Essential Practices for Impact on the 21st Century Manufacturing Industry and Workforce

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Tennessee Tech

AM WATCH
ADDITIVE MANUFACTURING WORKFORCE ADVANCEMENT TRAINING COALITION AND HUB

Additive Manufacturing Workforce Advancement Training Coalition and Hub (AM-WATCH)

Tennessee Technological University, Cookeville, TN
http://am-watch.org

AM-WATCH Uses Array of Instructional Settings

AM-WATCH provides opportunities for secondary school and two-year college students and educators to learn additive manufacturing technologies. More than 700 students were impacted positively by the project from fall 2017 to spring 2018. During 2018 the project plans to add 30 locations to the 25 learning sites it has established in high schools, community colleges, and applied technology centers in Tennessee and Washington.

AM-WATCH's Train-the-Trainer Studios teach educators how to build 3-D printers to help them prepare technicians for additive manufacturing careers.

AM-WATCH also uses massive online open courses to inform audiences of all ages and skill levels about additive manufacturing trends, safety, innovations, and entrepreneurship.

Educators' Results from Train-the-Trainer Studios

77%
increased their ability to design a system, component, or process.

80%
increased their technical and nontechnical communication skills.

Educators report AM-WATCH's Train-the-Trainer Studios improved their performance on specific ABET accreditation skill sets.

https://atecentral.net/downloads/3916/ATE_Impacts_2018-2019.pdf

AM-WATCH Consortium and Its Hubs

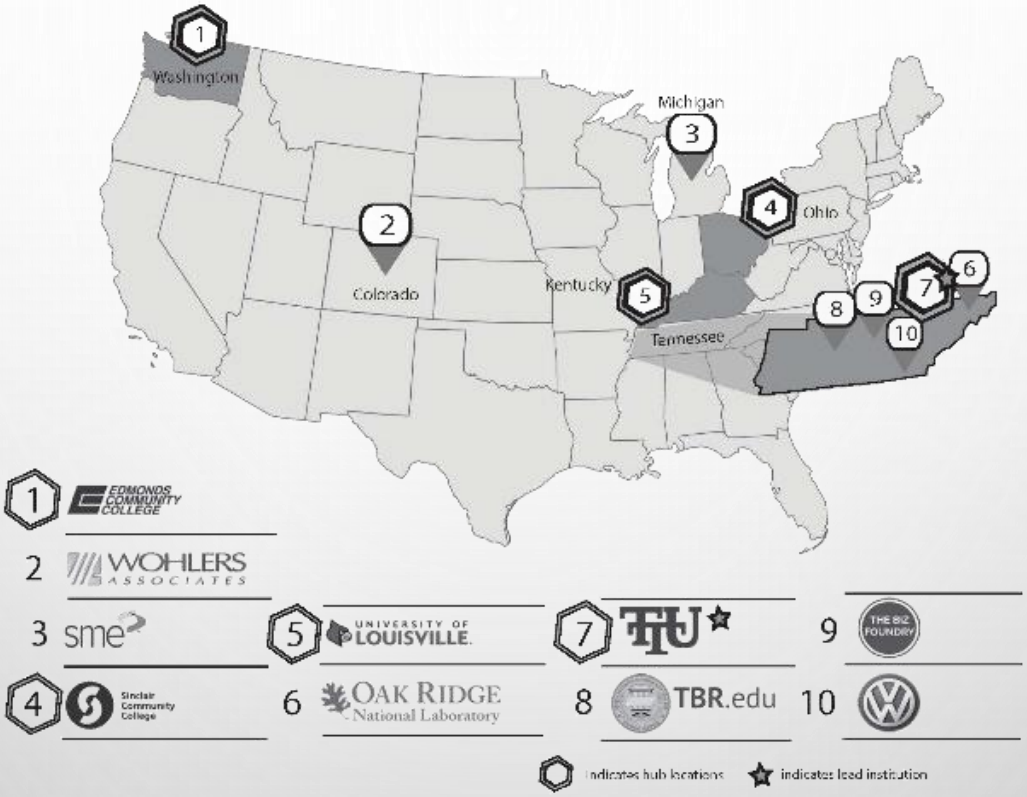
TENNESSEE TECH

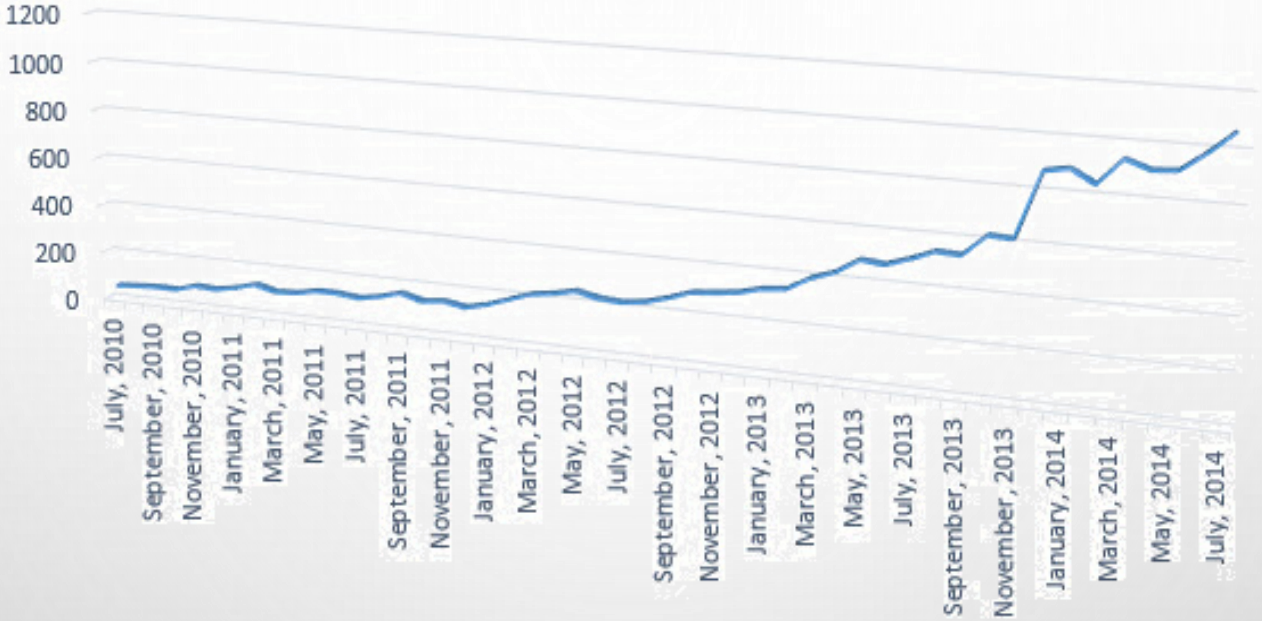
WASHINGTON STATE COMMUNITY COLLEGE DISTRICT 23 · EDMONDS COMMUNITY COLLEGE

SINCLAIR COMMUNITY COLLEGE

UNIVERSITY OF LOUISVILLE · KENTUCKY · 1846

OAK RIDGE National Laboratory

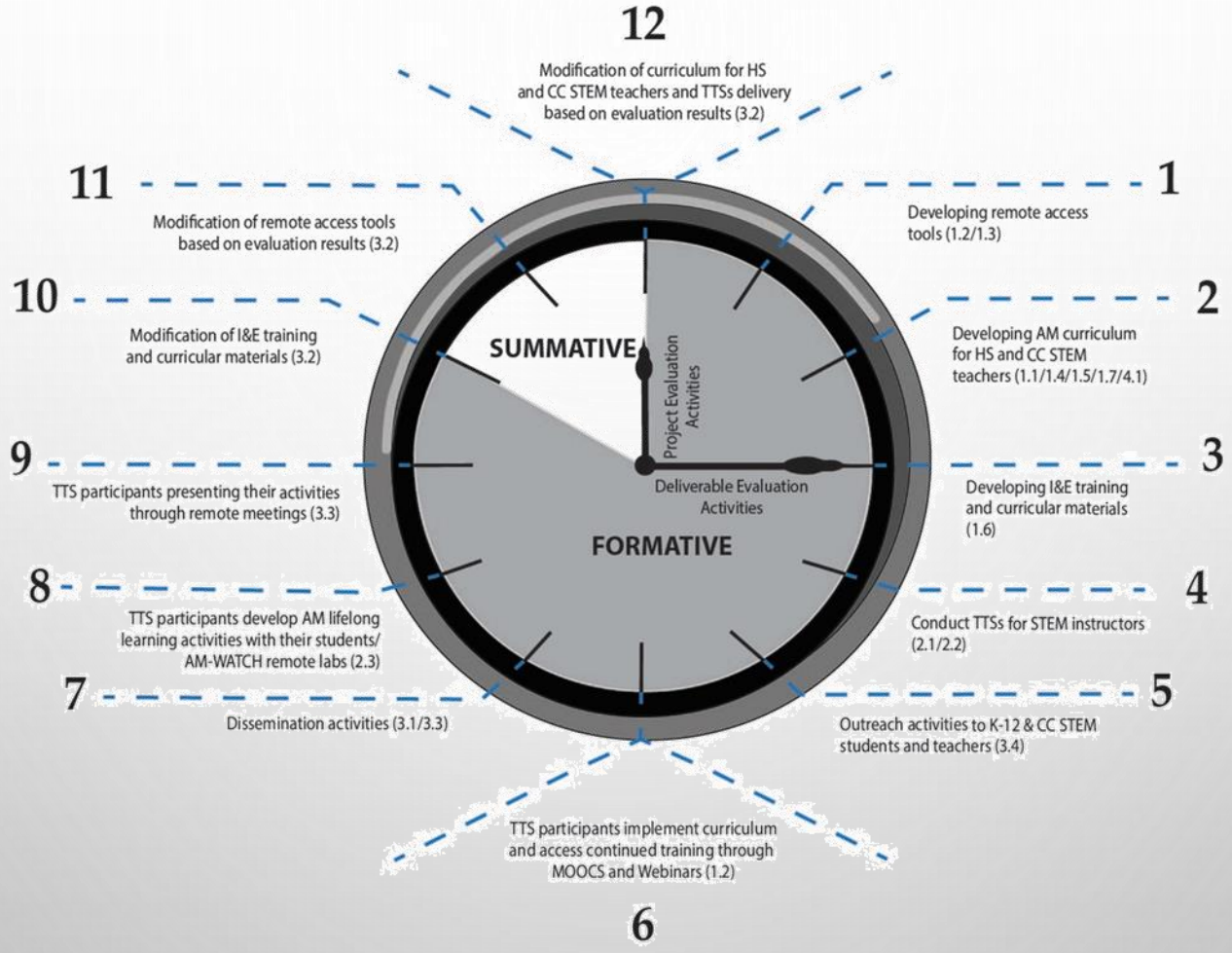

Washington
Michigan
Ohio
Colorado
Kentucky
Tennessee
1 EDMONDS COMMUNITY COLLEGE
2 WOHLERS ASSOCIATES
3 sme
4 Sinclair Community College
5 UNIVERSITY OF LOUISVILLE
6 OAK RIDGE National Laboratory
7 TTU
8 TBR.edu
9 THE BIZ FOUNDRY
10
indicates hub locations
indicates lead institution

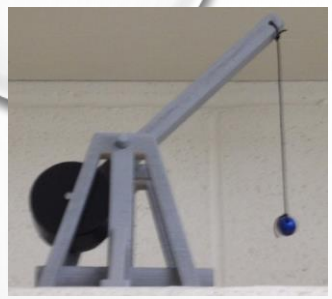


Demand For 3D Printing Skills Is Accelerating Globally, (http://www.forbes.com/sites/louiscolumbus/2014/09/15/demand-for-3d-printing-skills-is-accelerating-globally/#194665424cf7)

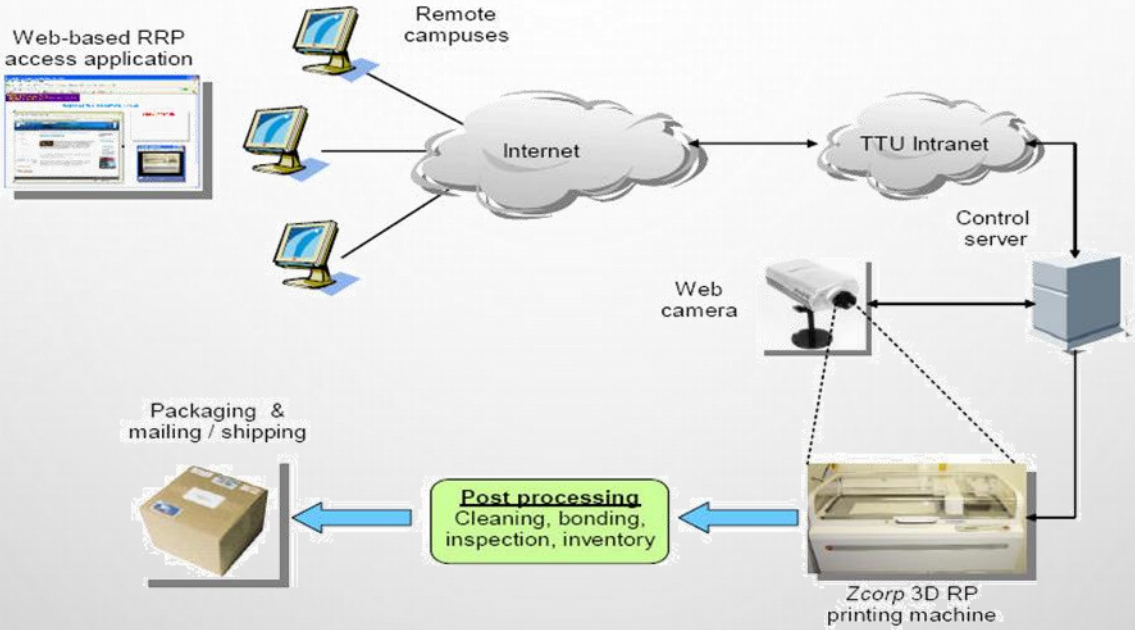
AM-WATCH coordinates with manufacturers using AM technology, and instructors teaching AM, to identify the up to date skills required of AM technicians.

AM-WATCH Model





Remotely Accessible Rapid Prototyping Laboratory



Develop Remote Access Facilities

Innovative and Entrepreneurial AM Projects

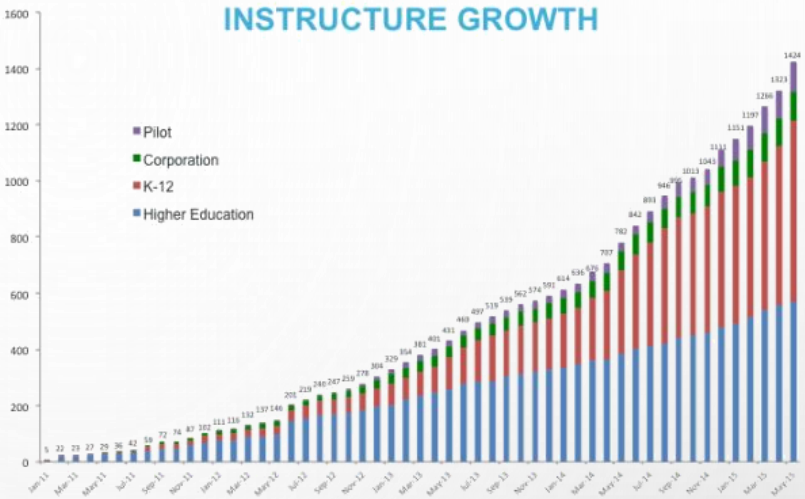
Case Studies to help students attain ABET Outcomes 3d, 3f, 3g, and 3h

Develop foundational hands-on modules and professional development activities designed to prepare teachers to integrate the modules into their classrooms.

- Ability to function effectively as a member of a technical team (3d);
- Ability to apply written, oral, and graphical communication in both technical and nontechnical environments; and use appropriate technical literature (3f);
- Understanding the need for and ability to engage in self-directed continuing professional development (3g),
- Understanding of and commitment to professional and ethical responsibilities including a respect for diversity (3h);

Develop and Disseminate MOOC AM Resources

MOOCs are an emerging strategy for reaching wide and diverse audiences. The MOOCs will serve as a window to AM learning for students that do not have AM curriculum immediately available to them.



https://marketbrief.edweek.org/marketplace-k-12/instructure_inc_known_for_canvas_lms_plans_to_go_public/

canvas
BY INSTRUCTURE

- Fundamentals of AM
- Design for AM
- Building a 3D printer (electronics, software, mechanical design, hands-on mechanics)
- Innovation and Techno-entrepreneurship Pathways and Initiatives in AM (NSF Lean Launchpad Model and Entrepreneurial Initiatives in AM)

Online AM and Train-the-Trainer Studio Resources

As TTSs are being conducted at TTU and partner institution sites, AM lectures, Q&A sessions, and hands-on activities will be video recorded and grouped into modules.

Golden Eagle Additively Innovative Lecture Series

11 - 11:30 a.m. CST **SPRING 2017**

Join from anywhere via tntech.zoom.us/j/432789883

February 9

A Technique for Quick Introduction of 3D Design and Prototyping

with Hugh Jack, Ph.D., Inaugural Cass Ballenger Distinguished Professor of Engineering
Director, School of Engineering and Technology, Western Carolina University

February 23

Additive Manufacturing: Instrumental systems in research, education, and service

with Bahram Asiabanpour, Ph.D., C.Mfg.E., Editor-in-Chief, International Journal of Rapid Manufacturing,
Associate Professor, Manufacturing Engineering, Ingram School of Engineering Texas State University

March 23

Making it Work

with Marilyn Barger, Ph.D., P.E., F.ASEE, Executive Director and Principal Investigator
NSF Florida Advanced Technological Education Center (FLATE), Hillsborough Community College

March 30

Bioprinting and tissue engineering

with Yunzhi Peter Yang, Ph.D., Associate Professor, Departments of Orthopedic Surgery, (by courtesy)
Materials Science and Engineering, and Bioengineering, Co-director of Medical Scholar Program in
Bioengineering Scholarly Concentration, Stanford University and Adjunct Associate Professor at
The University of Texas Health Science Center at Houston

tntech.edu/engineering/imakerspace

Golden Eagle Additively Innovative Virtual Lecture Series is partially funded by the NSF Award 1601587, "AM-WATCH: Additive Manufacturing-Workforce Advancement Training Coalition and Hub".

Golden Eagle Additively Innovative Lecture Series

11 - 11:30 a.m. CST FALL 2017

Join from anywhere via tntech.zoom.us/j/432789883

September 21

Workflow of the Additive Manufacturing Process

with Kyle Bates-Green, Subject Matter Expert
National Resource Center for Materials Technology Education, Lynnwood, Washington

October 12

3-D printing, Design Thinking, and the Entrepreneurial Mindset

with Phan Tran, Professor, Center for Architecture, Design, and Engineering
Lake Washington Institute of Technology, Kirkland, Washington

November 2

Using 3-D Printed Parts to couple Festo Didatic's MecLab Stations in an Assembly Process

with Khalid Tantawi, Professor, Department of Career Readiness-Mechatronics
Motlow State Community College, Smyrna, Tennessee

November 30

Next Generation Manufacturing: Professional & Technical Skills for the 21st Century workforce

with Karen Wosczyna-Birch, State Director, College of Technology
Executive Director, Center for Next Generation Manufacturing, Farmington, Connecticut

www.tntech.edu/engineering/imakerspace

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Golden Eagle Additively Innovative Lecture Series

11 - 11:30 a.m. CST **Fall 2018**

Join from anywhere via tntech.zoom.us/j/432789883

Thursday, Sept. 13

Integrating Additive Manufacturing into CAD Courses

with Tom Singer, Professor of Mechanical Engineering Technology and Manager of the STEM Guitar Laboratory, Sinclair Community College, Dayton, Ohio

Thursday, Oct. 11

Where's my Spare Part? Changing Maintenance, Repair, and Overhaul through Additive Manufacturing

With Brett P. Conner, Professor and Director of the Advanced Manufacturing Research Center at Youngstown State University, Ohio

Thursday, Oct. 25

Design for Additive Manufacturing: The Key to the Industrial Adoption of Additive Manufacturing

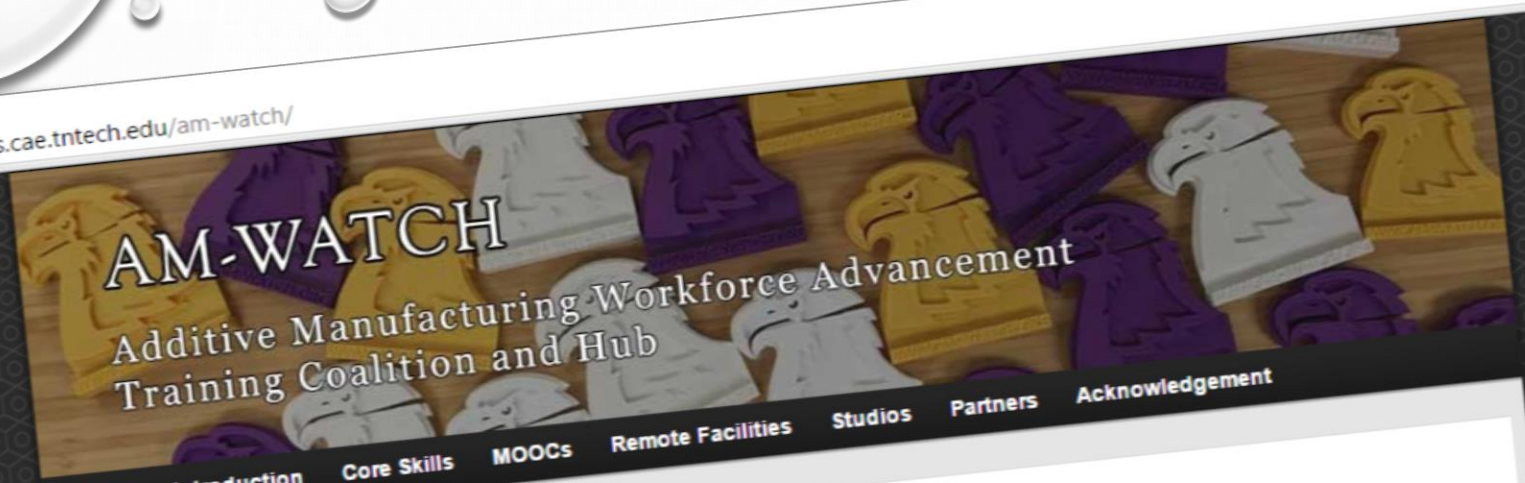
With Olaf Diegel, Professor of Product Development, School of Engineering, Department of Design Sciences, Lund University, Sweden

Thursday, Nov. 15

Functionally Graded Additive Manufacturing

with Eujin Pei, Program Director, Product Design & Product Design Engineering Institute of Materials and Manufacturing, Brunel University London, UK

blogs.cae.tntech.edu/am-watch/



AM-WATCH

Additive Manufacturing Workforce Advancement Training Coalition and Hub

Home | Introduction | Core Skills | MOOCs | Remote Facilities | Studios | Partners | Acknowledgement

Home

The objective of this Advanced Technological Education (ATE) project is to establish an Additive Manufacturing Workforce Advancement Training Coalition and Hub (AM-WATCH) to address current gaps in the knowledge base of 21st century technicians through the development of AM-WATCH educational modules, delivery of professional development activities and support to 30+ STEM instructors per year, and expanded outreach activities targeting K-12 and Community College teachers and students.

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Host Train the Trainer Studios (TTSs)

Tennessee Tech and the regionally diverse partner locations host one TTS annually. Minimum 30 educators are trained per year

http://serc.carleton.edu/introgeo/studio/what.html

Additive Manufacturing Workshop

May 20-21, 2017

9 a.m. - 5 p.m.

at the Tennessee College of Applied Technology - Knoxville

Build Your Own 3-D Printer, Train-the-trainer Studios, Learn the MOOCs Resources, State of the Industry by Terry Wohlers, Plant Tours, Guest Lectures

Breakfast and lunch will be provided.
Saturday dinner will be hosted by BB&T and C&J.

Supporting Organizations

Application Procedure

Submit your brief resume, letter of intent, and your implementation plan of the workshop subject matters to:

Michelle Davis, Outreach Coordinator at mdavis@tntech.edu
Center for Manufacturing Research, Tennessee Tech University
Phone: (931) 372-6386 or Fax: (931) 372-6345

Application/Registration Information

Application deadline is Friday, Feb. 24, 2017.
TCAT and CC instructors will be given preference.
Registration is limited to FIFTEEN instructors.
Each workshop participant will receive a $400 reimbursement check and a 3-D Printer.
Since space is limited, accepted candidates will be called/emailed by March 10, 2017.

Workshop Organizers

Ismail Fidan, Ph.D., Tennessee Tech University
Amy Elliott, Ph.D., Oak Ridge National Laboratory
John Townsend, Ph.D., The College System of Tennessee

Sponsored by

The National Science Foundation (Award Number 1601587, "AM-WATCH: Additive Manufacturing Workforce Training Coalition and Hub")

Additive Manufacturing Workshop

July 7 – 8, 2018

9 a.m. – 5 p.m.

at the Tennessee College of Applied Technology – Nashville

Build Your Own 3-D Printer, Train-the-trainer Studios, Learn the MOOCs Resources, State of the Industry, Entrepreneurial Product Design and Fabrication, Implementing Additive Manufacturing to your ABET Accreditation Process

Breakfast and lunch will be provided. Saturday dinner will be hosted by SME Nashville Chapter.

Application/Registration Information

Application deadline is Thursday, May 31, 2018.
TCAT and CC instructors will be given preference.
Registration is limited to 15 instructors.
Each workshop participant will receive a $400 reimbursement check and a 3-D Printer.
Since space is limited, accepted candidates will be called/emailed by June 11, 2018.

SUPPORTING ORGANIZATIONS

Application Procedure

Submit your brief resume, letter of intent, and a plan for implementing in your classroom what you learn at the workshop to:

Michelle Davis, Outreach Coordinator at mdavis@tntech.edu
Center for Manufacturing Research, Tennessee Tech University
Phone: (931) 372-6386 or Fax: (931) 372-6345

Workshop Organizers

Ismail Fidan, Tennessee Tech University
Amy Elliott, Oak Ridge National Laboratory
Michael Tinsley, The College System of Tennessee
Todd Tripp, ZF TRW
Dean Phillips, Link Electric

Sponsored by The National Science Foundation
(Award Number 1601587, "AM-WATCH: Additive Manufacturing Workforce Training Coalition and Hub")

Tennessee TECH

2017 NSF Additive Manufacturing Workshop
Knoxville, TN

AGENDA

ALL TIMES ARE EASTERN TIME ZONE

DAY ONE: Saturday, May 20, 2017		
TIME	**SESSION**	**LOCATION**
8:00-8:30 a.m.	**Breakfast and Welcoming** • All Attendees	TCAT-Knoxville at 1100 Liberty Street, Knoxville, TN 37919 Conference Room A
8:30-9:15 a.m.	**Review of the Workshop Agenda, Introductions, & Workshop Deliverables** • Ismail Fidan and Nick Russell, Tennessee Tech University	Conference Room A
9:15-9:45 a.m.	**Makerspaces: Transforming from Consumers to Producers** • David Voetmann, The Facility Makerspace, Edmonds Community College	Conference Room A
9:45-10-15 a.m.	**Where Additive Manufacturing Begins … The Design** • Tom Singer, Sinclair Community College	Conference Room A
10:15-11:00 a.m.	**State of the Additive Manufacturing Industry and Q&A** • Terry Wohlers, Wohlers Associates	ZOOM Connection from Conference Room A
11:00-11:15 a.m.	**Break**	Conference Room A
11:15-Noon	**Additive Manufacturing for Production** • Ed Tackett, University of Louisville	Conference Room A
Noon-1:00 p.m.	**Networking Lunch** • All Attendees	Conference Room A
1:00-1:30 p.m.	**AM MOOCs, AM Additively Innovative Lecture Series and Task Assignment for Studio Practices** • Ismail Fidan, Tennessee Tech University	Conference Room A
1:30-2:00 p.m.	**Technology Made Simple** • Brooks Partain, Global Strategic Account Manager	ZOOM Connection from Conference Room A
2:00-3:30 p.m.	**Set up, run, and test participant's 3D printers** • All Attendees	Conference Room A
3:30-4:00 p.m.	**Driving to Protomet** protomet.com 1010 Larson Drive, Oak Ridge, TN 37830 • All Attendees	Carpool to Protomet
4:00-5:00 p.m.	**Tour of Protomet** • Dan Sherwood, Protomet, Cell 865.696.7217	Protomet
5:00-5:30 p.m.	**Driving back to TCAT-Knoxville** • All Attendees	TCAT-Knoxville at 1100 Liberty Street, Knoxville, TN 37919
5:30-7:00 p.m.	**Honorary Dinner provided by Coulter & Justus, P.C. and BB&T** • All Attendees, and Mike Parton and John Harris	Conference Room A

2017 NSF Additive Manufacturing Workshop
Knoxville, TN

AGENDA

DAY TWO: Sunday, May 21, 2017		
TIME	**SESSION**	**LOCATION**
8:00-8:45 a.m.	**Breakfast and Review of Day One** • All Attendees	Conference Room A
8:45-9:15 a.m.	**Presenting an innovative and techno-entrepreneurial AM Case Study, Project InnoDino** • Nick Russell, Tennessee Tech University	Conference Room A
9:15-10:30 a.m.	**Assigning a project. Run your 3D Printer. Get together as a group and start working on your project** • Tom Singer, Sinclair Community College, Ismail Fidan, Tennessee Tech University and All Attendees	Conference Room A
10:30-11:00 a.m.	**Driving to MDF of ORNL** web.ornl.gov/sci/manufacturing/mdf 2370 Cherahala Blvd. Knoxville, TN 37932 • All Attendees	Carpool to MDF of ORNL
11:00 a.m.-Noon	**Tour of ORNL-MDF** • Amy Elliott, Oak Ridge National Laboratory	ORNL-MDF
Noon-12:30 p.m.	**Driving back to TCAT-Knoxville** 1100 Liberty Street, Knoxville, TN 37919 • All Attendees	TCAT-Knoxville
12:30-1:00 p.m.	**Networking Lunch** • All Attendees	Conference Room A
1:00-1:30 p.m.	**AM in Daily Life** • Amy Elliott, Oak Ridge National Laboratory	Conference Room A
1:30-3:30 p.m.	**Work on your team projects** • All attendees	Conference Room A
3:30-4:30 p.m.	**Get ready to present your team projects, presentations, and Q&As** • All attendees	Conference Room A
4:30-5:00 p.m.	**Get ready to present your team projects, presentations, and Q&As** **Closing Remarks and Workshop Evaluation** • Ismail Fidan, Nick Russell, and George Chitiyo, Tennessee Tech University	Conference Room A

UNIVERSITY OF LOUISVILLE

J.B. SPEED SCHOOL OF ENGINEERING

ADDITIVE MANUFACTURING WORKSHOP

Friday, December 8th, 2017

8 a.m. to 4 p.m.

Engineering Garage, 1960 Arthur Street, Louisville, KY

In partnership with

Attendees will receive a **3D Printer Classroom Kit** for their school, software, student exercises, train the trainer assistance, curriculum examples and student modules. **Breakfast and lunch will be provided.**

3D PRINTER CLASSROOM KIT

- Monoprice Maker Select Plus 3 OR Monoprice Select Mini
- 2 Spools of PLA Build Material
- 2 Extra .4mm nozzles
- Nozzle Cleaning Filament
- PTFE Tubing
- 3D Printer Toolkit
- 2 Memory Cards
- 1 Memory Card Reader
- CURA 3D Printer Software

Registration Information

- Application Deadline is Nov. 22, 2017
- Limited to 30 attendees
- Each participant will receive 3D Printer Kit for their classroom
- Accepted candidates will be emailed by Nov. 27

Online Application Procedure

https://goo.gl/forms/lf6J7vjncUspGd7r1

You must provide us with an signed institutional commitment letter from your administration acknowledging your participation in the workshop and implementation of the 3D printer in your educational activities and email the PDF to:
ed.tackett@louisville.edu

Sponsored by the National Science Foundation under Award Number 1601587, AM-WATCH: Addi ve Manufacturing Workforce Training Coalition and Hub. This material is based upon work supported by the Na onal Science Foundation under Grant No. 1601587. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.


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ABET Criteria: Knoxville Studio (N=15)

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I have increased ability to design a system, component, or process to meet desired needs. [3c]	60.0% (n=9)	13.3% (n=2)	20.0% (n=3)	6.7% (n=1)	0.00%
I have increased ability to function effectively as a member of a technical team. [3d]	60.0% (n=9)	26.7% (n=4)	6.7% (n=1)	6.7% (n=1)	0.00%
I have increased ability to apply written, oral, and graphical communication in both technical and nontechnical environments; and use appropriate technical literature. [3f]	46.7% (n=7)	40.0% (n=6)	6.7% (n=1)	0.00%	6.67%
I have an increased understanding of the need for and ability to engage in self-directed continuing professional development. [3g]	66.7% (n=10)	20.0% (n=3)	6.7% (n=1)	6.7% (n=1)	0.00%
I have an increased understanding of and commitment to professional and ethical responsibilities including a respect for diversity. [3h]	66.7% (n=10)	13.3% (n=2)	13.3% (n=2)	6.7% (n=1)	0.00%

ABET Criteria: Seattle Studio (N=15)

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I have increased ability to design a system, component, or process to meet desired needs. [3c]	40.0% (n=6)	40.0% (n=6)	13.3% (n=2)	0.00%	6.7% (n=1)
I have increased ability to function effectively as a member of a technical team. [3d]	33.3% (n=5)	26.7% (n=4)	33.3% (n=5)	0.00%	6.7% (n=1)
I have increased ability to apply written, oral, and graphical communication in both technical and nontechnical environments; and use appropriate technical literature. [3f]	33.3% (n=5)	40.0% (n=6)	20.0% (n=3)	0.00%	6.7% (n=1)
I have an increased understanding of the need for and ability to engage in self-directed continuing professional development. [3g]	40.0% (n=6)	46.7% (n=7)	6.7% (n=1)	0.00%	6.7% (n=1)
I have an increased understanding of and commitment to professional and ethical responsibilities including a respect for diversity. [3h]	40.0% (n=6)	26.7% (n=4)	26.7% (n=4)	0.00%	6.7% (n=1)

Summary of Evaluation Findings for the two Studio Workshops

Knoxville (TN) Studio	Seattle (WA) Studio
• 100% of participants agreed (strongly or somewhat) that the training experience will be useful in their work. • 93% of participants agreed (strongly or somewhat) that the training objectives were clearly defined, the training objectives were met, and the topics covered were relevant to their profession. • 93% of participants agreed (strongly or somewhat) that the quality of logistic and administrative support had a positive impact on the experience, the quality of instruction was excellent, the training materials/handouts distributed were helpful, and the facilities were adequate and comfortable. • 87% of participants agreed (strongly or somewhat) that each session stated the objectives clearly and the time allotted for each session was sufficient. • 80% of participants agreed (strongly or somewhat) that the content of the training workshop was what they expected.	• 100% of participants agreed (strongly or somewhat) that the training objectives were met, that the topics covered were relevant to their profession, and that the training materials/handouts distributed were helpful. • 100% of participants agreed that the quality of logistic and administrative support had a positive impact on their experience at this workshop and that the quality of instruction was exceptional. • 93% of participants agreed that pre-program logistics, support, and information were useful and thorough. • 93% of participants agreed that the training objectives were clearly defined and, that the training experience will be useful in their work. • 87% of participants agreed that each session stated the objectives clearly and that the meeting room and facilities were adequate and comfortable. • 80% of participants agreed that the content of the training workshop was what they expected.

Acknowledgements

Funding provided by NSF ATE Project,
AM-WATCH: Additive Manufacturing-Workforce Advancement and Training Consortium and Hub
is greatly appreciated.