R&D Workforce Working Group Update and Recommendations

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Acknowledgements

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Updated Charge to Working Group

Continue to make recommendations on how the R&D programs can best be leveraged to meet the workforce needs of the microelectronics industry for both R&D and manufacturing.

Areas to explore include:

- Coordinating discussions with the other IAC working groups regarding the governance and role of R&D programs for workforce development, including connection strategies with companies receiving CHIPS incentives awards
- Proposing the mission and structure for an NSTC-led 'center of excellence' for expanding the semiconductor workforce
- Considering how R&D programs can raise awareness and attract K-12 students
- Considering making recommendations for funding WFD infrastructure to support the scaling up of proven-effective programs and replication of successful models.
- Identifying packaging specific workforce needs required to achieve NAPMP goals

Vision and Strategy for NSTC: Workforce Programs

"The NSTC is envisioned to serve as a coordinating body and center of excellence to help scale the technical workforce…"

1. **Collaborate** to identify and scale gold-standard models and programs;
2. **Collect and disseminate** a wide range of information;
3. **Advance opportunities** for career exploration;
4. **Serve as a collaborative space** (convening, aligning resources, providing support) to solve industry workforce challenges.

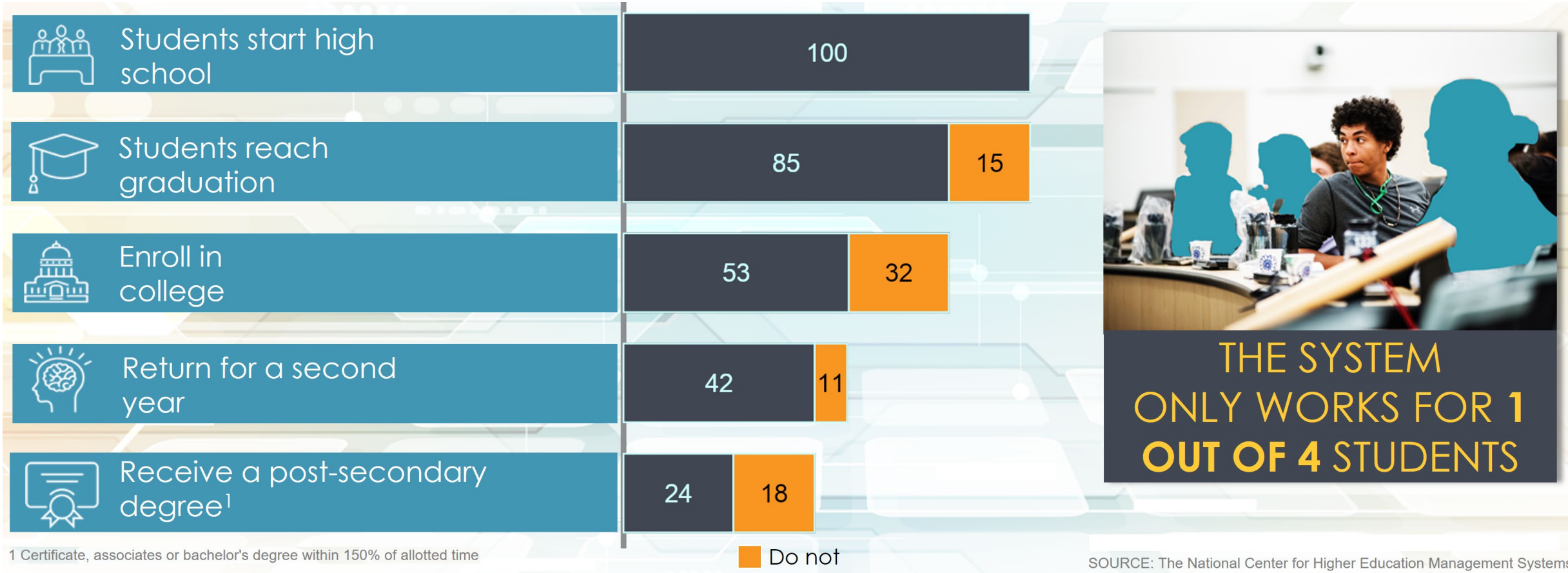
Invited Speakers

Date	Name	Organization	Topic
10-Feb	Oliver Brand et al.	Georgia Tech	National Nanotechnology Coordinated Infrastructure
24-Feb	Barry Johnson	NSF TIP Directorate	NSF & Semiconductor workforce development
24-Feb	Dave Hernandez	IPC Systems, Inc.	IPC electronics workforce training and credentialing
3-Mar	Om Nalamasu	Applied Materials	Semiconductor industry talent shortage projection
10-Mar	Jared Ashcroft	Pasadena City College	Micro Nano Technology Education Center
10-Mar	Leah Palmer	Maricopa Community Colleges	Arizona Advanced Manufacturing Institute strategic partnership model
20-Mar	Ken Gracey	Parallax Inc.	Free curriculum; STEM educator training and electronic hardware kits
20-Mar	Carol Handwerker	Purdue University	SRC Manufacturing and Advanced Packaging Technologies roadmap
27-Mar	Frank Gayle et al.	NIST Office of Advanced Manufacturing	Concepts for M-USA institute on digital twins
3-Apr	Victor Veliadis	North Carolina State University	PowerAmerica consortium
17-Apr	Michelle Maddalla	Washington-Saratoga-Warren-Hamilton-Essex Board of Cooperative Educational Services	Southern Adirondack Pathways in Technology Early College High School (P-TECH) program
17-Apr	Christina Warner	Oneida-Herkimer-Madison Board of Cooperative Educational Services	P-TECH OHM program
24-Apr	Sarah Oldmixon et al.	Partnership to Advance Youth Apprenticeship	Youth apprenticeship partnerships, design principles
1-May	Paul Funk et al.	U.S. Army (retired)	Veteran talent pool; transition programs
15-May	Noel Ginsburg et al.	CareerWise USA	Registered apprenticeships
22-May	Gerhard Klimeck	Purdue University	nanoHUB online resource for immersive learning
30-May	Jyoti Malhotra et al.	Manufacturing Extension Partnership National Network	MEPNN workforce strategies

Outline

- Findings
- Recommendations
- Additional thoughts

A Leaky Pipeline for Talent in the U.S.



1 Certificate, associates or bachelor's degree within 150% of allotted time

THE SYSTEM ONLY WORKS FOR **1 OUT OF 4** STUDENTS

SOURCE: The National Center for Higher Education Management Systems and U.S. Department of Education's National Center for Education Statistics

CareerWise

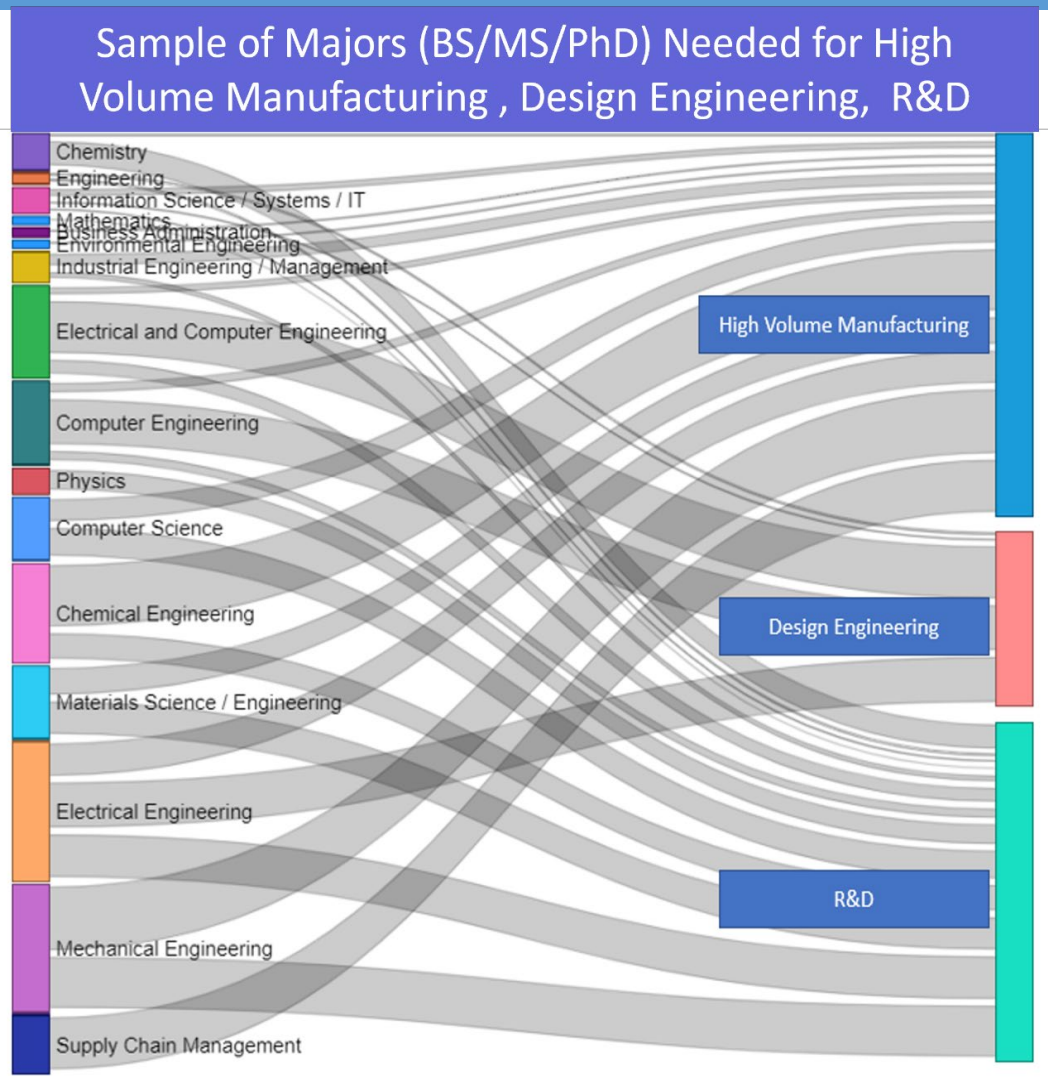
Inspiring and Preparing Future Workers

- **Engaging K-14 students is vital for introducing young minds to the thrill of jobs and careers in engineering and manufacturing.**

  Examples:

  - Hands-on building and coding of robotics, *e.g.* learn.parallax.com
  - Registered apprenticeship programs, *e.g*. facilitated by CareerWise USA
  - Virtual reality (VR) for recruitment, *e.g*. Maricopa CCs Career Exploration tool
  - Competitions exercising hardware and software skills that are important to the semiconductor industry

Coordinating and Scaling WFD Programs



SRC Roadmap for Microelectronics and Advanced Packaging Technologies (MAPT)

- **Required knowledge, skills and abilities (KSAs) for each role** in chip manufacturing, design engineering, and R&D **need to be articulated**, for a diversity of curricular pathways to those jobs to be defined.

  Example: The NIST National Initiative for Cybersecurity Education (NICE) Framework maps KSAs to work roles.

Various organizations already have started to develop KSA frameworks.

Developing the U.S. Packaging Workforce

- To achieve the goals of the National Advanced Packaging Manufacturing Program (NAPMP), an industry-connected microelectronics packaging curriculum needs to be defined and ported to universities and colleges nationwide.
- Professional societies such as the Institute for Electrical and Electronics Engineers (IEEE) and International Microelectronics Assembly and Packaging Society (IMAPS), and trade associations such as IPC International, have developed effective short courses and training programs in chip assembly, test and packaging.

Retaining Talent

- The most important factor in a student's decision to leave engineering has been found to be the lack of a sense of belonging.
- A study of a diverse cohort of high-achieving, low-income STEM undergraduate students revealed that STEM faculty **mentoring, early-immersion pre-research experience, and community building activities were the most helpful wraparound services for academic socialization and success**.
  - Participants expressed a desire to meet with STEM professionals not only in academia but also from the industry to discuss and learn more about different experiences and opportunities.
  - A lack of female mentors and role models can negatively influence female engineering students.

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Recommendation #5: National WFD Framework

Charge a National Task Force to develop a KSA-to-Education-to-Jobs framework *within the next year*, bringing together educational institutions, companies, trade associations, consortia, and other partners to pave a diversity of educational pathways to careers in microelectronics.

- This will maximize the impact of CHIPS program funding for WFD, by guiding the development of industry-connected microelectronics and advanced packaging curricula and experiential learning programs.

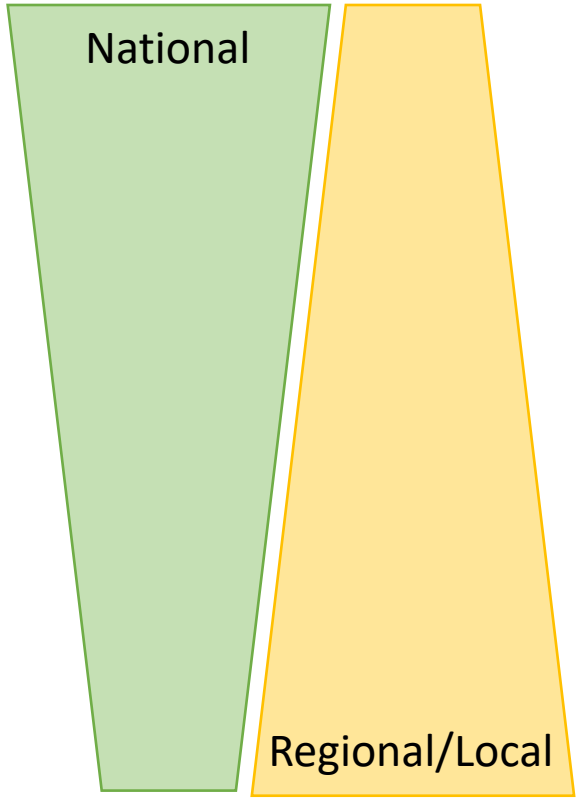
Nationwide Coordination of WFD Programs

Workforce Development Levels

- Industry
- Graduate
- Undergraduate
- Community Colleges
- K-12

Coordination Focus by WFD Levels

MEP National Network



Lorain County CC; Maricopa CCs

Stakeholders:
educational institutions, companies, industry trade associations, consortia, non-profits, government entities, and others

Coordination at National Level

- Awareness & Outreach
- Common 'level-appropriate' curricula
- Alignment on KSAs and Metrics/KPIs
- WFD program mapping, tracking and gap analysis
- Large infrastructure investments with NSTC
- Internship (Univ), Apprenticeship (CC) frameworks

Coordination at Regional/Local Level

- Regional/local funding, State policies & standards
- Access to local facilities and faculty
- Programs tailored to demographics, *e.g.* URM/MSI
- Community college and K-12 networks
- Workforce development agencies

Recommendation #6a: NAPMP Curriculum

Develop an industry-connected advanced packaging curriculum and education infrastructure for the U.S., spanning all levels of higher education.

- Content should include experiential, project- and lab-based learning.

- Training of faculty to deliver this curriculum is needed.
- Facilities and institutions funded by NAPMP should be encouraged to support experiential learning for effective WFD, *e.g.*, by offering apprenticeships and internships.

Recommendation #6b: NAPMP Curriculum

Incentivize trade associations and professional societies to make their education and training programs more relevant and accessible nationwide for example, by:

- Developing programs explicitly for retraining and upskilling workers, including those already in the industry, veterans, and others;
- Teaching packaging concepts currently not practiced in the U.S. (*e.g.*, back-grind and saw, chip attach, underfill and mold, test and inspection, tape and reel plus metrology);
- Making advanced packaging courses and content available to educational institutions, to enrich industry connection.

Recommendation #7a: Awareness & Outreach

Launch a full-scale national campaign to increase awareness and excitement about microelectronics, with an inspiring tagline.

- Multiple modes of marketing should be used to reach K-14 students and teachers.
- The campaign should be linked to opportunities to learn more about careers in microelectronics and advanced packaging.

Recommendation #7b: Awareness & Outreach

Fund CHIPS R&D programs to expand experiential learning opportunities for students.

- Industry partners should be encouraged to engage with Registered Apprenticeship (RA) programs and/or programs like P-TECH.
- Industry partners should be encouraged to offer paid internships to engineering students at the community-college, undergraduate and/or graduate levels

Recommendation #8: Talent Retention

Require CHIPS R&D program workforce development activities to include effective mentorship, and other wrap-around services as appropriate

- Technical mentors should have completed training in best practices
- Staff advisers should have access to resources to help reduce barriers

to motivate and support a greater number and diversity of students to pursue STEM education and develop professional skills for success in microelectronics and advanced packaging careers.

Exemplary Models for Mentorship Programs
Scalable Asymmetric Lifecycle Engagement (SCALE) Community of Practice
Big Brother/Big Sister and AmeriCorp Seniors RSVP programs

Recommendation #9: Metrics for WFD programs

Hold recipients of CHIPS R&D program funding accountable for WFD effectiveness and efficiency, gauged by metrics tied to key performance indicators (KPIs) in the following categories:

Awareness: number of students exposed to the field of semiconductors

Accessibility: number of experiential learning experiences offered

Training: number of mentorships of students - and employees

Results: Increase in enrollments and graduates of STEM programs; increase in number of students hired and diversity of talent hired into the industry

Exemplary Model: SCALE program outcome evaluations and process assessments

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Filling the Talent Pipeline

- To excite students, K-12 teachers must be trained with content that is stand-alone and easy to implement, as well as accessible online to reach further into rural and underserved communities.
  - Teacher training programs like those offered by Parallax should be expanded.
- Students from underserved communities and veterans need to be incentivized, *e.g*. via earn & learn programs, and remote learning and virtual reality training opportunities.
  - Remote education & training materials created during and after the COVID-19 pandemic should be leveraged.
  - nanoHUB is an online resource for remote, interactive learning

Summary of Additional Recommendations

5. Charge a National Task Force to develop a KSA-to-Education-to-Jobs framework within the next year.

6. Develop an industry-connected advanced packaging curriculum and education infrastructure for the U.S., spanning all levels of higher education, and incentivize trade associations and professional societies to make their education and training programs more relevant and accessible nationwide.

7. Launch a full-scale national campaign to increase awareness and excitement about microelectronics, with an inspiring tagline, and fund CHIPS R&D programs to expand experiential learning opportunities for students.

8. Require CHIPS R&D program workforce development activities to include effective mentorship, and other wrap-around services as appropriate.

9. Hold recipients of CHIPS R&D program funding accountable for WFD effectiveness and efficiency, gauged by metrics tied to key performance indicators (KPIs) in the following categories: Awareness, Accessibility, Training, Results.