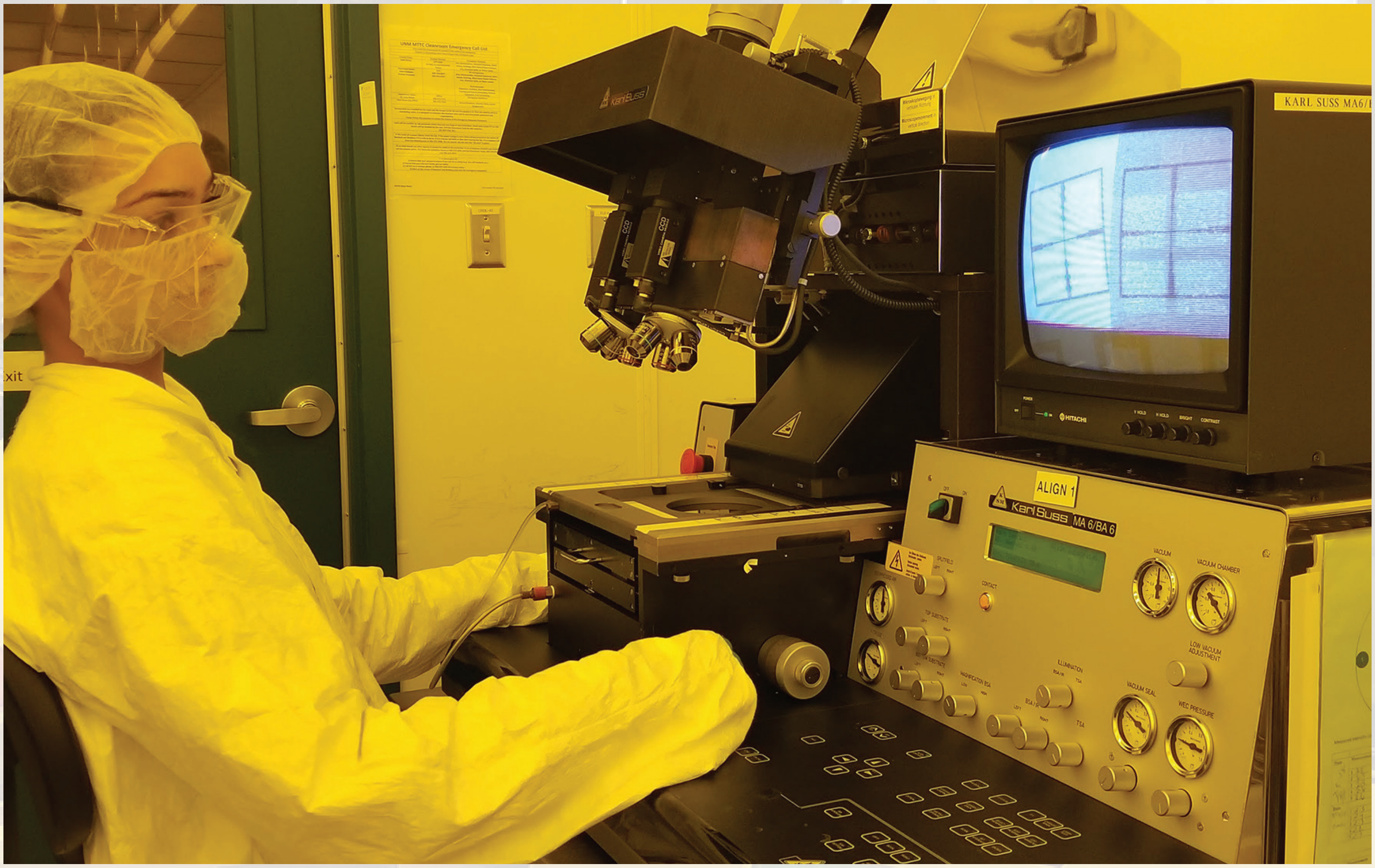
Microsystems Process Technician



Knowledge, Skills & Abilities

By Micro Nano Technology Education Center in partnership with SEMI Foundation and National Institute for Innovation and Technology

MNT-EC Micro Nano Technology Education Center

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Acknowledgement & Disclaimer

The team at the Micro Nano Technology Education Center (MNT-EC) appreciates the support of the National Science Foundation's Advanced Technological Education (ATE) program and its funding of other ATE projects and centers. Those initiatives have informed our ongoing efforts to develop a highly skilled technical workforce.

Any opinions, findings, conclusions or recommendations expressed in this publication are those of the principal investigator, co-principal investigators, MNT-EC staff, MNT-EC's education and industry partners, and MNT-EC's Business and Industry Leadership Team members. They do not necessarily reflect the views of the National Science Foundation.

Photo Sources

Many of the photos in this publication (cover, pages 3, 4, 5, 6, 8, 11) were taken in the University of New Mexico's Manufacturing Training and Technology Center (MTTC) cleanroom, which the Support Center for Microsystems Education (SCME) utilizes for weeklong experiences for community college faculty and students. Photos were provided by the High Impact Technology Exchange Conference (page 2), Northwest Vista Community College (page 9), Ivy Tech Community College (pages 3, 4, 5, 7, 8), SCME (pages 6, 11), Center for Laser and Fiber Optics Education (LASER-TEC) at Indian River State College (page 10), the Nanotechnology Applications and Career Knowledge Support Center (NACK) at Penn State University (page 12).

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MNT-EC
Micro Nano Technology
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Pasadena City College

Industry Professionals Influence *Microsystems Process Technician Knowledge, Skills & Abilities (KSA)*

This KSA publication is the result of a collaborative effort between MNT-EC and its partners from education and industry. The MNT-EC Team is grateful for the foundational work of the Maricopa Advanced Technology Education Center (MATEC) in the early 2000s to identify the knowledge, skills, and abilities of technicians in automated work environments. We would particularly like to recognize the leadership of Michael Lesiecki, MATEC's executive director, and the contributions of MATEC's industry partners.

MNT-EC appreciates the time and expertise of its Industry Team members, who helped draft the KSAs, and the members of MNT-EC's Business Industry Leadership Team (BILT), who contributed their insights about the KSAs during virtual, modified focus groups.

The following Industry Team members worked with MNT-EC staff on this project: Kate W. Alcott, Demis John, Jim Marti, Eldon McMurray, Matthias Pleil, and John Wood.

The following BILT members participated in the KSA discussions and voting: Chris Buser; Todd Christenson, Amish Desai, David DiPaola, Robert Giasolli, LaMar Hill, Mark Hofheins, Randy Hsing, John Hubacz, Len McNally, Frank Silva, Aric Shorey, Todd Smith, Robert Weinman, Adrienne Williams, Mark Wilson, and Lei Yin.

About SEMI Foundation

SEMI Foundation is the workforce development arm of SEMI, the global industry association representing the entire electronics manufacturing and design supply chain. SEMI connects more than 2,600 member companies worldwide to address common industry challenges together. The SEMI Foundation supports companies and partners in developing holistic workforce development strategies and programs with a focus on diversifying the talent pipeline.

About National Institute for Innovation and Technology (NIIT)

The National Institute for Innovation and Technology (NIIT) leads the deployment of a national strategy to broaden and build the talent pipeline for the semiconductor industry and strategic industry sectors. Its National Talent Pipeline Development Initiative aligns with education programs at all levels, offers infrastructure to attract broad populations, and improves connections to career and technical education.

What is MNT-EC?

The Micro Nano Technology Education Center (MNT-EC) was founded on the idea that collaborations between educators and employers will enhance education and prepare higher quality technicians for the micro nano technology (MNT) industry. With the support it receives from the National Science Foundation's Advanced Technological Education (ATE) program, MNT-EC aims to grow the MNT workforce by fostering academic and industry partnerships between MNT educators and industry partners.

MNT-EC Principal Investigator Jared Ashcroft (left) congratulates Todd Christenson (center) on receiving the Industry Partner of the Year Award at the 2022 HI-TEC Conference. Matthias Pleil, principal investigator of the Support Center for Microsystems Education (SCME) and MNT-EC partner, is on the right. Christenson, who serves as the industry lead on MNT-EC's BILT, helps MNT-EC partners and community college students by sharing his insights into industry trends and offering tours of HT MicroAnalytical, Inc., which he co-founded. Christenson is also president of MANCEF, a not-for-profit foundation that focuses on emerging micro and nano technologies.

MNT-EC is working on the following objectives:

1. Developing a coordinated national approach to advance MNT education.
2. Delivering professional development to enhance knowledge, skills, and abilities.
3. Conducting strategic outreach, recruitment, and retention of traditional and underrepresented faculty/students.
4. Creating a deep industry-education alliance that supports student success. [1]

What is a BILT?

The Business and Industry Leadership Team (BILT) model is based on work developed by the Convergence Technology Center of Excellence, an ATE Center at Collin College. A BILT consists of executives and technicians from large corporations, small companies, and government laboratories who keep community college educators informed about the current state of industry, workforce trends, and employer needs. The MNT-EC BILT meets quarterly to discuss these topics as well as to evaluate the knowledge, skills, and abilities (KSAs) that graduates will need to be employable one-to-three years in the future. The BILT allows industry representatives to shape the future of MNT technical education and secure access to the pipeline of highly skilled technicians from community colleges across the country. In addition the BILT connects industry directly with educators who are working in MNT technician education. [2] [3]

What are KSAs?

Knowledge, skills, and abilities (KSAs) are the attributes required to perform a job.

Knowledge is a body of information applied directly to the performance of a function: How well does a student understand a concept theoretically?

Skills are observable competencies needed to perform learned psychomotor acts: How well can a student execute a specific activity?

Abilities are competencies to perform an observable behavior or behaviors that results in an observable product: Does the student meet expectations outside of strictly technical expertise? [4]

MNT-EC BILT Industry Lead Cait Cramer (left foreground) led a group of Ivy Tech engineering technology students during a week-long learning experience at the University of New Mexico's Manufacturing Training and Technology Center (MTTC) cleanroom. MNT-EC facilitates micro and nano technology experiential learning opportunities for community college faculty and students with its partner the Support Center for Microsystems Education. Cramer is now on the engineering faculty at Highline College.

How were the KSAs determined?

The first set of KSAs that covered the work of microsystems technicians were developed by the Maricopa Advanced Technology Education Center (MATEC) and subject-matter experts from its industry partners, which included Intel and Texas Instruments. MATEC was funded as a center in the National Science Foundation's Advanced Technological Education program from 1994 to 2017; its focus was on the development of technicians for semiconductor manufacturing and related industries.

The key outcome of MATEC's process for identifying KSAs was the publication of *Skill Standards for Technicians in the Highly Automated Manufacturing Environment* in 2002. [5] This publication has served community college educators and employers well for more than two decades. MATEC's *Skill Standards* provided an excellent starting point for MNT-ECs development of the KSAs in this document, which consider the workplace technologies that microsystems technicians use in 2020s and employers' expectations.

MNT-EC personnel began drafting *Microsystems Process Technician Knowledge, Skills & Abilities* in 2021 by updating MATEC's *Skill Standards* and adding more detailed information in each section. This draft was shared with members of MNT-EC's Business Industry Leadership Team (BILT). Feedback from the BILT was incorporated into the KSAs. In 2021 and 2022 MNT-EC convened modified focus group meetings via video conferences to gather more input on the revised KSAs from BILT members. MNT-EC's BILT members are employed by companies of various sizes and include representatives of two industry associations. During the meetings, BILT members voted on each KSA, discussed points that lacked consensus, and suggested additions and deletions to the document. Each suggestion was then voted on by the BILT members during the meeting.

[1] Micro Nano Technology Education Center, "About MNT-EC," Micro Nano Technology Education Center, [Online]. Available: https://micronanoeducation.org/about/.

[2] Micro Nano Technology Education Center, "Business Industry Leadership Team (BILT)," Micro Nano Technology Education Center, [Online]. Available: https://micronanoeducation.org/industry/bilt-team/.

[3] National Convergence Technology Center, "Business & Industry Leadership Team," [Online]. Available: https://connectedtech.org/business-industry-leadership-team/.

[4] USA Jobs, "What are KSAs?," USA Jobs, [Online]. Available: https://airforce.usajobs.gov/Help/faq/job-announcement/KSAs/.

[5] Maricopa Advanced Technology Education Center, "Skill Standards for Technicians in the Highly Automated Manufacturing Environment," [Online]. Available: https://atecentral.net/r13978/skill_standards_for_technicians_in_the_highly_automated_manufacturing_environment

Knowledge

Knowledge ***is a body of information applied directly to the performance of a function.***

Wafer Processing & Equipment

K-1 Given a list of process areas, describe the purpose of each and the steps within to accomplish the fabrication of a completed micro device.

K-2 Given a list of process equipment, describe the functions and how the equipment works to achieve the corresponding process step.

K-3 Given a measurement system (e.g. thin film interference, optical critical dimension, profilometer, scanning electron microscope, particle counter, probe station), describe how it works and where it is used in monitoring the fabrication process.

Safety

K-4 Given wafer fabrication manufacturing equipment, manufacturing scenarios in electrical, chemical, radio frequency (RF), high voltage, and/or gas environments, and minimal assistance, identify potential hazards.

K-5 Given a Safety Data Sheet (SDS) for a common chemical used in the semiconductor industry, explain common terms found within SDS forms (e.g., physical data, reactivity, storage, toxicity, health effects, first aid, etc.).

K-6 Without references or assistance, describe the purpose of and list common responsibilities of the emergency response team.

Vacuum Systems

K-7 Given a list of vacuum pumps, describe their operation and corresponding gauges.

K-8 Given the specifications required of a vacuum system, understand the common sources of contamination.

Scientific Fundamentals

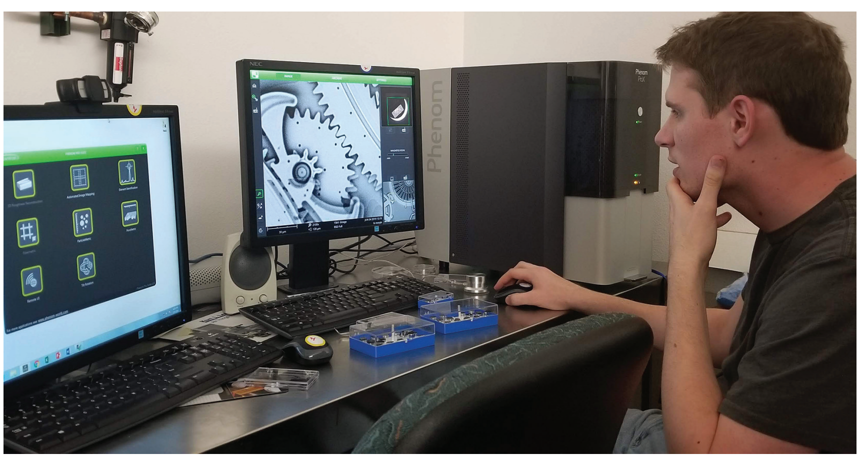
K-9 Without references or assistance, explain the reason to use deionized (DI) water in semiconductor manufacturing.

K-10 Given a list of solvents, acids, and base chemicals found in a wafer fab (cleanroom), list the application (process step(s)) where they may be used.

K-11 Given a semiconductor process (e.g., etch, deposition, sputtering, photolithography), describe the basics of how the process works and key chemicals used.

K-12 Without references or assistance, define hydrophilic and hydrophobic, and explain how these terms are used on safety data sheets and other documents related to chemicals.

K-13 Given a wet lab bench and chemicals, confirm the compatibility of chemicals with each other and with the wet bench.



A community college student studies the image of a Sandia National Labs-produced micro gear using the surface micro machining process called SUMMiIT V. Each gear tooth is about 10 microns wide.

Math

K-14 Given a measurement system, identify sources of variation to the measurements and the measurement tool's contribution to the overall measurement process variation.

K-15 Given measurement data (i.e. thin film thickness, critical dimensions, etc.), be able to provide across-wafer, wafer-to-wafer, lot-to-lot statistics.

K-16 Given measurement data (i.e. thin film thickness, critical dimensions, etc.), identify sources of variation in order of importance to identify probable root cause(s) and propose solutions.

Troubleshooting

K-17 Given a set of equipment performance scenarios, identify equipment and/or process out-of-control conditions.

K-18 Given a transducer, sensor, or measurement device used in semiconductor process equipment, describe how the measurement device is used to troubleshoot and perform maintenance on the tool and verify when it can be released to production.

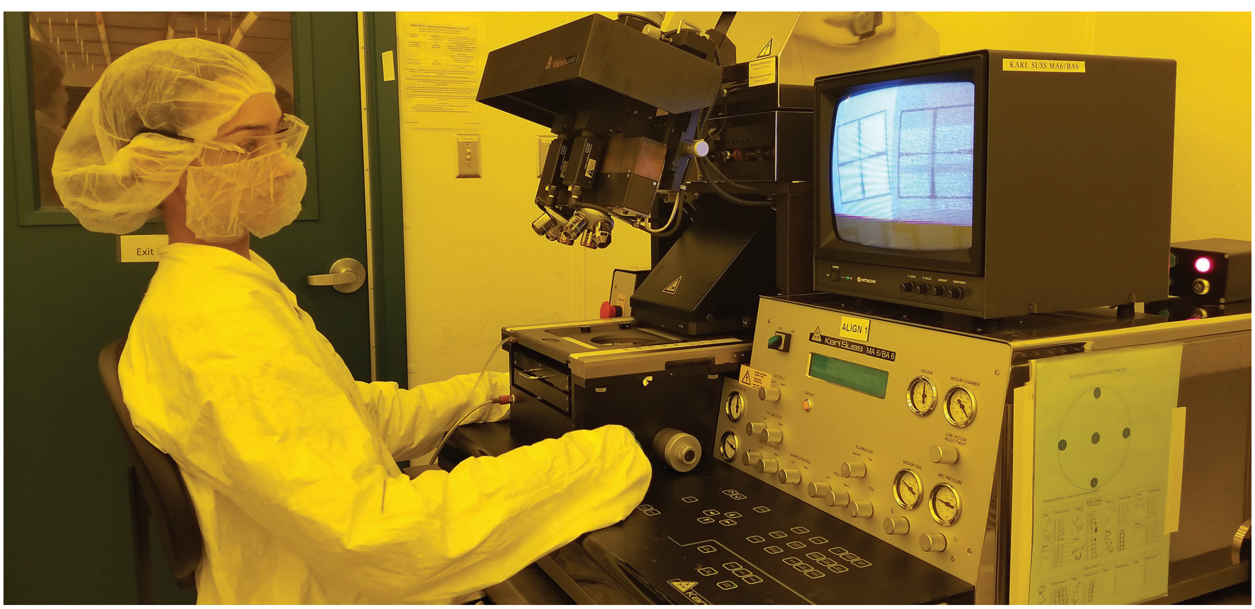
K-19 Given a statistical process control chart, identify out-of-control conditions and suggest an appropriate corrective action(s).

K-20 Given a microscopic image, be able to identify common inline defects and corresponding probable root cause(s).

A community college student holds a wafer after sputter deposition of a thin 200nm layer of metal. The wafer will then go through a lift-off process to reveal the final circuit design.

K-21 Given a product, explain why a manufacturing process is conducted in a cleanroom environment.

K-22 Given a cleanroom class, understand proper gowning and entry protocols required to maintain that class.



A community college student aligns the Wheatstone Bridge circuit mask to the backside pressure sensor chamber pattern during the photolithography process. This ensures that the front and backside features are aligned so the sensor functions as designed.

Skills

Skills ***are observable competencies used to perform a learned psychomotor act: How well can a student execute a specific activity?***

Wafer Processing

S-1 Given processing equipment, ergonomic constraints, instructions, and minimal supervision, demonstrate the ability to adhere to wafer handling and manufacturing procedures and specifications.

S-2 Given processing equipment, measurement tools (e.g., metrology tools, scanning electron microscope (SEM), and resistivity) and procedures, measure and chart process metrics.

A community college student aligns a wafer to ensure proper alignment prior to dicing the micropressure sensors into individual chips during a week-long learning experience in the University of New Mexico's MTTC cleanroom.

Quality

S-3 Given a case scenario of unacceptable product quality, communicate trends of machine performance that may have contributed to this situation.

S-4 Given electrostatic discharge (ESD) protection equipment, observe ESD precautions for product and equipment components.

S-5 Given a series of control charts and process specifications, interpret data of statistical process control (SPC) charts, identify out-of-control and out-of-specification scenarios, and communicate response accordingly.

S-6 Given a flow chart with input conditions, be able to analyze and demonstrate an understanding of how the inputs (causes) influence the output (effects) as related to a micro-fabrication process.

Operating Equipment

S-7 Given newly acquired data, identify if it is within compliance and escalate any concerns appropriately.

S-8 Given processing equipment, specified parameters and minimal assistance, operate manufacturing equipment.

S-9 Given processing equipment, specified parameters, a checklist and minimal assistance, follow the checklist to qualify manufacturing equipment (by adjusting, calibrating, and testing) to be released for production.

S-10 Given processing equipment in and out of control or malfunctioning mode and a troubleshooting procedure, troubleshoot manufacturing equipment and provide a solution path.

Cleanroom

S-11 Given processing equipment, document any adjustments, calibrations, and tests for future reference.

S-12 Given a standard operating procedure, optimize, and document best practices effectively.

S-13 Given a microscope, sample, a manual, and suitable training, use the controls to focus, adjust the stage, and adjust the eye pieces to acquire required images.

S-14 Given a cleanroom environment, materials, protocol guidelines, and a set of task-oriented scenarios, conform to cleanroom protocol.

S-15 Given appropriate instructions and minimal assistance, follow the appropriate hazardous waste disposal process.

Computer Skills

S-16 Given a microcomputer system equipped with software, read and respond to screen commands.

S-17 Given a computer data base, query and extract requested data.

S-18 Given a computer system equipped with application software, utilize standard business functions of word processing and spreadsheets.

Safety

S-19 Given wafer fabrication manufacturing equipment, manufacturing scenarios in electrical, chemical, RF, high voltage and gas environments, and with minimal assistance, follow specified safety procedures, including using appropriate personal protective equipment (PPE).

S-20 Given wafer fabrication manufacturing scenarios, Occupational Safety and Health Administration (OSHA) standards, and no assistance, apply appropriate OSHA standards to the scenario.

S-21 Given vacuum equipment and the reference manual, follow specific safety practices when working around the vacuum system.

S-22 Given an RF system, demonstrate safe working practices.

Math

S-23 Given a dilution proportion, carefully dilute the liquid to the required concentrations and label the container correctly.

S-24 Given etch rate and acid concentration table and desired material thickness, perform calculations to provide specified etch rate, percentage concentration, and resulting film thickness.

S-25 Given a set of measurements, including scientific notations and mathematical operators, perform calculations and express results in metric units.

S-26 Perform unit conversions, arithmetic, and basic algebraic calculations without error.

S-27 Given resist thickness spin speed (SS) curves and target thickness, read the chart to provide the correct SS adjustment to match target.

S-28 Given an etched product, identify if it is within compliance and escalate any concerns.

S-29 Given a concentration of chemical by weight, calculate the amount of deionized (DI) water and chemical needed to reach the desired concentration at the requested volume.

Electronics

S-30 Given processing equipment and a digital multimeter, measure voltage, current, and resistance.

S-31 Given a variety of sensors and transducers, analyze devices for proper operation and calibration.

S-32 Given a multimeter, understand the voltage, current and mechanical parameters' limits while using the device/process.

Troubleshooting & Maintenance

S-33 Given an electromechanical device, measure voltage, current, and resistance safely.

S-34 Given preventative maintenance (PM) procedure, basic hand tools and replacement parts, conduct routine preventive maintenance.

S-35 Given screwdrivers, wrenches, sockets, hammers, pliers, wire strippers, saws, torque wrenches, vises, files, and other special tools, demonstrate cleanroom-approved workmanship when using any hand tools.

S-36 Given a service bulletin and processing equipment, comply with requirements of service bulletin.

S-37 Given appropriate measurement tools and a group of items requiring measurements of depth, length, width, thickness, inside diameter, outside diameter or gap, use mechanical measuring devices to calculate dimensions.

S-38 Given a set of graphs or charts with references, interpret graphs or charts.

S-39 Given a set of particle count specifications, perform the appropriate cleaning and/or equipment maintenance procedure to bring the system back into control.

S-40 Identify robot mishandling issues, safely halt the system, and escalate or respond accordingly.

Abilities

Abilities ***are competencies to perform an observable behavior or a behavior that results in an observable product.***

The arrangement of the Abilities section closely matches the U.S. Department of Labor Employability Skills and its terminology. The eventual goal is for all KSAs to have a documented proficiency level. **The abilities in boldface below are what the BILT has identified as the proficiency levels for entry-level microsystems technicians.**

A-1 Workplace Professionalism & Ethics

Demonstrate sound professionalism, judgment, and integrity in the workplace. Abide by organization's formal and informal expectations, including punctuality and dependability.

Proficiency Level

4 Employee exhibits a mastery of professionalism and workplace norms and can provide peer guidance to co-workers and new hires.

3 **Employee exhibits sound professionalism, judgment and integrity, and accepts responsibility for own behavior.**

Employee exhibits these qualities without guidance, but refers to policies as needed.

2 Employee learns expectations of workplace environment (professional behavior and ethics) and adheres to practices with some guidance.

1 This skill is not necessary for the role of microsystems technician.

A community college student prepares a silicon wafer for dicing and packaging in the MTTC cleanroom at the University of New Mexico.

A-2 Written Communication

Comprehend and execute written instructions. Communicate concepts in writing effectively.

Proficiency Level

4 Employee exhibits a mastery of professionalism and workplace norms and can provide peer guidance to co-workers and new hires.

3 **Employee comprehends and executes written instructions with minimal guidance.**

Employee composes well-organized written documents.

2 Employee understands written instructions and executes tasks with guidance and feedback from supervisor. Employee clearly communicates concepts in writing.

1 This skill is not necessary for the role of microsystems technician.

A-3 Oral Communication

Comprehend and execute oral instructions. Communicate concepts orally effectively and listen for details and speakers' intention.

Proficiency Level

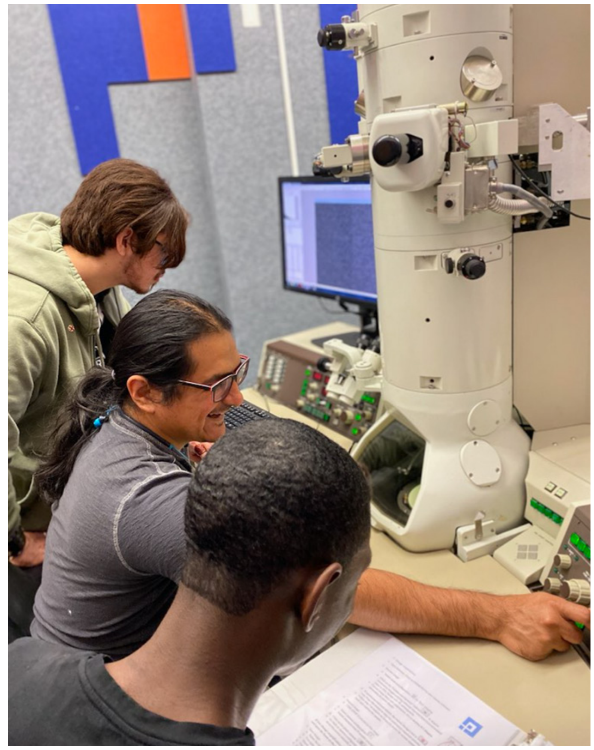
4 Employee exhibits a mastery of communication internally and externally, demonstrating the ability to present complex ideas and concepts.

3 **Employee comprehends and executes oral instructions with minimal guidance and exhibits good listening skills.**

Employee clarifies for meaning without needing prompting from supervisor.

2 Employee understands oral instructions and executes tasks with guidance and feedback from supervisor. Employee communicates concepts orally while clarifying for meaning. Employee develops listening skills.

1 This skill is not necessary for the role of microsystems technician.



Northwest Vista Community College students look at samples in a scanning electron microscope.

A-4 Teamwork

Collaborate with colleagues to accomplish a project goal. Mediate conflict, including taking steps to build consensus and to avoid conflict.

Proficiency Level

4 Employee assumes responsibility for accomplishing team goals. Employee exhibits commitment to organization, exerts effort and perseverance, motivates team members to extend their capabilities, and helps to resolve conflicts.

3 **Employee demonstrates commitment, enthusiasm, and supports team members.**

Employee follows up on assigned tasks and leads by example.

2 With guidance and feedback from supervisor, employee obeys team rules and understands team member roles. Employee actively participates in team activities, volunteers for special tasks and establishes rapport with co-workers.

1 This skill is not necessary for the role of microsystems technician.

A-5 Problem Solving & Critical Thinking

Identify and analyze challenges in a project and determine potential solutions (troubleshooting). Be aware of company, departmental, and regulatory constraints and know how to work within guidelines to obtain relevant information and to solve problems.

Proficiency Level

4 Employee predicts outcomes and results based on data, experience and prior knowledge. Employee generates and evaluates alternative solutions and formulates plan of action. Employee adapts and creates rules and principles for new situations.

3 **Employee analyzes underlying causes, considers risks and implications, and uses logic to draw conclusions with minimal direction from supervisor.**

Employee applies rules and principles to processes and recommends solutions.

2 Employee identifies the problem and relevant facts and principles with guidance and feedback from supervisor. Employee summarizes existing ideas and demonstrates creative thinking process while problem solving.

1 This skill is not necessary for the role of microsystems technician.

A-6 Organization and Planning

Manage elements of a project with foresight to the next steps. Plan project with awareness of people, resources, time for each process, and deadlines. Prioritize and identify appropriate safety protocols.

Proficiency Level

4 Employee formulates proposals for goal and timeline modification and new processes and procedures. Employee develops plans of action.

3 **Employee manages timelines and recommends timeline adjustments in response to changing conditions. Employee escalates timeline-impacting issues as appropriate.**

2 Employee prepares schedule for self, monitors and adjusts task sequence, and analyzes work assignments with guidance from supervisor.

1 This skill is not necessary for the role of microsystems technician.

A-7 Management of Materials

Gather the materials needed to perform a task. Ensure required materials are on hand. Follow all safety protocols.

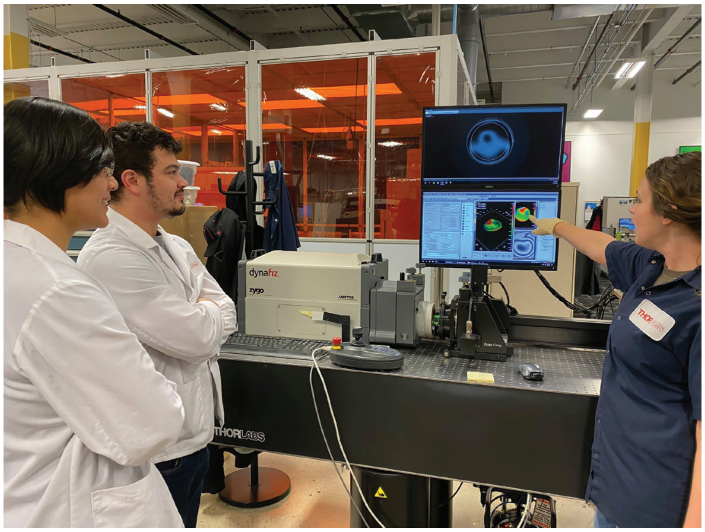
Proficiency Level

4 Employee identifies future material needs and communicates them to appropriate personnel.

3 **Employee monitors safe and efficient utilization of materials and maintains job-specific supplies and equipment.**

2 Employee uses materials in a safe and efficient manner.

1 This skill is not necessary for the role of microsystems technician.



Indian River State College students analyze optical surface qualities using a ZYGO DynaFiz Interferometer System.

A-8 Adaptability and Flexibility

Adjust personal work assignments and priorities, habits and knowledge based on external pressures and changing expectations. Manage variables to succeed under pressure.

Proficiency Level

4 Employee independently demonstrates ability to adjust to changing work environments to meet the needs of the organization. Independently recognizes the need to meet deadlines and responds accordingly.

3 **Employee makes inquiries of coworkers regarding possible changes needed in ways of doing work and adapts accordingly. Observes coworkers increasing work productivity under pressure and follows their lead.**

2 With guidance and feedback from supervisor, employee is able to adjust ways of doing work based on changing dynamics. Working under pressure is difficult, but employee makes it through the project with guidance and oversight.

1 This skill is not necessary for the role of microsystems technician.

A community college student completes the steps to ensure the quality of a microfabricated circuit pattern made during a week-long learning experience at the University of New Mexico's MTTC cleanroom.

A-9 Initiative

Seek appropriate opportunities to take on value-added work without being directed.

Proficiency Level

4 Employee identifies areas of work in the organization that could be improved and appropriately takes initiative to make them better.

3 **Employee finishes multiple steps in a project and appropriately begins working on the next step without being asked.**

2 Employee finishes a step in a project and waits for direction before going on to the next step.

1 This skill is not necessary for the role of microsystems technician.

A-10 Meeting Specifications

Recognition of specifications and ability to meet them, including cybersecurity and intellectual property protocols.

Proficiency Level

4 Employee continually demonstrates accuracy in nearly all facets of the job.

3 **Employee occasionally makes mistakes, but quickly makes adjustments to work habits to avoid making the same mistake twice.**

2 Employee makes mistakes routinely, but is committed to learning to adjust work habits to prevent them in the future.

1 This skill is not necessary for the role of microsystems technician.

A-11 Cultural Competence

Work effectively within a technically and culturally diverse team. Demonstrate respect for differences of individuals within the team.

Proficiency Level

4 Easily works with diverse teams to achieve collective goals. Demonstrates empathy and respect for all colleagues leading to positive working relationships throughout the organization.

3 **Employee is committed to working with diverse teams, but struggles when differences arise.**

Employee identifies challenges and works with colleagues to find ways to work effectively.

2 Employee is inexperienced with working with diverse teams. With support and guidance and getting to know team members, employee develops working relationships.

1 This skill is not necessary for the role of microsystems technician.

A-12 Self and Career Development

Embrace lifelong learning to improve professional and technical knowledge, skills, abilities (KSAs) and personal growth. Develop a healthy work and personal life balance.

Proficiency Level

4 Employee generates ideas for developing professional and technical skills and proactively initiates discussions with supervisor. Employee completes training within deadline time frame.

3 **Employee builds upon self-assessment experience and can develop a professional and technical skills improvement plan in conjunction with supervisor.**

Employee completes development plan without prompting from supervisor.

2 Employee requires feedback and direction from supervisor regarding improvement needed in professional and technical skills. Employee follows through with skills development with monitoring by supervisor.

1 This skill is not necessary for the role of microsystems technician.

A-13 Identify Out-of-Control Conditions

Demonstrate the ability to identify and communicate out-of-control conditions in the process, product and/or safety systems. Have confidence to raise one's hand and "stop" the process if something looks wrong.

Proficiency Level

4 Employee stops the line when something looks "off" and takes initiative to troubleshoot the tool or process to bring it back up.

3 **Employee stops the line when something looks "off" or wrong.**

Employee clearly makes supervisor aware of problem(s) and only brings the tool or process back up once the error has been addressed.

2 Employee is hesitant to stop the line or bring a tool down if something looks "off." Employee brings the tool down once a major error has occurred or when directed to do so.

1 This skill is not necessary for the role of microsystems technician.

Community college students earn nano-manufacturing certificates during an associate degree capstone semester at Penn State University, an MNT-EC partner.

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MNT-EC Welcomes Involvement of Employers & Educators

The Micro Nano Technology Education Center (MNT-EC) was founded on the idea that working together with employers and educators will enhance the quality of education for students who then become higher quality technicians for the micro and nano technology industry.

Email info@micronanoeducation.org to join the initiative or ask questions.

A PDF of *Microsystems Process Technician Knowledge, Skills & Abilities* is available for download at http://www.micronanoeducation.org/educators

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