Semiconductor Research Corporation

Next Generation Semiconductor Workforce to Enable Multi-disciplinary Co-design among NIST Microelectronic and Advanced Packaging Technology (MAPT) Roadmap

Marcus Pan, Science Director

Semiconductor Research Corporation

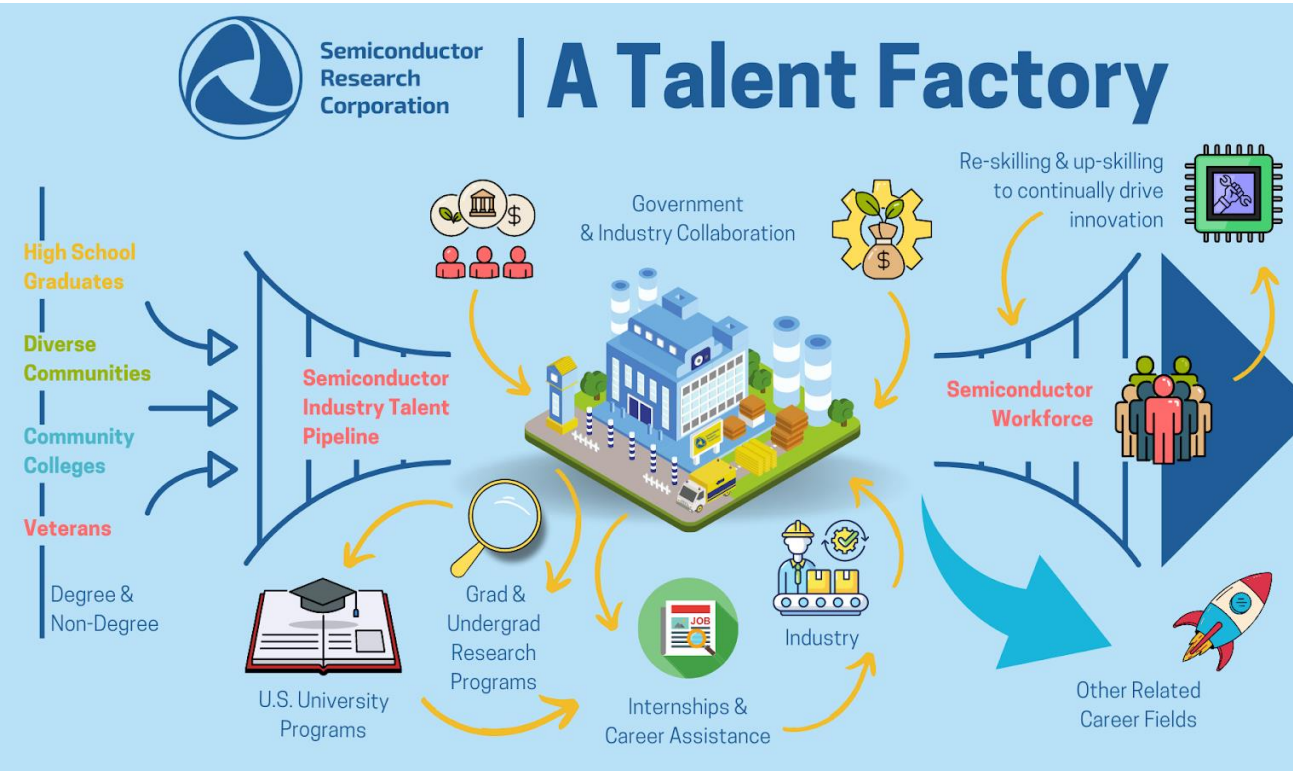
marcus.pan@src.org

Today's Outline

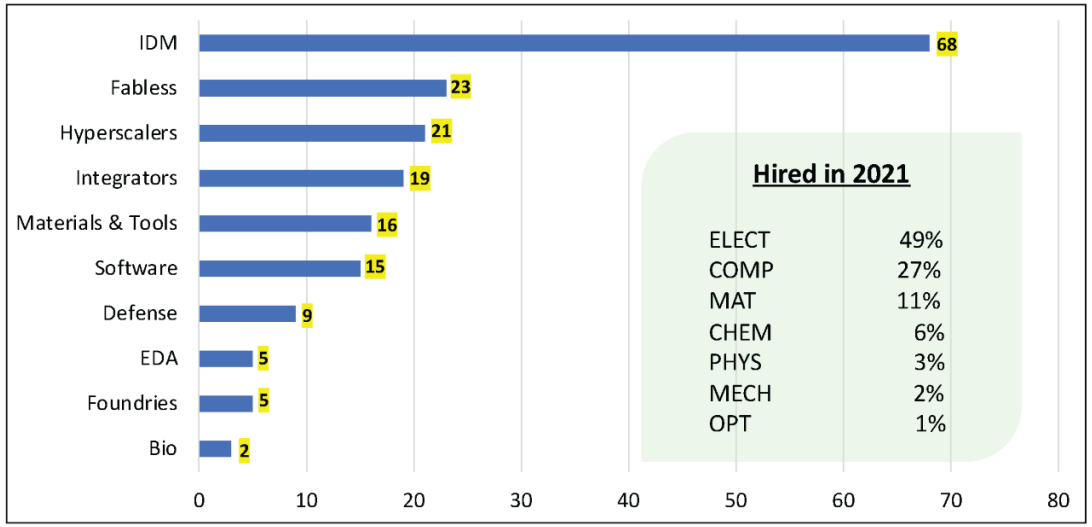
- SRC : a Talent Factory
  - Brief Refresher
  - Current Pipeline
- Steps to Close Gaps
  - Quantitative supply/demand modeling with KSA matrix
  - Better Workforce Engagement
- What to how
  - Decadal Plan to MAPT Roadmap
- Summary

SRC : a Talent Factory

https://www.src.org/newsroom/article/2023/1044/



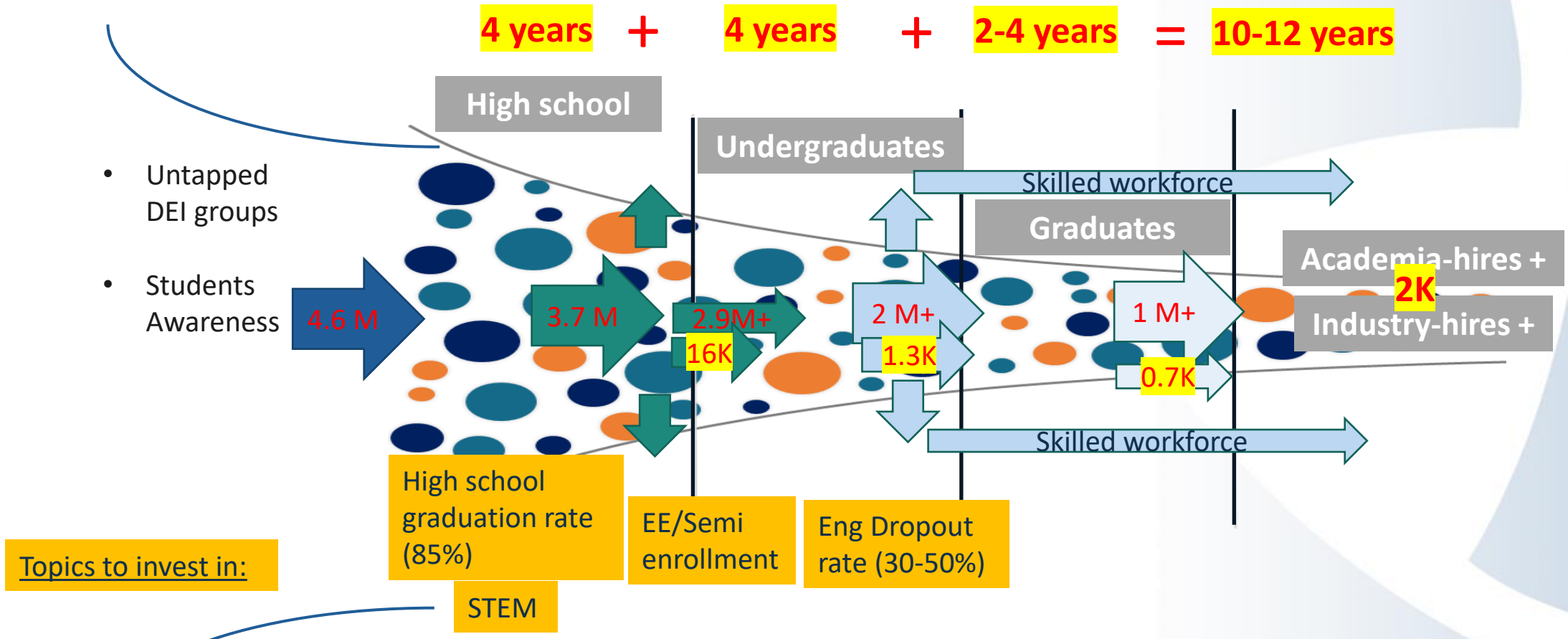
2021 SRC Grads Hired by Industry Segments



- We bring semiconductor industry talents to be semiconductor workforce
- Our member companies hired talent across various industry segments.

SRC

Current Semiconductor Workforce Development Pipeline



- The U.S. semiconductor industry has 300K people now → will need 600K additional skilled workers in 2030
- However, with status quote → jobs shortfall of 165K jobs (28%) out of the projected 600K jobs by 2030.

https://srcmapt.org/chapter7/

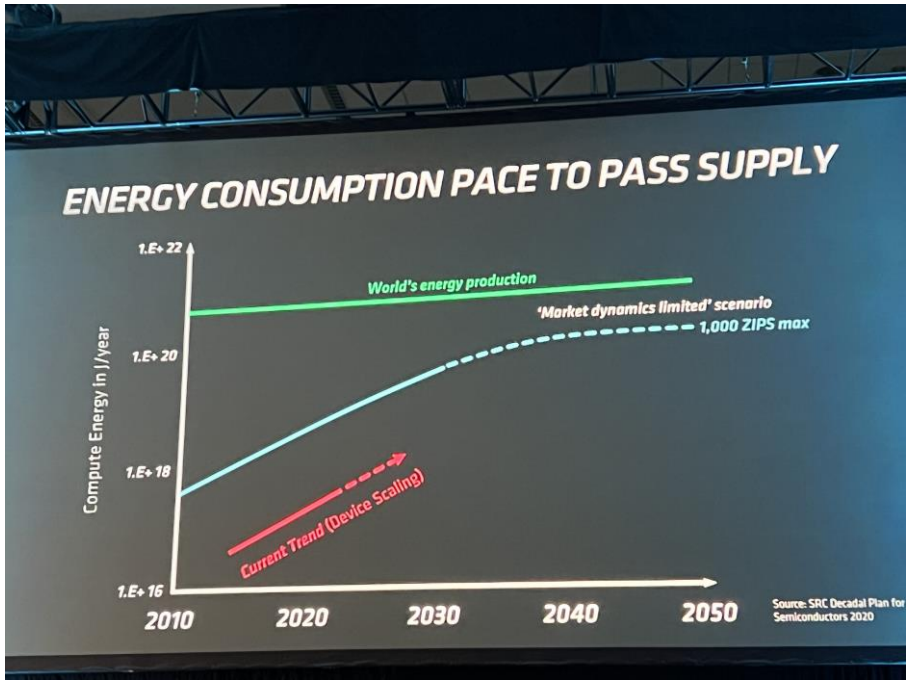
Robert Noyce's Takeaways Looking Good

- We need to close the gap by
  - Quantitative supply/demand modeling with KSA matrix
  - Better Workforce Engagement

  and Winning Hearts and Minds

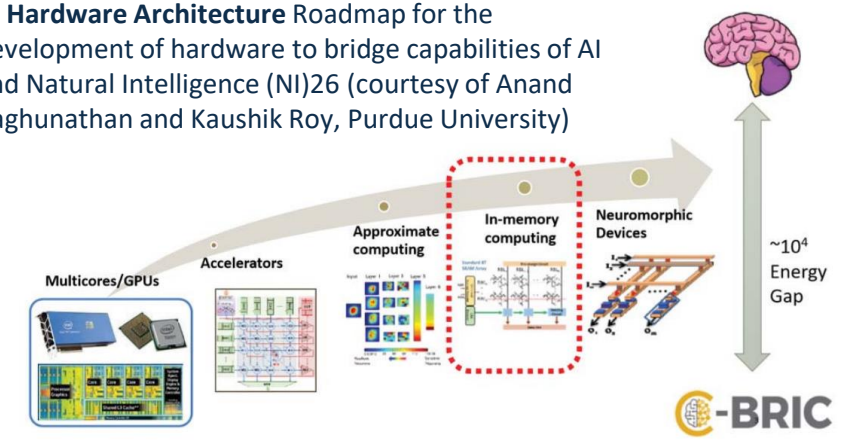
SRC

Tackling Future Challenges for Global Energy Consumption Need Multi-disciplinary Co-design

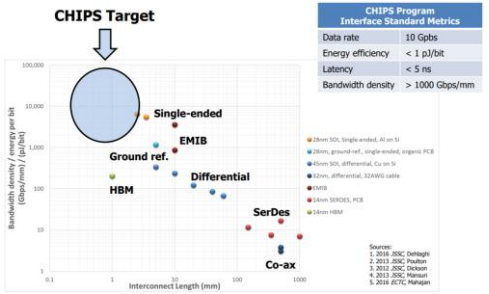


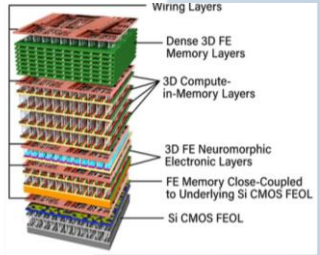
AMD CTO Mark Papermaster quoted SRC Decadal Plan on "Compute Energy Consumption Challenge" during Design Automation Conference 2022, San Francisco

AI Hardware Architecture Roadmap for the development of hardware to bridge capabilities of AI and Natural Intelligence (NI)26 (courtesy of Anand Raghunathan and Kaushik Roy, Purdue University)

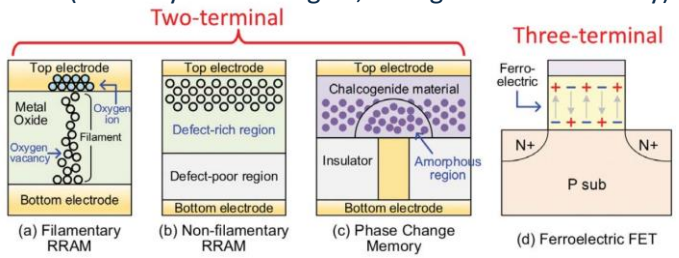


Heterogenous Integration with efficient interconnects (courtesy of DARPA)





Devices Structures of memories used in AI Engines (courtesy of Shimeng Yu, Georgia Tech. University)



The skilled semiconductor workforce for tomorrow's would require a different set of Knowledge, Skills and Abilities.

Skilled Workforce for Next Generation Semiconductor

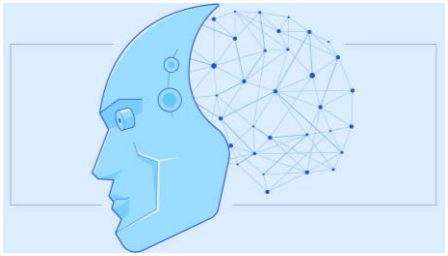
Courtesy: Alessandro Piovaccari

AI/ML Application System Layer

- Natural language AI/ML
- Analytics machine learning
- Web application software
- Cloud infrastructure application software
- Edge applications software
- Operating systems & high-level networking software stacks
- Machine learning at the edge
- Low-level networking software stacks
- Real-time operating systems & device drivers
- Firmware & hardware-software co-design

Co-design for Microelectronics

- Architecture exploration & high-level synthesis
- Hardware verification
- Hardware description languages & design synthesis
- Device-level design, simulation, custom layout
- Device modeling & design enablement
- Device physics & foundry engineering
- Material science & nanotechnologies
- Solid-state physics & statistical mechanics
- Electromagnetics & quantum mechanics



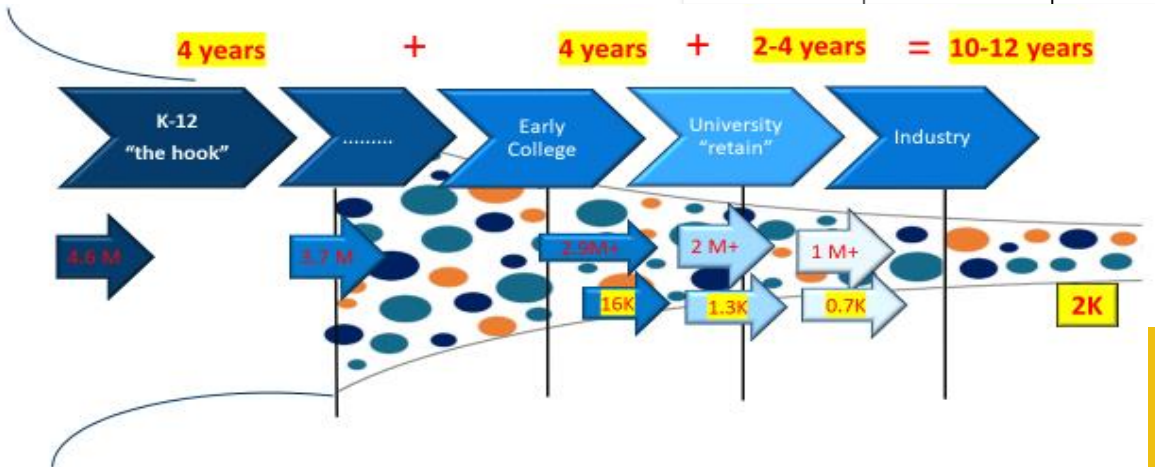
+

- Tomorrow, Designers Need = AI/ML + Co-design across microelectronics.
- We need to sync between industries and academia.

SRC

Knowledge, Skills and Abilities (KSA) Matrix for Next Generation Workforce Development Pipeline

- 4 million students entering high school and either drop out, graduate and go to college or enter directly into the workforce.
- Massive decrease in students completing STEM degrees of bachelors, masters or doctoral, with ~2 thousand highly skilled eventually pursuing careers in the microelectronics workforce.



Role	Data Analysis			Statistics & DOE			Coding/Programming/Shell Scripting			ML
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1
Design Engineer	0.5	0.3	0.7	0.3	0.7	1	1	0.7	0.3	0.3
Product Engineer/Security/Arch	0.5	0	0.7	0.3	1	1	0.7	0.7	0.3	0.3
Process Engineer	0.7	0	0.1	0.3	0.3	0.3	0.3	0.5	1	1
Metrology	0.5	0	0.1	0.3	0.3	0.3	0.3	0.5	0.7	0.5
Equipment Engineer	0.7	0	0.3	0.1	0	0	0	0	0.3	0.5
Process Control	0.5	0	0.7	0.5	0.1	0.1	0.1	0.3	0.3	0.7
Packaging Engineer	0.5	0	0.3	0.1	0.5	0.5	0.3	0.5	1	0.5
Integrators	0.7	0	0.3	0.3	0.3	0.5	0.5	1	0.5	0.5
Yield and Reliability Engineers	0.7	0	0.3	0.3	0.3	0.5	0.5	1	0.5	0.5
Data Scientist	0.5	0.7	1	0.3	0.3	0.5	0.5	0.1	0.3	0.3
Operations/Productivity Engineers	0.7	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fab Automation	0.5	0.3	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Software Engineer/Developer	0.3	0.3	0	0.3	0.3	0.5	0.5	0.5	0.5	0.5
Environmental Engineer	0.5	0.5	0	0.3	0.1	0.1	0.1	0.1	0.1	0.1
Fab / Lab Technician	0.3	0.3	0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
Field Service Engineers	0.3	0.3	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Program Managers	0.5	0.3	0	0	0.1	0.1	0.1	0.1	0.1	0.1
Supply Chain Manager	0.5	0.3	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HR	0.1	0	0	0	0	0	0	0	0	0

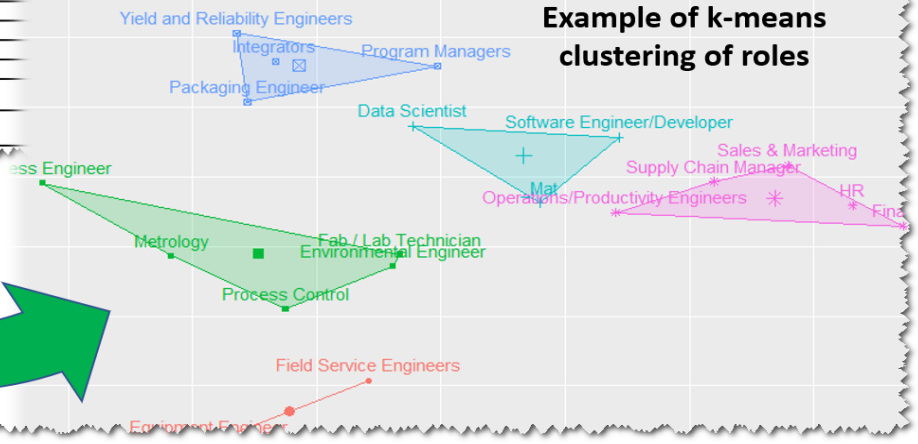
Skills

Skills Expertise

Roles

- **KSA mapping of skills to job function**
- **Clustering analysis allows grouping of job functions**

Example of k-means clustering of roles

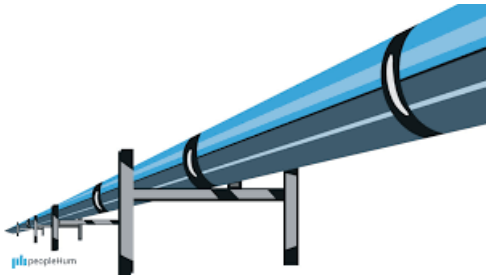


- A comprehensive KSA matrix can ensure academia and industries are aligned with curricula, internship, apprenticeship and employment opportunities.

SRC

Better Workforce Engagement

- **Awareness:** Increase awareness for US students, teachers, professors, counselors and parents; veterans; women; underrepresented people of color; and rural residents



- **Building communities/pipelines**: connect industry to K-12, community colleges, university students

- **Diverse talent:** with a focus on underserved, tribal, and rural student populations and international students.

- **Scale for impact:** Scale effective programs and models including mentorship, apprenticeship, internships, curriculum alignment

More Awareness

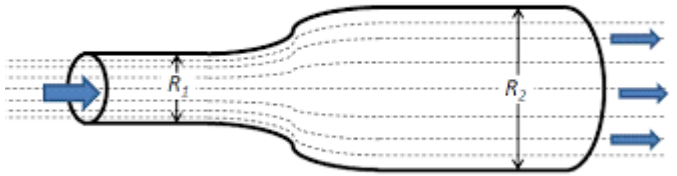
2030 Broadening Participation Pledge
"Throughout the decade, as SRC defines, selects, and manages its research and education programs, we will look to grow our student base, establish a balanced mix of bachelors, masters, and Ph.D.-level initiatives, and create a more diverse and inclusive community."

https://www.src.org/about/broadening-participation/bp_pledge_year1_update_final.pdf
https://www.src.org/about/broadening-participation/bp_year_2_update_final.pdf

Industry Image and Awareness Campaign – a series of national and regional media activities that highlight the industry

SEMI High Tech U and related initiatives – programs that encourage industry employee engagement in classrooms, teacher training, tools to help families understand the industry, its companies, and its wide range of career opportunities.

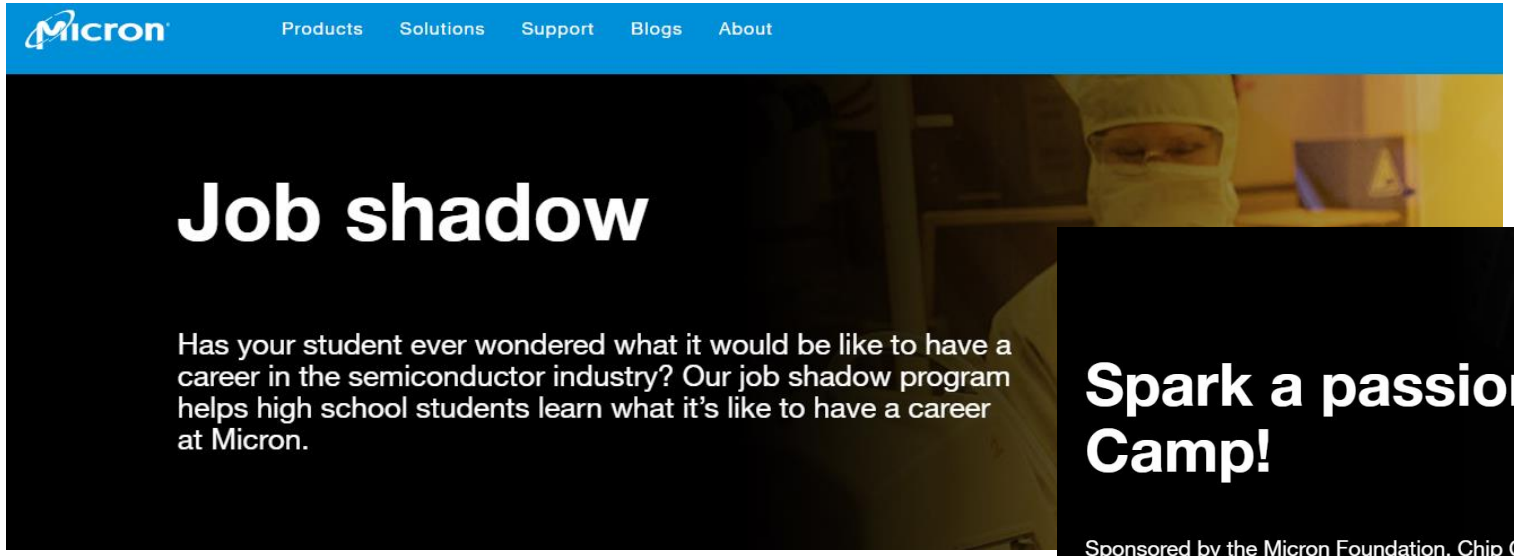
https://semi.org/en/semi-news/topic/semi-high-tech-u



Widen the pipeline by increasing overall industry, career, and employer awareness for U.S. students, teachers, professors, counselors and parents; veterans; women; underrepresented people of color; and rural residents

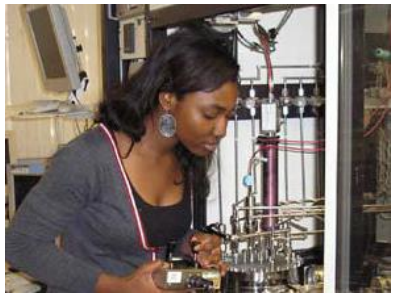
SRC

Building Communities/Pipelines



- Develop sustainable, effective engagement opportunities for industry employees that connect them to K-12, community colleges, Univ teachers / professors / students .
- Leverage existing work-based learning experiences that can be replicated across other companies nationwide, for example Micron Foundation's Job Shadow and Chip Camp programs for high school students that provide virtual and in-person immersions.

SRC-NSF Research Experiences for Undergraduates (REU) Partnership



2 Apr 2021

Announced SRC's Broadening Participation Pledge

28 Sept 2021

GC approved $9.9M, 5-year NSF REU investment in NST++

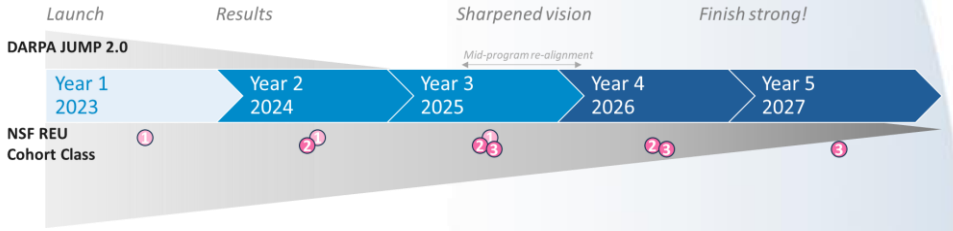
Summer 2023

1st REU Class will begin; SRC will connect them to JUMP 2.0 Centers

Q2-3 2023

NSF to open "Class 2" solicitation for REU programs that would run in summer 2024-2026

Click here for more information



Estimate 24 cohorts and ~210 students

Cohorts

		Calendar Year				
		2023	2024	2025	2026	2027
Program Year	Class 1	8 cohorts				
	Class 2		8 cohorts			
	Class 3			8 cohorts		
	Cohorts	8	16	24	16	8

Scholars

		Calendar Year				
		2023	2024	2025	2026	2027
Program Year	Class 1	70	70	70		
	Class 2		70	70	70	
	Class 3			70	70	70
	Scholars	70	140	210	140	70

Learn more

Follow SRC on Linked In to catch the "Class 2" solicitation announcement

Diverse Talent Pipelines

JUMP 2.0: 3 out 7 center directors are female

Theme 1 – Cognition

COCOSYS (GaTech)

Arijit Raychowdhury
GaTech

Anand Raghunathan
Purdue

Tajana Rosing
UC/San Diego

Nam Sung Kim
UIUC

Theme 5 - Intelligent Memory & Storage

PRISM (UCSD)

Theme 2 – Communications & Connectivity

CUbiC (Columbia)

Keren Bergman
Columbia

Ali Niknejad
UC/Berkeley

Madhavan Swaminathan
Penn State

Muhannad Bakir
GaTech

Theme 6 – Advanced Monolithic & Heterogeneous Integration

CHIMES (Penn State)

Theme 3 – Intelligent Sensing to Action

CogniSense (GaTech)

Saibal Mukhopadhyay
GaTech

James Buckwalter
UC/Santa Barbara

Huili (Grace) Xing
Cornell

Tomas Palacios
MIT

Theme 7 – High-Performance Energy-Efficient Devices for Digital & Analog Applications

SUPREME (Cornell)

Theme 4 – Systems & Architectures for Distributed Compute

ACE (UIUC)

Josep Torrellas
UIUC

Minlan Yu
Harvard

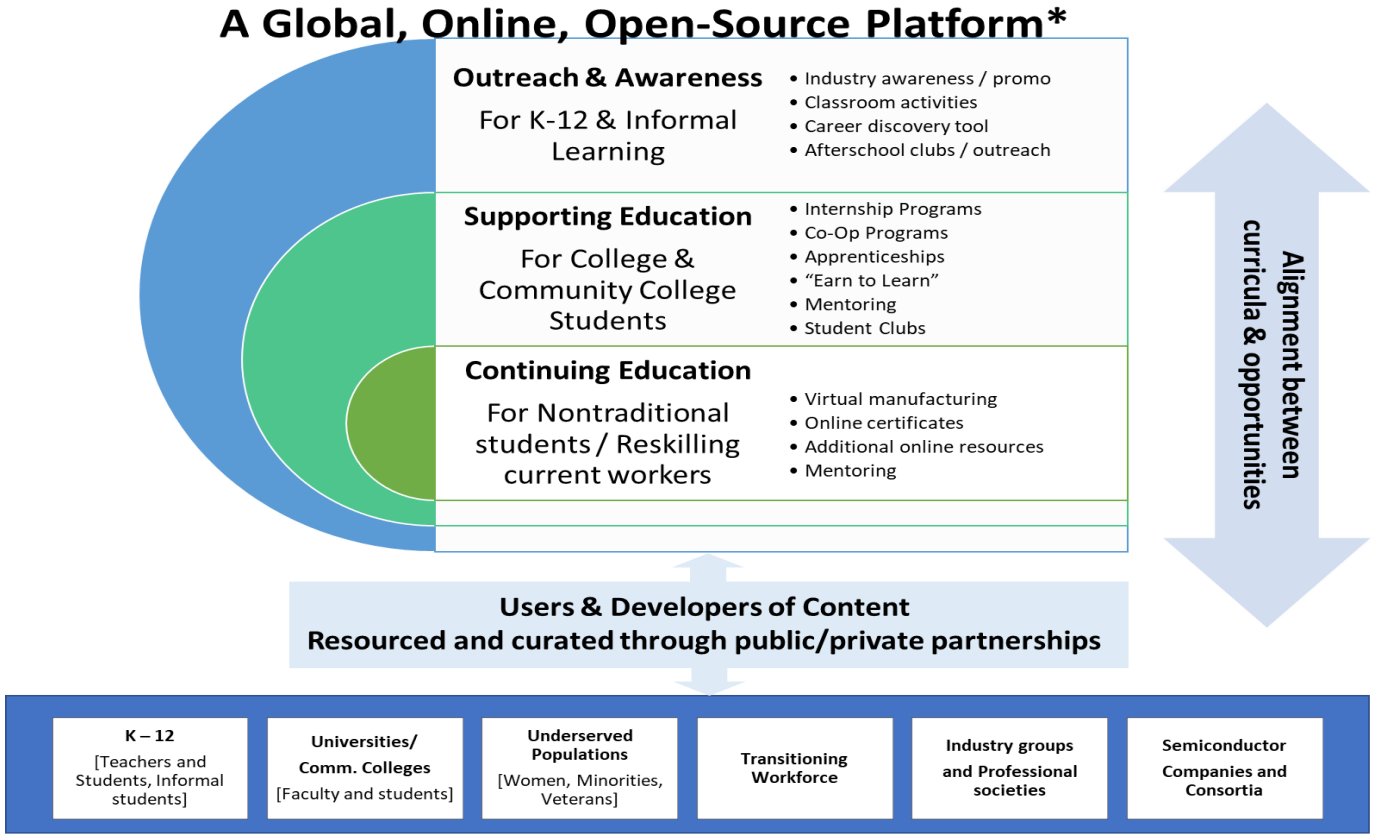
TECHCON 2022

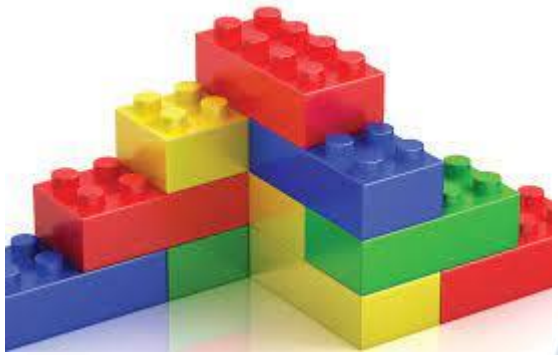
>50% out of 355 attendees are female and/or URM

Reach diverse talent pipelines by linking programs from high schools, vocational schools, and community colleges with a focus on underserved, tribal, and rural student populations and those transitioning from other industries

SRC

Online, Open-source Platform to Scale for Impact





- Scale effective programs and models including mentorship, apprenticeship, internships, curriculum alignment by understanding and quantifying the ROI for different effective models so that investment choices and commitments can be made by different stakeholders

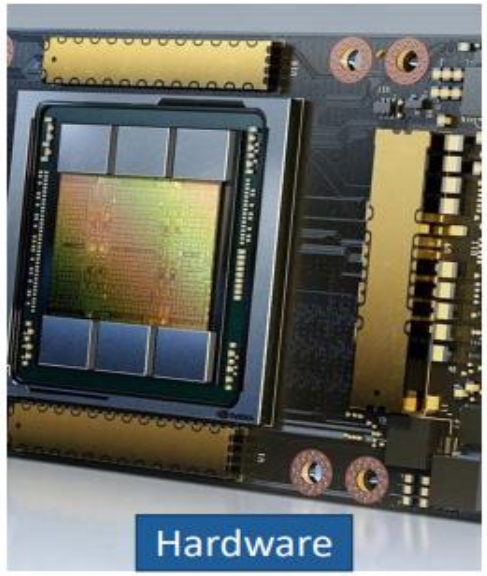
SRC

SRC Blog Series

- Blog 1 – Introduction to semiconductor WFD challenges (this blog)
- Blog 2 – Talent gap details, SRC chart details about 2021 hires
- Blog 3 – KSA, training, industry involvement, resources
- Blog 4 – Workforce Engagement
- Blog 5 – Winning the hearts and minds of semiconductor innovators
- Blog 6 – Summary of blogs and where do we go from here?

- Please check us on
  - https://www.src.org/newsroom/

Microelectronic and Advanced Packaging Technology (MAPT) Roadmap : A natural next step for Decadal Plan



Decadal Plan

Define **WHAT** is needed

- 5 workshops
- 50+ presentations,
- Hundreds contributors
- Plan for 10 years (refresh!)

NIST-SRC MAPT Roadmap

Define **HOW** to accomplish

- 6 TWG, 5 Crosscuts,
- 106 Org. ;274 contributors
- Interim report is ready
- Fina report : Oct ‘23

CHIPS Funding

Implementation Plan

- Industry, academia, gov, labs
- NSTC, NAPMP
- **SRC Manufacturing USA Inst.**

SRC

- Decadal Plan (WHAT) → MAPT (HOW) (srcmapt.org)
- SRC Manufacturing USA Institute to bring Workforce for real.

Call to Action

- We are committed to workforce development and broadening participation. There is a bright future for semiconductors, but we must change our narrative to win over the hearts and minds of next gen innovators.
- The current hardware paradigm must shift to create the desired value with heterogeneity from 3D microelectronic and advanced packaging technologies (MAPT) as the key driver.
- To stay at the leading edge of hardware innovation, we must invest in early-stage ideas and tech maturation with co-design, exploring key options with next generation workforce with a fast-fail and tech-transfer mindset.

The greatest risk is not investing in semiconductor R&D workforce for our future

Want to learn more about SRC?

- Get caught up on our MAPT Roadmap:
  - https://srcmapt.org/
- Get caught up on our Decadal Plan (including SIA webinars):
  - https://www.src.org/about/decadal-plan/
- Learn about our Decadal Commitments to people and the planet:
  - https://www.src.org/about/
- Contact us.

Questions?


ACADEMIA • INDUSTRY • GOVERNMENT