



Semiconductor
Research
Corporation

IEEE EPS President's Panel: Challenges in Education and Workforce Development in the New Chips Economy

May 31, 2024

John Oakley

Science Director for Hardware Security, AI Hardware, Semiconductor
Packaging, and Supply Chain AI Realized Future

John.Oakley@src.org



SRC - "It's simple..."

42 Years
Neutral, Trusted, Science-Driven
>\$2.5B in Academic Investments
>15,000 SRC Scholar Alumni

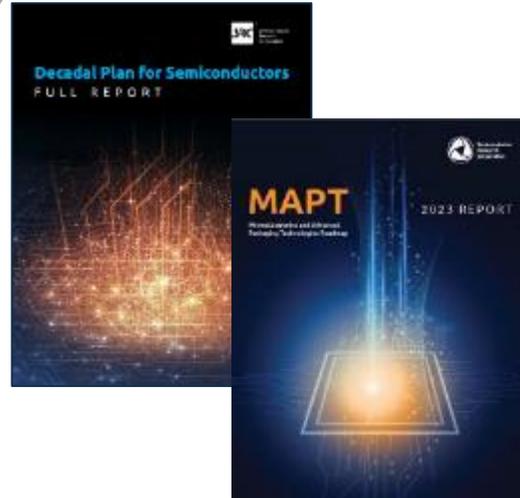


"We need to channel more funds to research and add to the supply and quality of degreed professional people."

-Robert Noyce

SRC's Three Pillars for Semiconductors' "Roaring 20s"

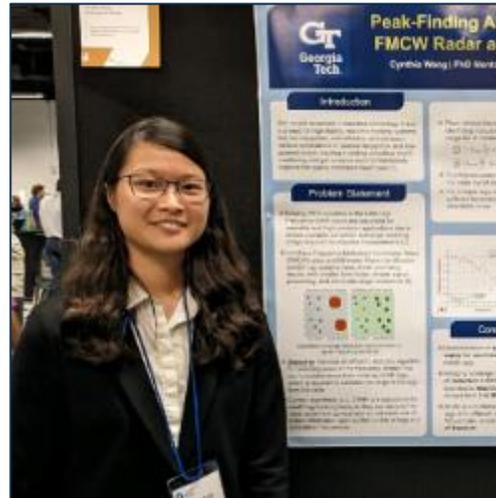
Prosperity



Jan 2021
2030 Decadal Plan for Semiconductors
3x↑ in Annual Funding
Oct 2023
Roadmap for Microelectronics and
Advanced Packaging (MAPT)

<https://www.src.org/about/nist-mapt-roadmap>

The People



Apr 2021
Broadening Participation Pledge
3x↑ Scholar Pipeline (AA-PostDoc)
Greater Diversity, Equity, & Inclusion
Ignite passion for Semi in US
Workforce Advisory Board (WAB)

<https://www.src.org/about/broadening-participation/>

The Planet

Images from Samsung

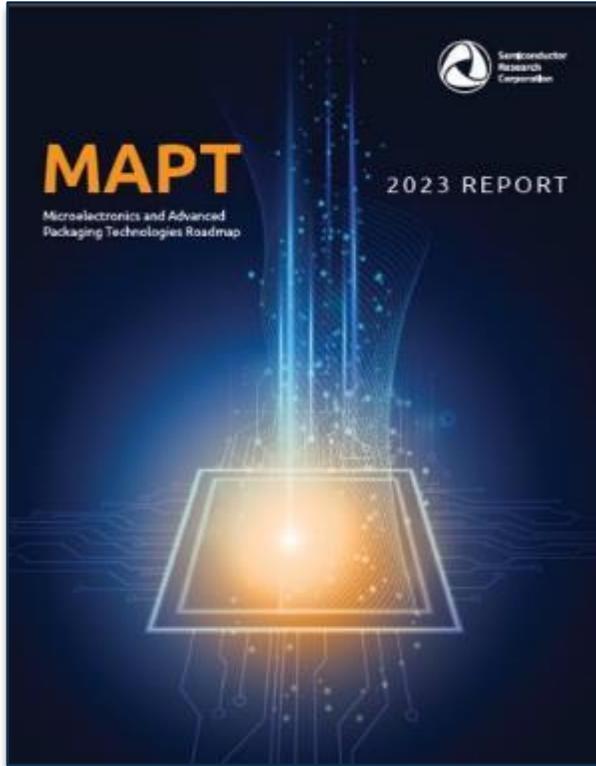


Oct 2021
Commitment to Sustainability
Green Materials & Processes
Energy Efficient ICT Systems
**Win Hearts & Minds of
Next Gen Innovators**

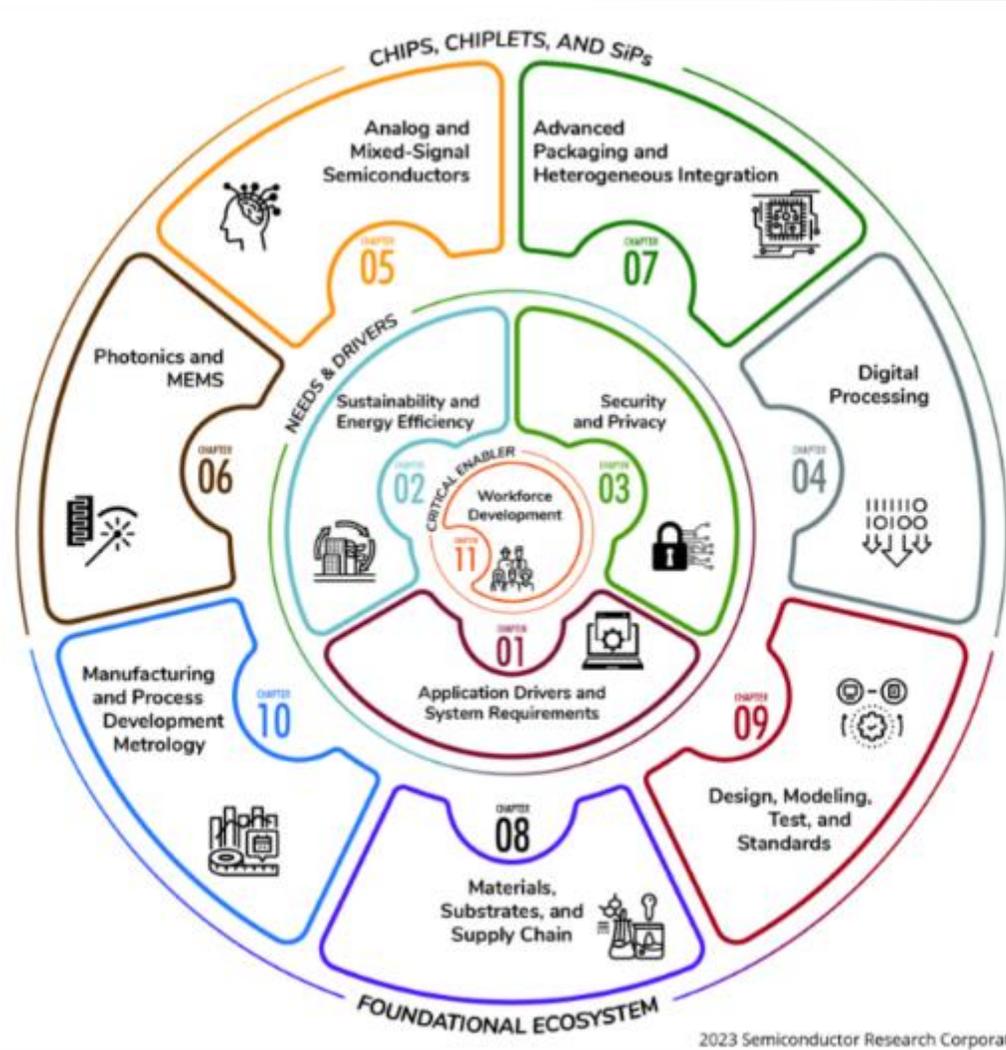
<https://www.src.org/about/sustainability>

Since Spring-2022, SRC has used these 3 criteria to drive all new investments

Microelectronics and Advanced Packaging Technologies (MAPT) Roadmap



Released October 2023



2023 Semiconductor Research Corporation



<https://srcmapt.org/>

MAPT Roadmap - Workforce Development – Critical Enabler

Call to Action: Time is Now for Industry, Academia and Government to Act

Needs and Key Findings	<ul style="list-style-type: none"> • 114,800 Additional Semi Jobs by 2030 vs 19K in pipeline • Mix – multiple disciplines and multi-degrees, engineers, technicians <ul style="list-style-type: none"> • 60-70% are technicians
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Challenges	<ul style="list-style-type: none"> • Interest / Motivation – students • Time Lag - pipeline • Financial cost • Scale – people and programs • Ownership?
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Approach – 3 pronged

Model

- What = KSA
- When = timing
- Where = locality
- *The Matrix*

	Device & Circuit Concepts	System Design & Experimentation	Modeling & Simulation	AI & ML
Devices, Circuits, Systems - Design, Architecture & Test	🔥	🔥	🔥	🔥
Product Management & Strategic Development			🔥	
Engineered Design, Build & Maintenance				
Logistics & Operations			🔥	🔥
Deployment Support				
Process Engineering & Metrology		🔥	🔥	
Business & Fab Support			🔥	🔥

Engagement

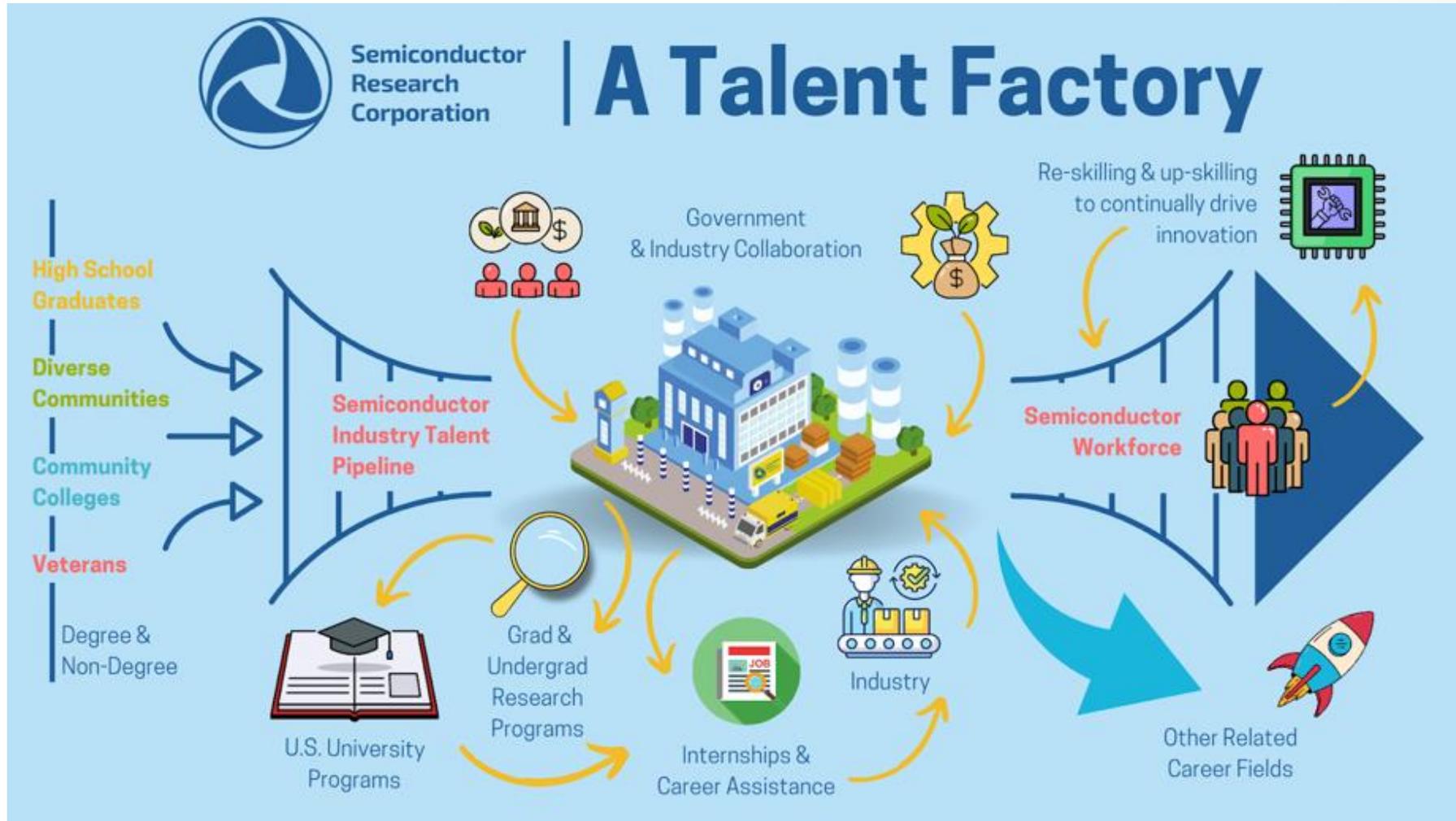
- Hands On Experience
- Access
- Training/Mentors
- Incentives
 - Financial
 - Social
 - Emotional
 - Reward/Challenge
- Leverage Best Programs
 - Drive to scale
- Global Platform
- **Industry is Key**

“Hearts & Minds”

- Motivation
- Awareness K-12
- Education ecosystem engagement
- Full stack engaged
 - Teachers
 - Counselors
 - Family
 - Friends
 - Industry



A Talent Factory*: The SRC Story



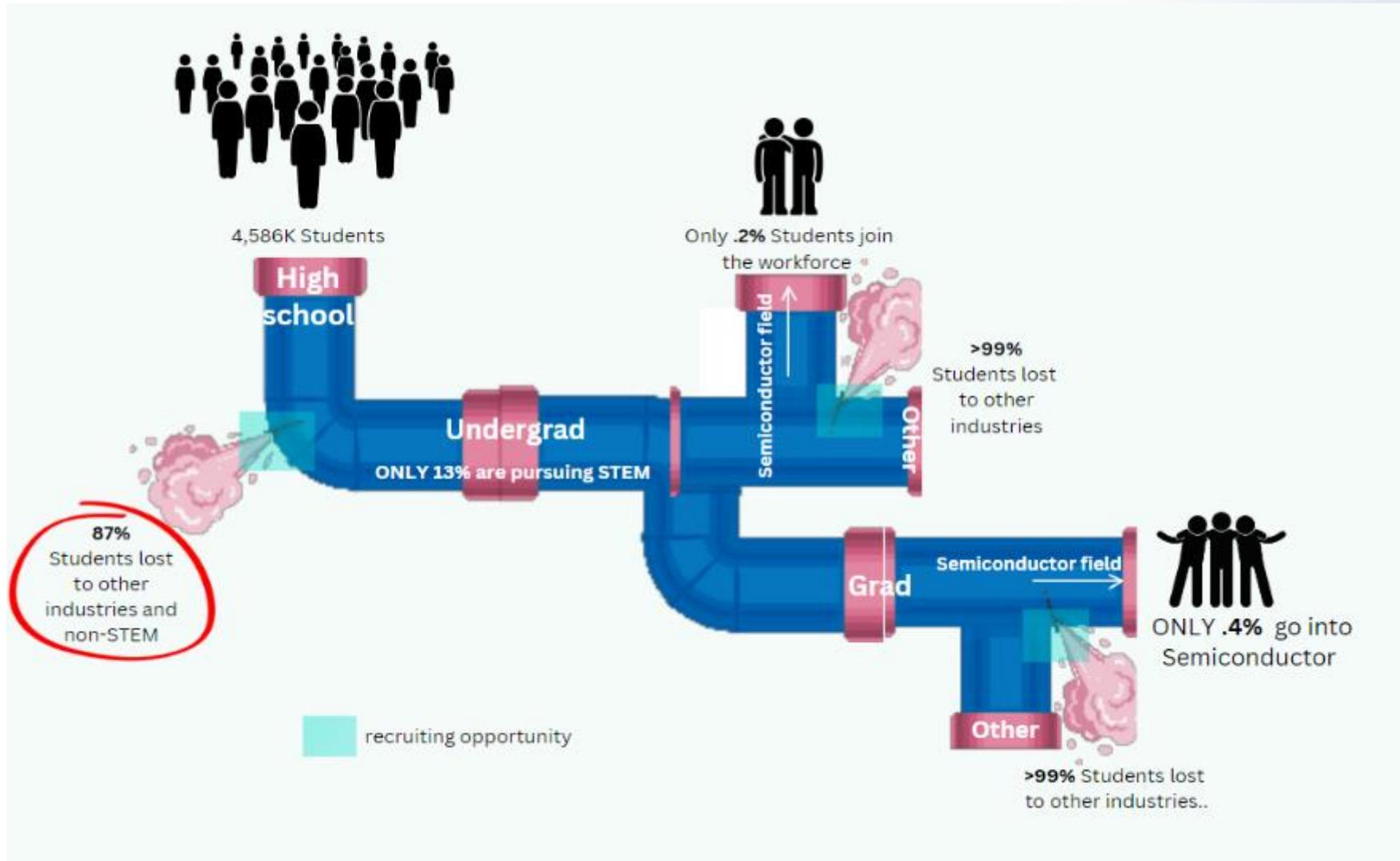
Currently, SRC supplies nearly 20% of the semiconductor PhD workforce in the U.S. and has the capability to increase output by 3-5 times to meet growing demand

42
Successful
Years!

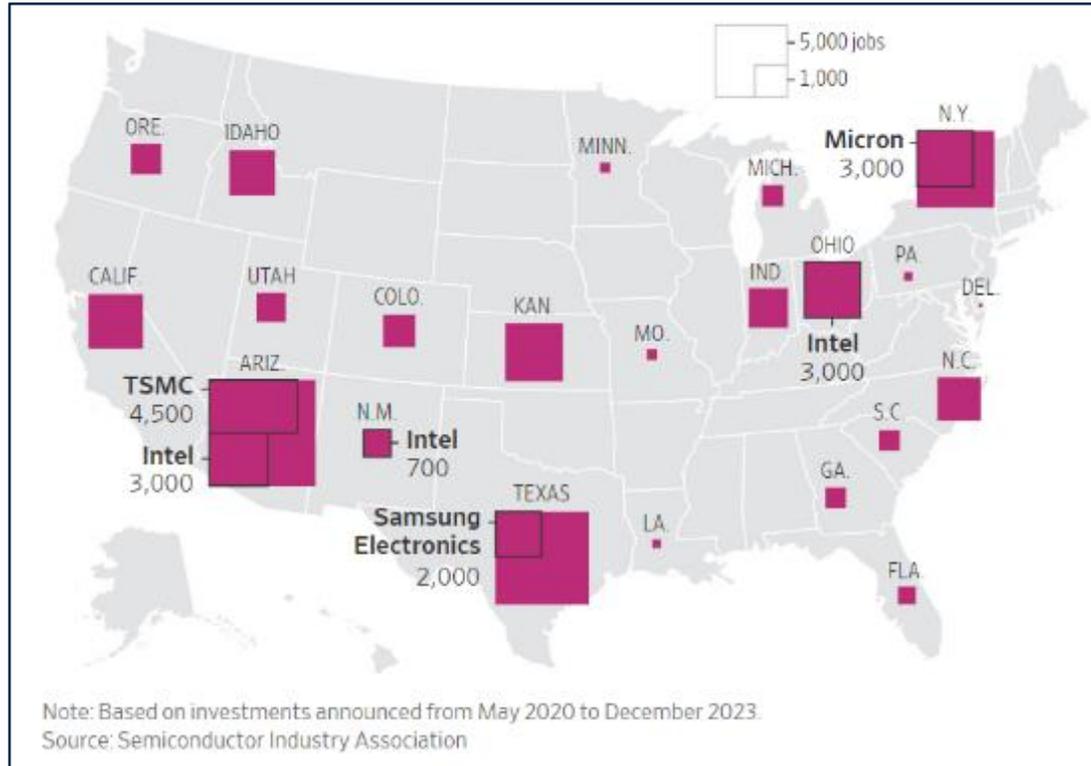


* a special entity created by the semiconductor industry for planning and execution of research and workforce development

Crisis Problem - Leaking Talent Pipeline



Jobs: Where and How Many are Projected?



Nice summary of jobs projection in WSJ Article - Jan. 27, 2024¹



Secretary of
Commerce
Gina M. Raimondo

Sec. Raimondo has set the goal of:

- “**Doubling** the U.S. semiconductor workforce over the next decade” and has
- “**Urged U.S. colleges and universities to triple their graduates in semiconductor-related fields**”

Questions?

- Currently, SRC supplies nearly 20% of the semiconductor PhD workforce in the U.S. and has the capability to increase output by 3-5 times to meet growing demand
- The Leaky Pipeline was modeled by the team in Chapter 11 of the SRC MAPT Roadmap tracking High Schoolers to semiconductor industry and discovers millions were missing as potential employees



- John Oakley
- Science Director
- John.Oakley@src.org



Who am I?



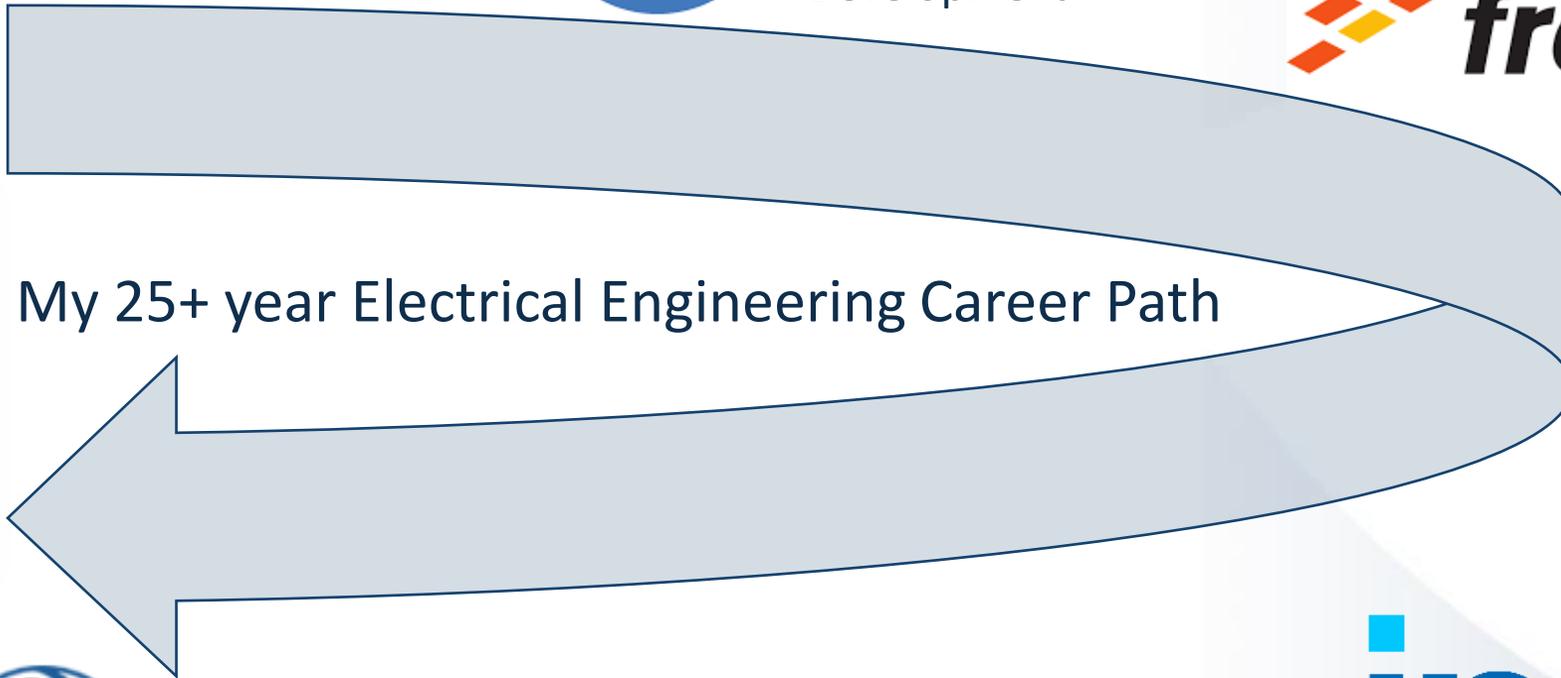
Analog Design,
Power Electronics,
Research



Leading Academic
Research For Govt/
Industry Members



Mixed Signal Design,
Pagers/Cell Phones,
Research with some
Development



My 25+ year Electrical Engineering Career Path



Semiconductor
Research
Corporation

System Architect for
2 generations of cell phones,
Development

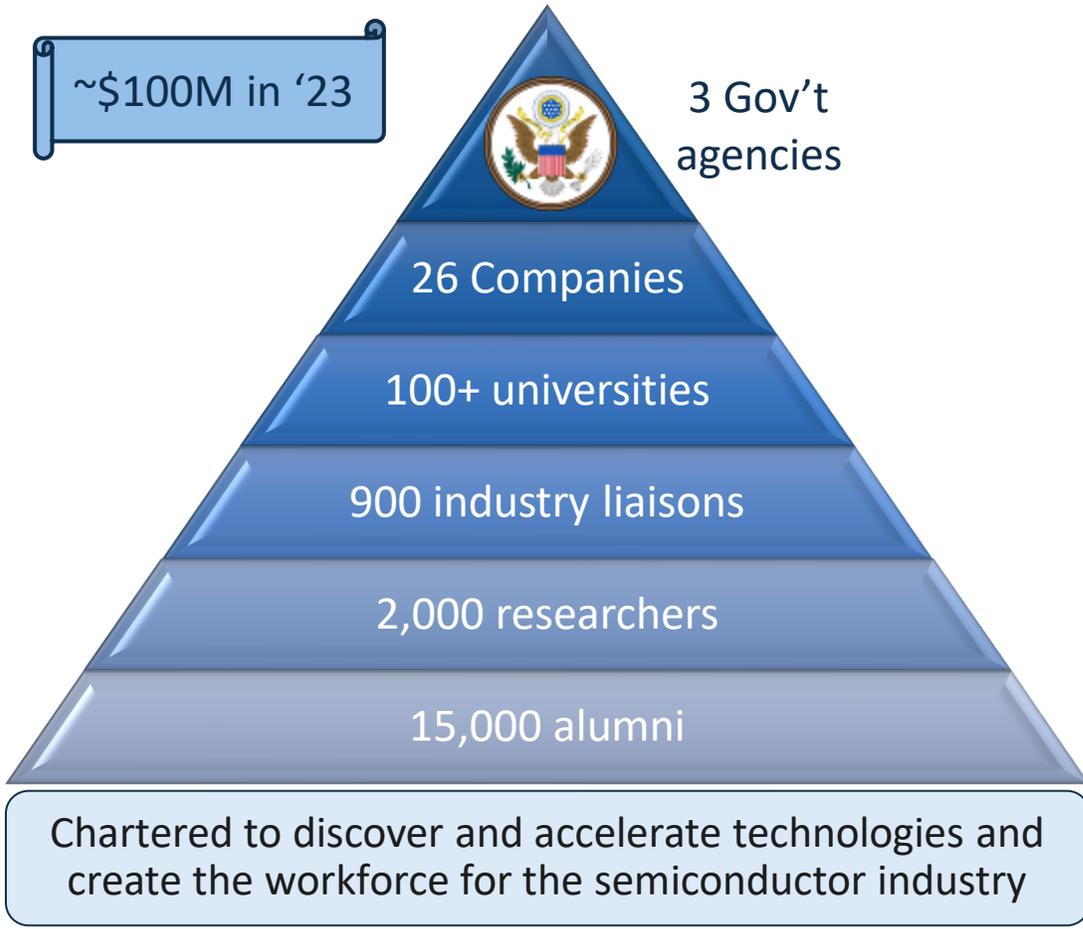


System Design
And Use Cases,
Research and
Development



<https://www.src.org/about/management-team/oakley-john/>

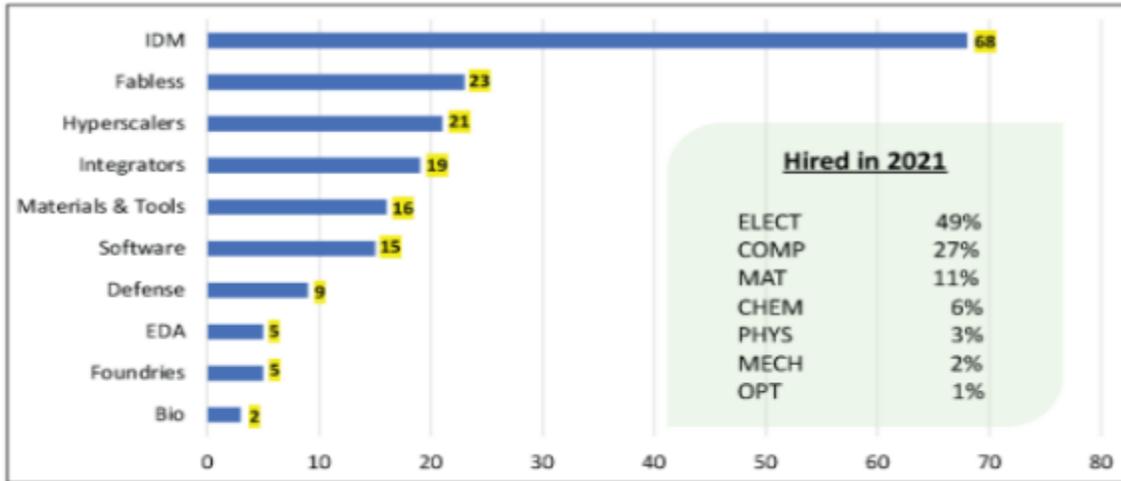
Premier Global Microelectronics Consortium



SRC is a neutral, trusted advisor that serves a vast network of engineers and researchers. All are dedicated to research, prototyping, and workforce training programs in advanced semiconductor technologies.

Workforce Development – SRC’s WFD Blog & MAPT Ch. 11

What is a Semiconductor Degree?



SRC Workforce Development Blog

See <https://www.src.org/newsroom/article/2023/1039/>

What Knowledge-Skills-Abilities (KSAs) are Required?



MAPT Workforce Development

See <https://srcmapt.org/chapter11/> and supplementary information

Need a ~3x↑ commitment to ECE and ~6x↑ Materials (MatSci, Chem) & Mech Eng.



**BUSINESS
FINLAND**

On the Availability of Skilled Labor Force to Support the Expected Market Growth

2024 ECTC President's Panel

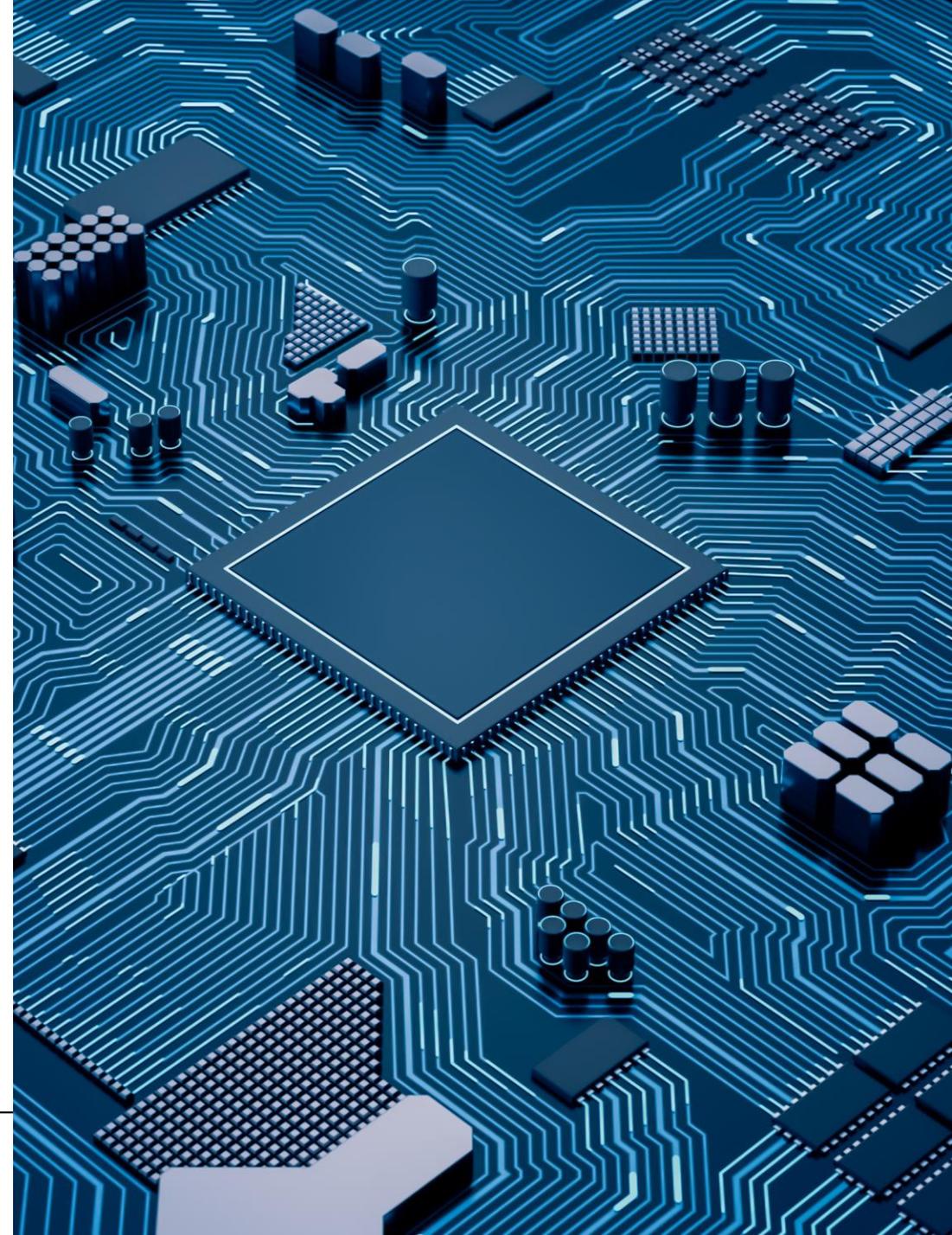
16.5.2024

Toni Mattila

Head of Microelectronics, Photonics and Quantum (HW Tech) – "The CHIPS Campaign"

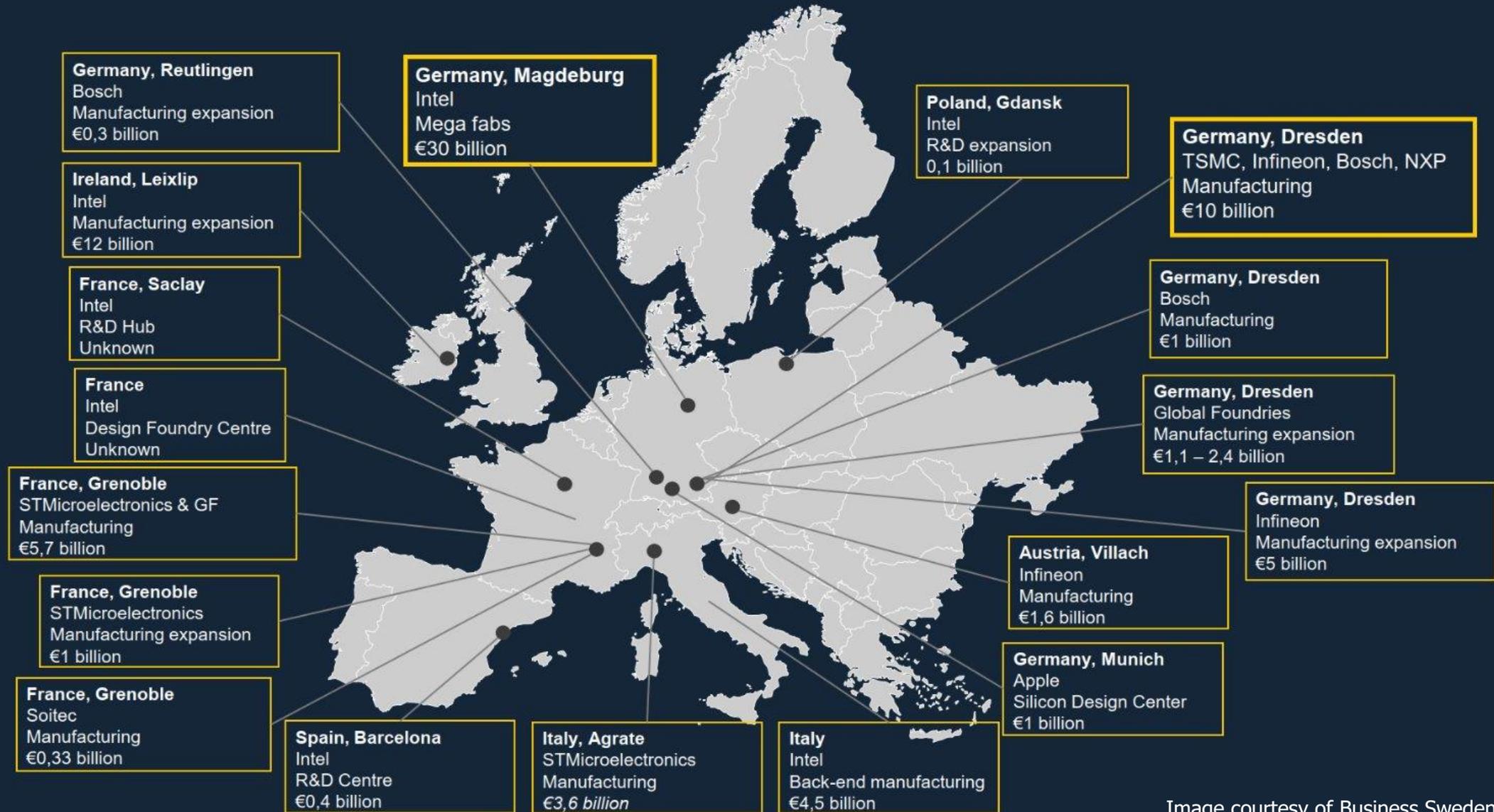
Market Development

- Digitalization of societies is dependent on the **physical technologies**
 - The global semiconductor market is expected to break US\$ 1 trillion by 2030
 - Market share of Europe today is about 10 %
 - The EU Chips Act aims to raise it to 20 %
- Since the announcement of the Chips Act in 2022, European Union has attracted new investments worth over € 90 billion
 - 20+ new large (billion €) sites + countless smaller ones
 - **Workforce and education** the most critical enablers of industry growth



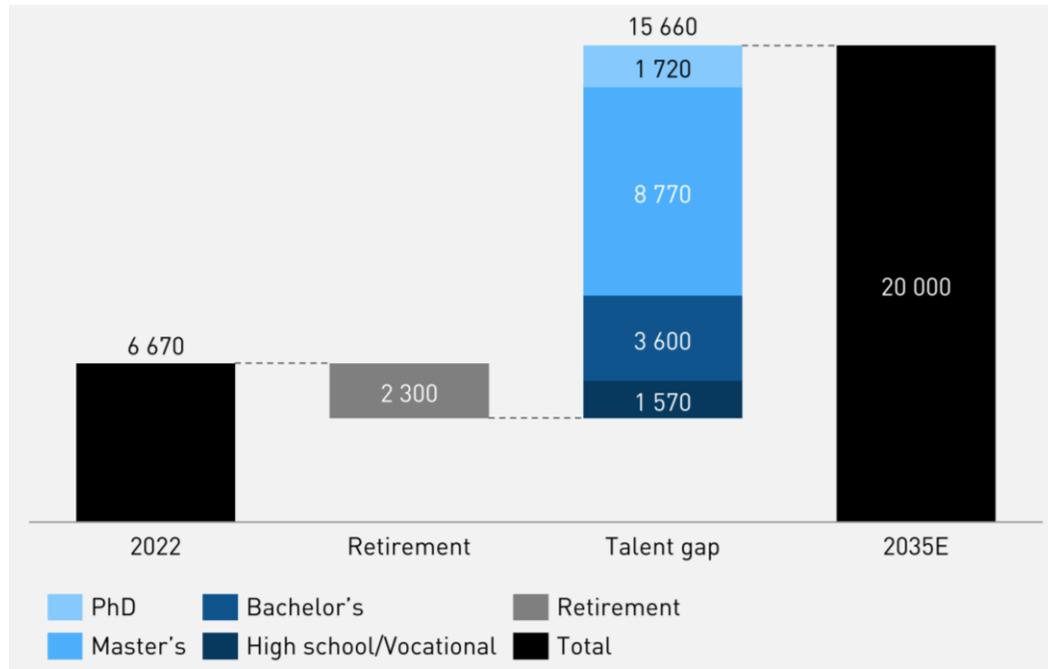


The European Union has attracted investments of over €90 billion in the semiconductor industry since the announcement of the chips act in February 2022.



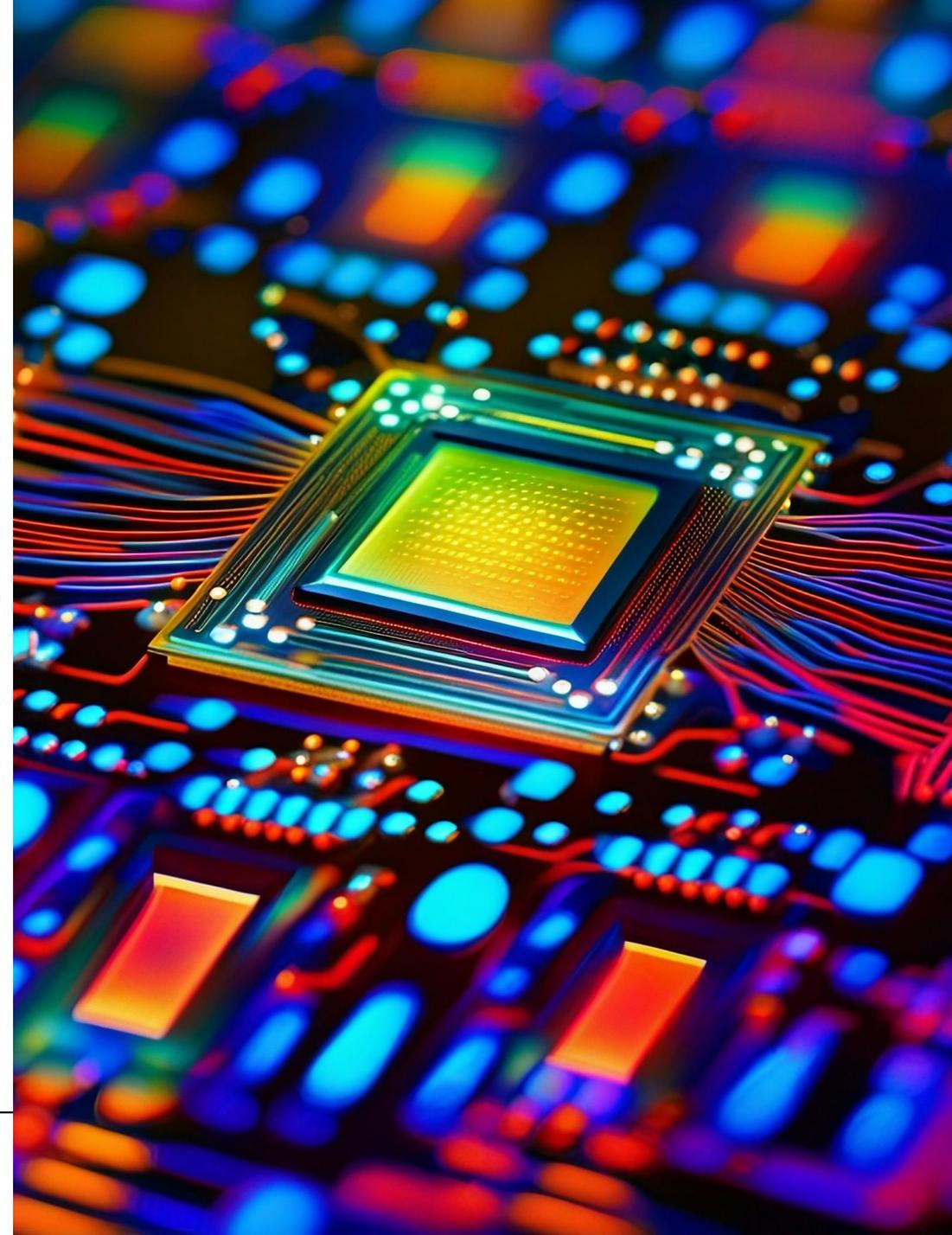
Opportunity for Finland?

- Industry is expected to grow significantly in Finland*
 - € 2 billion in 2023 to **€ 6 billion** in 2035
 - 6 000 employees in 2023 to **20 000** in 2035



Ways to Tackle the Skills Challenge

- Significant investments into education at all levels
 - Both university & vocational (increased intake)
 - Degree programs co-created with academia and industry
 - Extracurricular activities supported by companies
 - Attraction of university professors with research funding mechanisms
 - Transfer/updating education, on-the-job learning (esp. PPPs)
 - International collaboration in education
- Occupational immigration
 - Country image & concrete incentives
- Active promotion of the industry towards young students to raise the image of semiconductor industry
 - Practical work-related engagements during studies
- Industry-academia networks
 - Scholarships, internships
 - Increased levels of collaborative R&D



**BUSINESS
FINLAND**

THANK YOU FOR YOUR ATTENTION



Toni Mattila, Ph.D. (Tech), Adj. Prof.

Head of Microelectronics, Photonics and Quantum (HW Tech) – *"The CHIPS Campaign"*

Business Finland

Toni.Mattila@businessfinland.fi

May 2024

NY CREATES: Supporting the Talent Pipeline for Microelectronics

Robert Geer
VP for Education and Workforce Development

 **NYCREATES**
CENTER FOR RESEARCH,
ECONOMIC ADVANCEMENT, TECHNOLOGY
ENGINEERING AND SCIENCE



Advancing Semiconductor Workforce Development

NY CREATES expands the talent pipeline for next-generation semiconductor manufacturing and advanced packaging



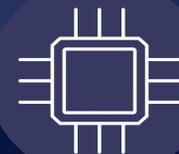
Regional Consortia for Education Innovation



**Military Veterans and Semiconductor Careers:
The VET S.T.E.P. Program**



**Apprenticeships, Co-ops & Internships at
NY CREATES Facilities**



**Direct Training for
NY CREATES
Industry Partners**





NY Semiconductor Cluster

Universities, Colleges, & WFD Infrastructure

Each Year in New York:

- 43,000 STEM—related college graduates



NY CREATES Workforce Development: Connecting US Military Veterans to the Semiconductor Industry



NY CREATES VET S.T.E.P. Program



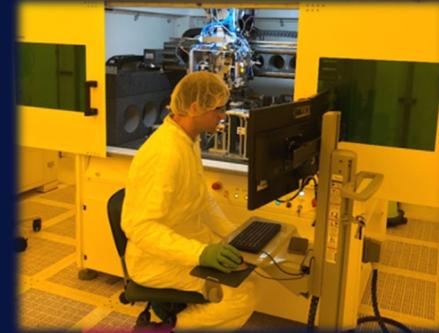
- Hands-on Training at NY CREATES
- Internships at Industry Partners
- Transition to employment
- 90% hiring rate for vets completing program

Tapping into
160,000
Vets
entering U.S.
workforce
each year



NY CREATES Workforce Development: 'Learn and Earn': Learning by Doing at NY CREATES

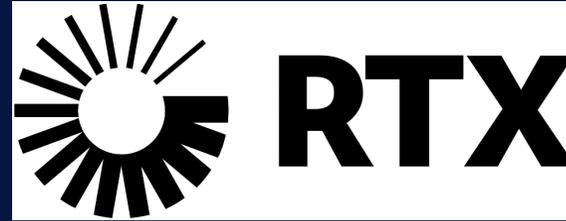
- Albany Nanotech Complex and TAP Packaging Facility
 - Job shadowing
 - Internships
 - Co-operative education
- Registered Apprenticeship
 - First cohort summer 2024
 - 16-month apprenticeships for process operators and technicians
 - Partnership with U.S. Department of Labor, SUNY, and NIIT



NY CREATES Workforce Development: Direct Training for NY CREATES Industry Partners

Customized Training Program Delivery for Fab Technicians and Service Engineers

- Direct training programs for key partners
 - GlobalFoundries – 800+ techs trained
 - TEL – 100+ engineers trained
 - RTX (Raytheon) – New training partner
- Training Development Partnerships
 - Wolfspeed Technician Training Program (SiC)
 - NXP Technician Training Program (Si)



“The common theme was that it was by far the most useful training we’ve provided our engineers.” Raytheon/RTX



Semiconductor Workforce Impacts: 2023 Outcomes

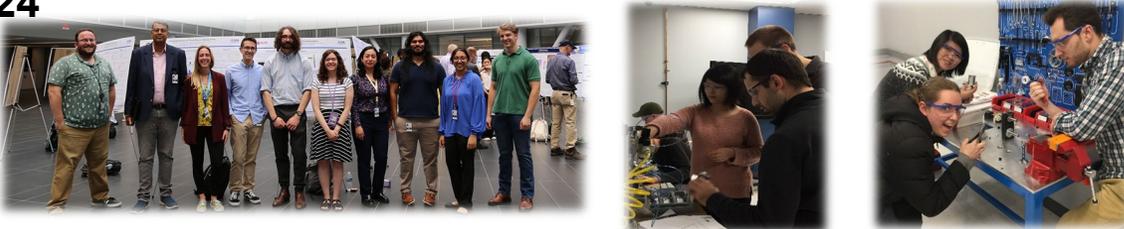


Awareness, Engagement & Training for Semiconductor Careers

More than **1,200 K-12 students and teachers** attended NY CREATES Educational Outreach Programs in 2023/2024



More than **600 college/university students and professionals** participated in NY CREATES Educational Development in 2023/2024



More than **850 participants** in NY CREATES Military/Veterans Workforce Outreach Programs in 2023/2024



NY CREATES provided more than **12,000 hours of hands-on semiconductor training** at our facilities in Albany and Rochester



Workforce Needs Critical and Broad

Jim Wieser

Director – University Research and Technology

CTO Office – Texas Instruments

MAPT Ch. 11: Workforce Development – Critical Enabler

Call to Action: Time is Now for Industry, Academia and Government to Act

Needs and Key Findings

- 114,800 Additional Semi Jobs by 2030 vs 19K in pipeline
- Mix – multiple disciplines and multi-discipline, engineers, technicians
 - 60-70% are technicians

Challenges

- Interest / Motivation – students
- Time Lag - pipeline
- Financial cost
- **Scale – people and programs**
- **Ownership?**

Approach – 3 pronged

Model

- What = KSA
- When = timing
- Where = locality
- **The Matrix**

	Device & Circuit Concepts	System Design & Simulation Tools	Experimentation & Data Analysis	Modeling & Simulation	AI & ML
Device, Circuit, Systems - Design, Architecture & Test	🔴	👉	👉	👉	👉
Product Management & Strategy Development			👉		
Equipment Design, Install & Maintenance					
Logistics & Operations				👉	👉
Organization Support					
Process Engineering & Metrology			👉	👉	
Business & Fab Support				👉	👉

Engagement

- Hands On Experience
- Access
- Training/Mentors
- Incentives
 - Financial
 - Social
 - Emotional
 - Reward/Challenge
- Leverage Best Programs
 - Drive to scale
- Global Platform
- **Industry is Key**

“Hearts & Minds”

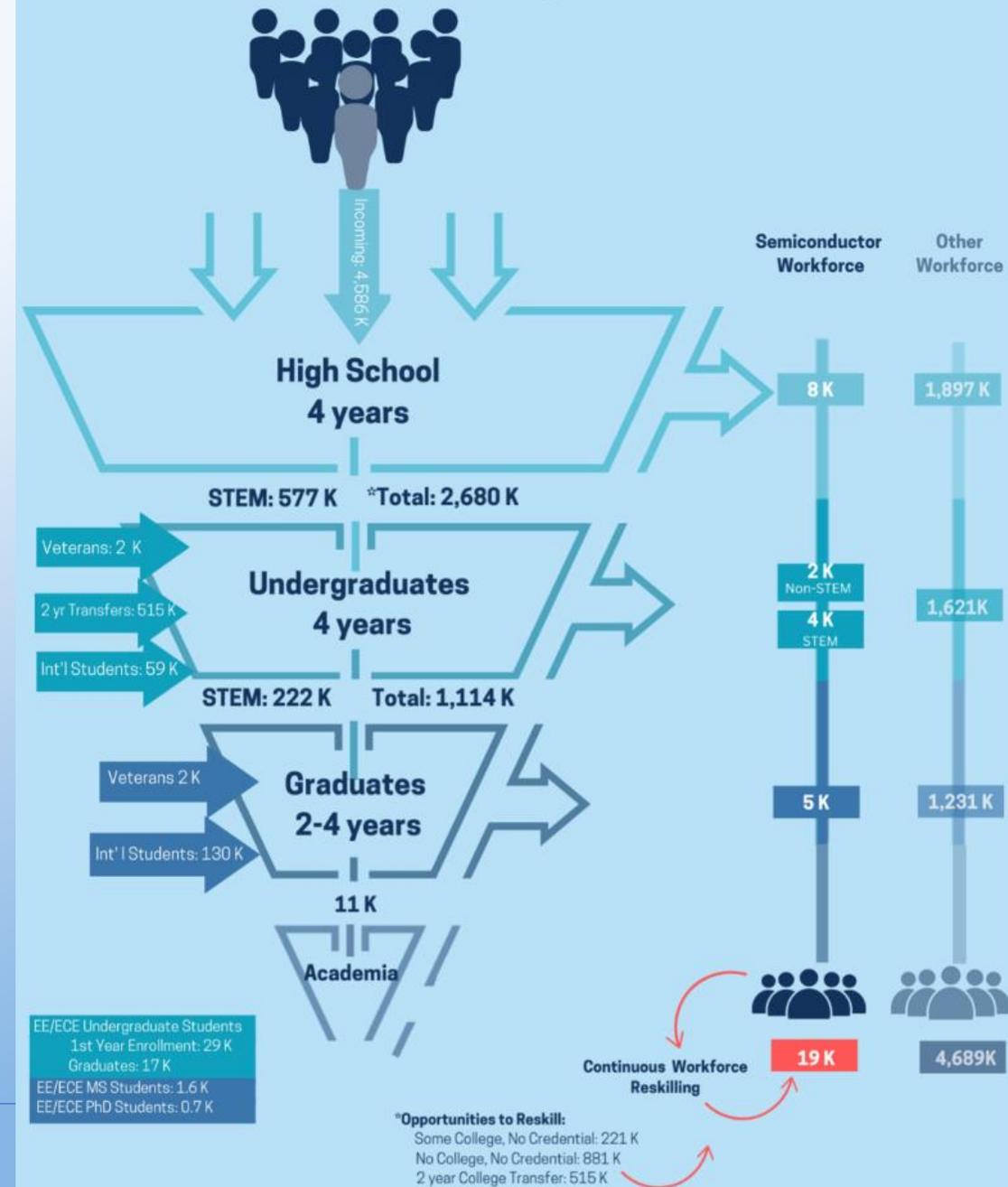
- Motivation
 - “Change the World”
- Awareness K-12
- Education ecosystem engagement
- Full stack engaged
 - Teachers
 - Counselors
 - Family
 - Friends
 - Industry

WFD = Talent Factory + Talent Marketplace

Talent Challenges

- Awareness is Key – lack of knowledge
 - What IS a semiconductor?
 - Value of semiconductors?
 - Careers in Semiconductors
 - Societal Impact
- Early Influences – starts in middle school
 - Environment
 - Friends
 - Teachers
 - Parents
 - Perception
- Pipeline is Long – HS – Graduate Level = 12 years
 - Leaky – many move to other interests/careers
- Wide Breadth of Needs
 - Technicians/Operators – 60-70% of workforce need
 - Most not need college degree
 - 30% Degreed – BS, MS, PhD
 - Multiple Skills needed
 - Electrical, Mechanical, Chemical, Physics, Materials, Industrial

Semiconductor Industry Talent Flow (2021)



KSA Model

<https://srcmapt.org/chapter-11-supplementary-materials-ksa-matrix/>

	Device & Circuit Concepts	System Design & Simulation Tools	Experimentation & Data Analysis	Modeling & Simulation
Device, Circuit, Systems - Design, Architecture & Test		↗	↗	↗
Product Management & Strategy Development			↗	
Equipment Design, Install & Maintenance				
Logistics & Operations				↗
Organization Support				
Process Engineering & Metrology			↗	↗
Business & Fab Support				↗

- **Job Functions**
 - Many
 - Multi-disciplines
 - Ranges of expertise
- **Skills**
 - Foundational
 - Technical
 - “Soft Skills”
 - Level of Expertise
- **Dynamic**
 - WILL change over time

		SKILLS →																				
		Device Operations & Characteristics	Logic Circuit	Analog Circuit	Mixed Signal Circuit	RF Circuits	SoC, ASIC, FPGA, SIP, SSD	HDL/HVL, Circuit Simulators	Programming Lang & Applied Math	Board Design & Layout	Board Design and Layout	Electrical, Optical, Thermal and Mechanical	FEM & CFD	Data Analysis	Statistics	DOE	Neural Networks/Deep learning	Programming Languages	FMEA	Quality & Reliability	Physical & Electrical Failure Analysis	Prog languages (Python, Java, C++, C#, Ruby)
		Device & Circuit Concepts	System Design, Verification, Validation & Simulation Tools					Modeling and Simulation	Experimentation	AI/ML Concepts	Failure Analysis	Software Development										
↑ ONS	Process and Product Architect	Desired	Desired					Desired	Desired	Not Required	Not Required	Desired										
	Roadmap Development Manager	Desired	Desired					Desired	Desired	Not Required	Not Required	Not Required										
	Digital Design & Architecture Engineer	Critical	Critical					Desired	Critical	Desired	Desired	Desired	Desired	Desired								
	Analog / Circuit Design Engineer	Critical	Critical					Desired	Critical	Desired	Desired	Desired	Desired	Desired								
	RF Design Engineer	Critical	Critical					Desired	Critical	Desired	Desired	Desired	Desired	Desired								
	Test Engineers	Critical	Desired					Desired	Desired	Desired	Desired	Desired	Desired	Desired								
	Product Engineer	Critical	Critical					Desired	Desired	Not Required	Desired	Desired	Desired	Desired								
	Application Engineers	Desired	Critical					Desired	Desired	Not Required	Desired	Desired	Desired	Desired								
	Layout/CAD Engineer	Desired	Desired					Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required								
	Systems Engineer	Critical	Critical					Desired	Desired	Not Required	Not Required	Not Required	Not Required	Desired								
	Firmware Engineer	Desired	Desired					Not Required	Desired	Not Required	Not Required	Not Required	Not Required	Desired								
	Process Integrators (Team Lead)	Desired	Not Required					Not Required	Desired	Not Required	Desired	Not Required	Desired	Not Required								
	Quality, Yield and Reliability Engineers	Not Required	Desired					Not Required	Critical	Not Required	Critical	Not Required	Not Required	Not Required								
	Program Managers	Not Required	Not Required					Not Required	Desired	Not Required	Not Required	Not Required	Not Required	Not Required								
	Data Scientist	Not Required	Not Required					Desired	Desired	Critical	Not Required	Not Required	Critical	Critical								
Operations/Productivity Engineers	Not Required	Not Required					Not Required	Desired	Not Required	Not Required	Not Required	Not Required	Not Required									
Software Engineer/Developer	Not Required	Not Required					Not Required	Desired	Not Required	Not Required	Not Required	Critical	Critical									

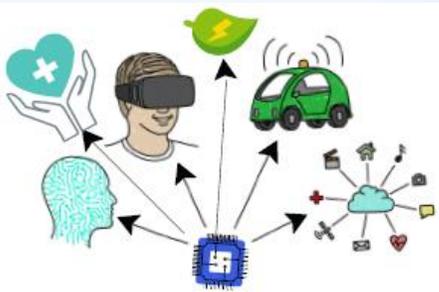
Global Platform



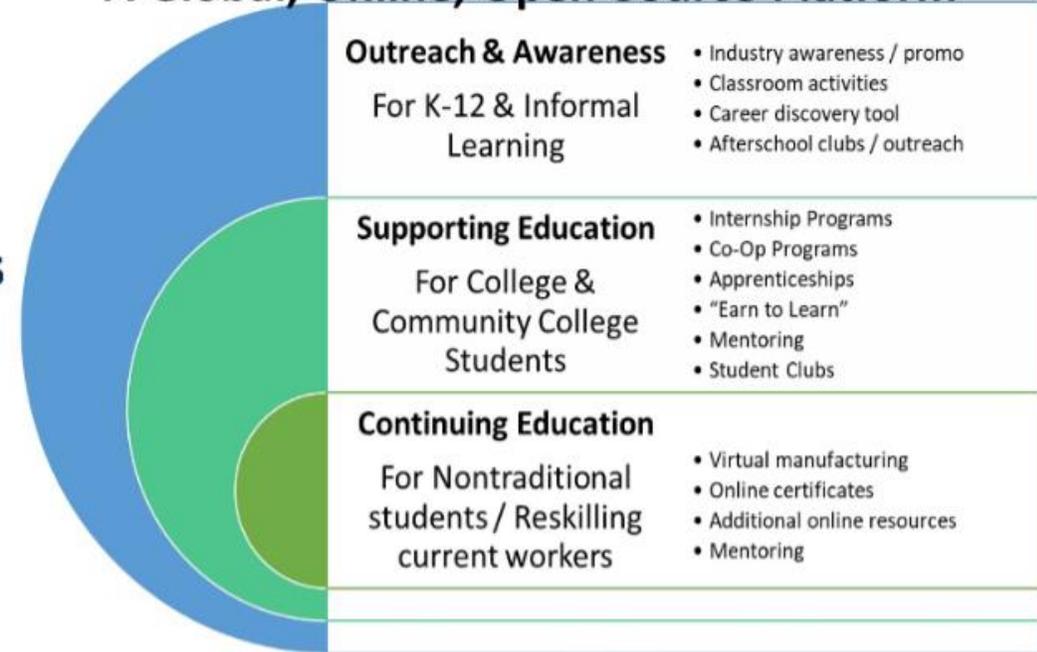
Work Nationally Grow Locally

National Community for Winning Hearts and Minds

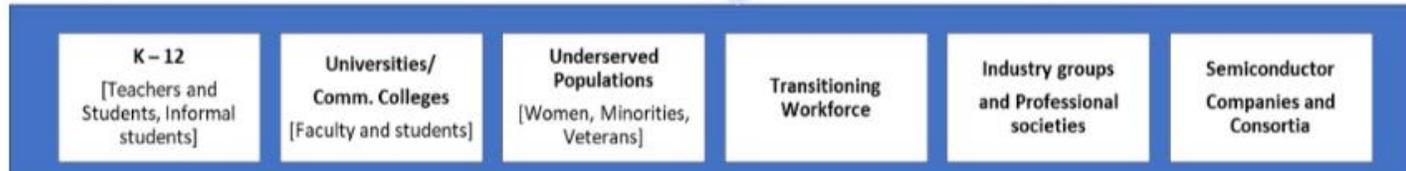
- AWARENESS
- UNDERSTANDING
- RELEVANCE
- Wrap-around Services
- Needs Substantial RESOURCES BEYOND CHIPS Act Funding
- Unique Role of Manufacturing Institutes



A Global, Online, Open-Source Platform*



Users & Developers of Content
 Resourced and curated through public/private partnerships



Chapter 11 – Workforce Development – Key Insights

Call to Action: Industry, Govt, Academia - Act Now!

- **NEEDS**

- Sheer number of workforce for microelectronics:
 - 114,800 by 2030 projected need and only 19K/yr in pipeline
 - CHIPS Act to add 89,250 direct and 176,000 supply chain jobs
 - More people/students at ALL levels of pipeline - K - Career
- Diversity in disciplines, skills and people is needed and growing
- 60-70% of employees needed are non-degreed – technician and in short supply today

- **CHALLENGES**

- Pipeline is long and “leaky” – latency to output people and not sufficient to meet needs
 - 4-8 yrs for degrees alone
 - 10 yrs or more
- Scale – how to reach more “potential” workforce – “missing millions” and diversity
 - Motivation for students and their “ecosystem” of family, friends, teachers
- Scale – existing programs small and difficult to scale
- Who will own the national WFD effort? Govt? Industry? Academia?
 - All are important contributors though coordination and leadership is needed

- **APPROACH**

- **Model with KSA** and emphasis on critical thinking/team work/potential
 - Model will change over time and what, where, when workforce category is needed
 - Model is complex with jobs vs KSAs though there are common KSAs to highlight for most impact
- **Engagement** has many potential models and some good in practice today – **Need to Leverage and Scale**
- **Hearts and Minds** are set at a very early age (middle school in many cases)
 - Need holistic plan to address K – Career awareness, motivation and “Change the World” excitement

THANK YOU!
