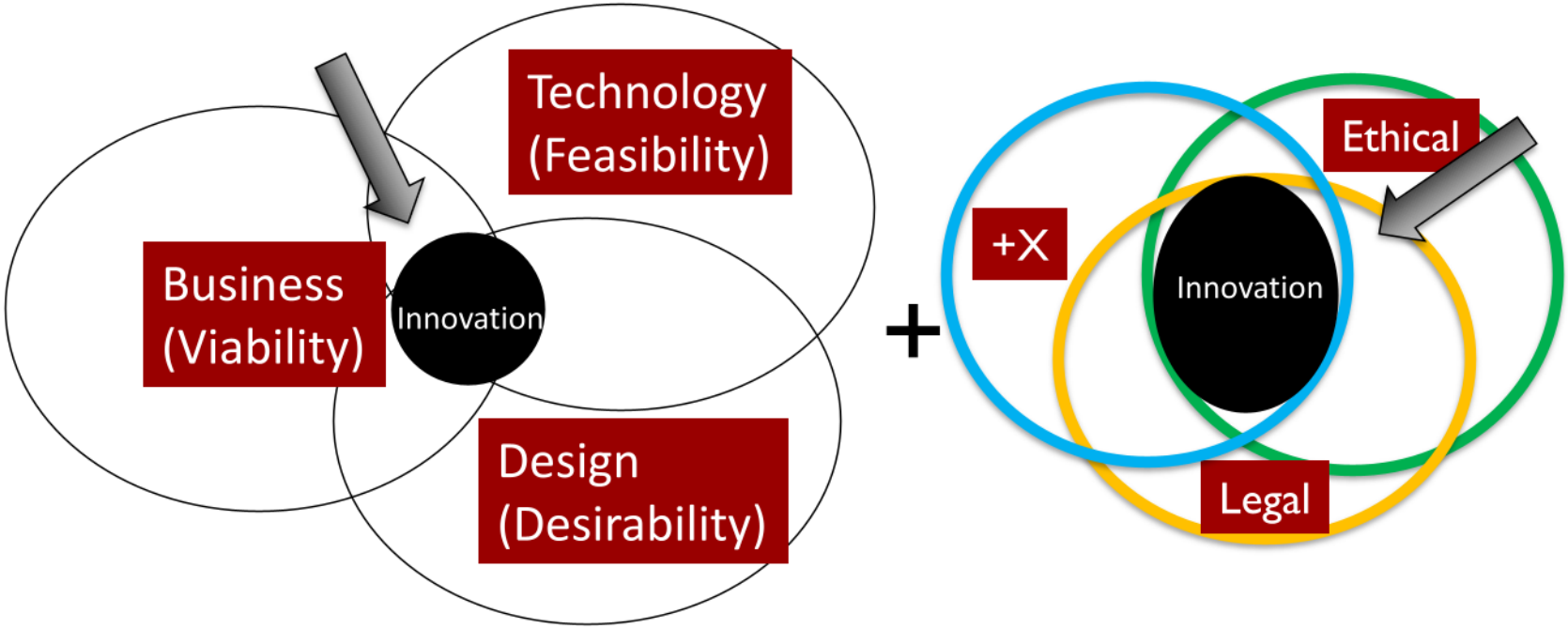
EVOLUTION OF TECHNOLOGY



The changing societal demands on innovation



USC Viterbi School of Engineering

Top 10 accomplishments

1. Reached gender parity in Fall 2019 entering class (historic)
2. Rocket Propulsion Laboratory reached Space -and breaks student world record
3. Increased faculty ranks with four new NAE members
4. Leads Engineering Education transformation (GCSP in London Global Summit; Competence *and* Character)
5. Reached Exemplar National status on Engineering Diversity
6. Well-positioned for research thought leadership (AI, Quantum, Sustainability, Bioengineering, Materials)
7. Successfully completed $500M fundraising initiative
8. Maintained high rankings
9. Maintained robust enrollments and budget
10. Positioning for a new CS building

USC Viterbi School of Engineering

USC VITERBI CAMPAIGN

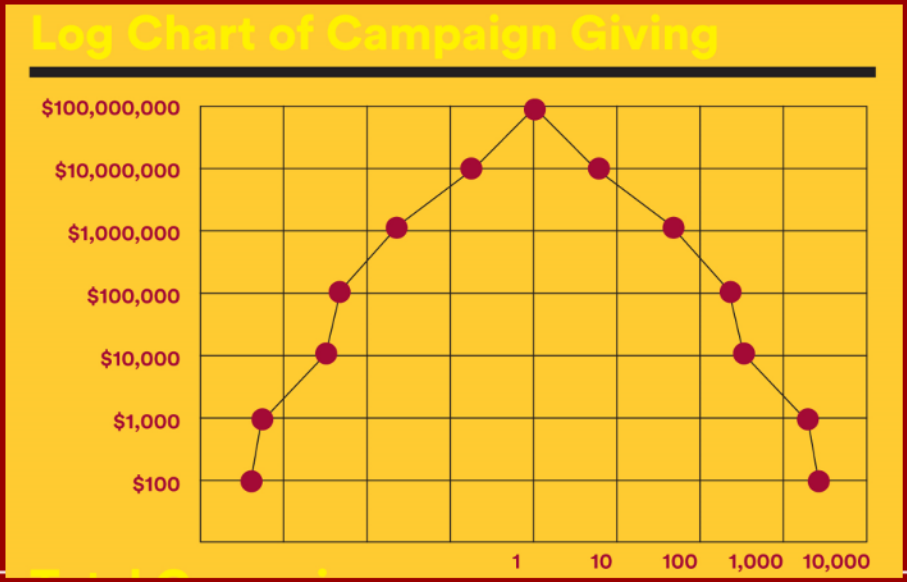
$500 MILLION GOAL
RAISED $500.5M (100%)

$381M in cash

28% Individuals; 57% CFR

15% Parents

67 gifts of $1M+ ($329M)



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IMPACT

Top Impact

- John D. O'Brien Nanofabrication Lab
- Computer Science Building
- Baum Family Maker Space
- Diversify Corporate Funding Sources

Viterbi Campaign Impact

- New Infrastructure
- New Centers
- 19 New Endowed Chairs & Professorships
- 59 New Endowed Scholarships & Fellowships
- Program Rankings

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USC Viterbi School of Engineering

VITERBI RANKINGS

- **Ranked 9:** All Graduate Programs
- **Ranked Top 5:** Private University Engineering Schools (after MIT, Stanford, Cal Tech, CMU)
- **Ranked 1:** Online (DEN@Viterbi) Graduate Computer Science Program (fifth consecutive year); Online Graduate Engineering for Veterans
- **Tied- Ranked 2:** Online (DEN@Viterbi) Graduate Engineering Program
- **The only engineering school with three top 10-rankings**
- **Ranked 1:** Graduate Engineering Program with the Largest number of Women
- **Ranked 1:** CS (Games) with Cinematics Arts Program (Princeton Review)

BEST ONLINE PROGRAMS U.S.News & WORLD REPORT GRAD ENGINEERING RANKINGS

Rankings are Methodology-dependent

Media Highlights

MEDIA HIGHLIGH

THE WALL STREET JOURNAL

How to Build Robots People Can Relate To

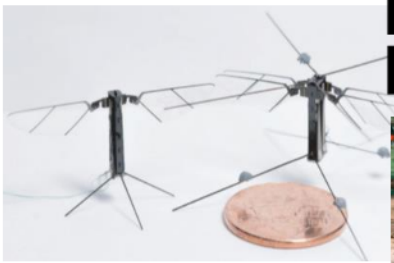
The Washington Post

A sneaker that fixes itself? It could be coming soon.

Is That Your Fingerprint or a Fake? This AI Can Tell

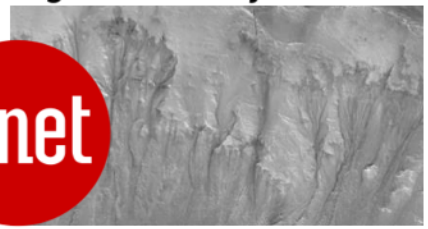
MIT Technology Review

Ten recent low-tech inventions that have changed the world



A tiny four-winged robotic insect flies more like the real thing

Scientists suggest Mars still has an active underground water system



c|net

USC students work with refugees to engineer solutions for better camp life

"PRI"

USC engineering students continue legacy of alum Neil Armstrong, set world record

790 KABC

WIRED

A Rocket Built by Students Reached Space for the First Time

USC Viterbi School of Engineering

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USC Viterbi
School of Engineering

SELECTIVITY

Undergraduate Program (1st Year)

13,590 Applications

407 Enrolled

2.99%

Masters Program

14,269 Applications

1,685 Enrolled

11.8%

PhD Program

2,750 Applications

237 Enrolled

8.62%

Faculty

1,580 Applications

10 Hired

0.63%

USC Viterbi School of Engineering

GLOBAL REACH

Partnerships (iPodia) with:

- Peking University
- Tsinghua University
- Technion Israel Institute of Technology
- Indian Institute of Sciences
- Technical University of Aachen
- University of Sao Paolo

Two overseas offices:

- Shanghai
- Bangalore

International boards:

- China/East Asia
- India

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USC Viterbi School of Engineering

Computer Science Building Site and Orientation

~98,000 Gross SF
~77,900 Net SF

6 floors above ground + basement

300 seat auditorium with adjacent
foyer/pre-function area

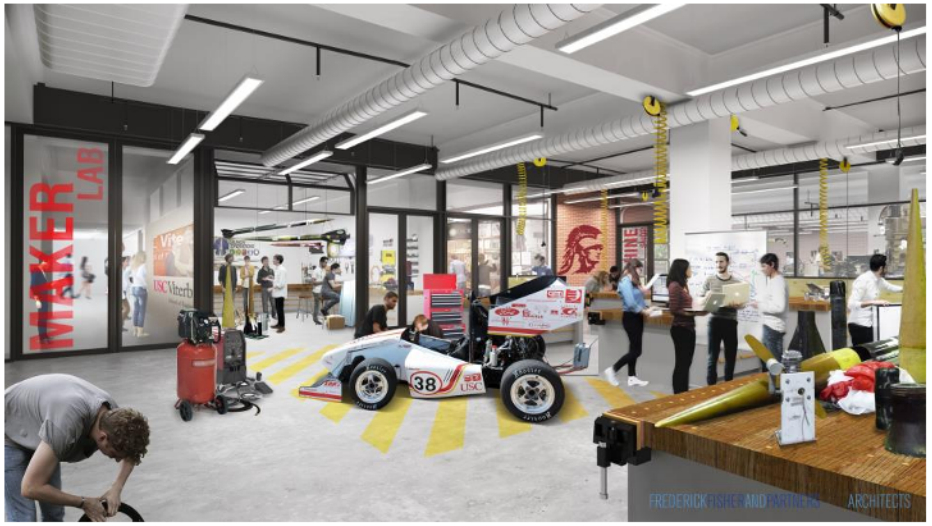
USC Viterbi School of Engineering

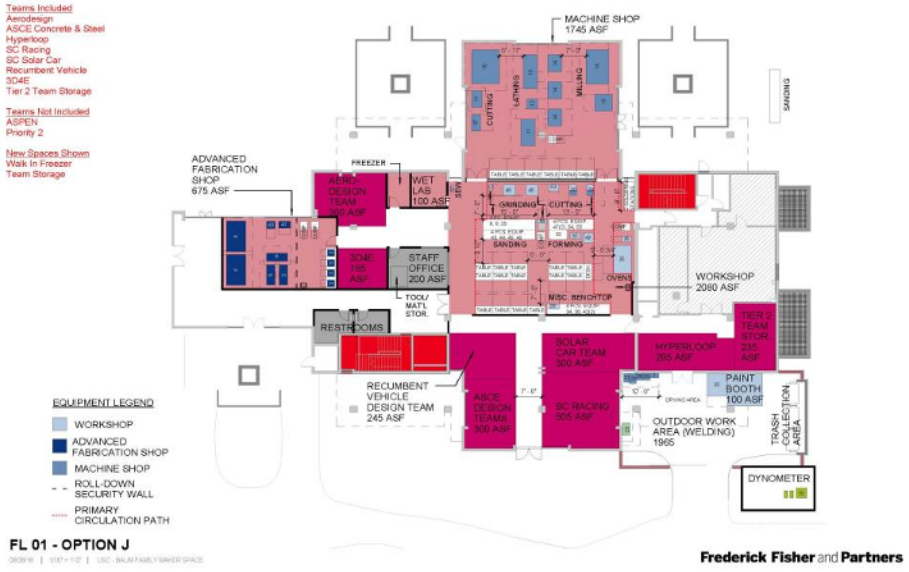
BAUM FAMILY MAKER SPACE
EXPECTED COMPLETION JANUARY 2020

Phase 1 - ~8,000 SF
Undergraduate Student Facility

- Machine Shop
- Advanced Fabrication Shop
- Work Shop
- Student Team Spaces

Phase 2 - ~1000 SF – 2nd floor





- Freshman design/build experience and capstone design courses
- Space for most of our student design teams

SUMMARIZING….

Powerful and Convergent Technology Helps:

Setting and Solving Humanity's Goals- and Changing the Conversation about Engineering

- Problems are inevitable
- All Problems are solvable

(From David Deutsch's book "The beginning of infinity")