STELAR Webinar Series

Webinar 1: Workforce Development Through Making

Friday, April 12, 12-1 pm ET
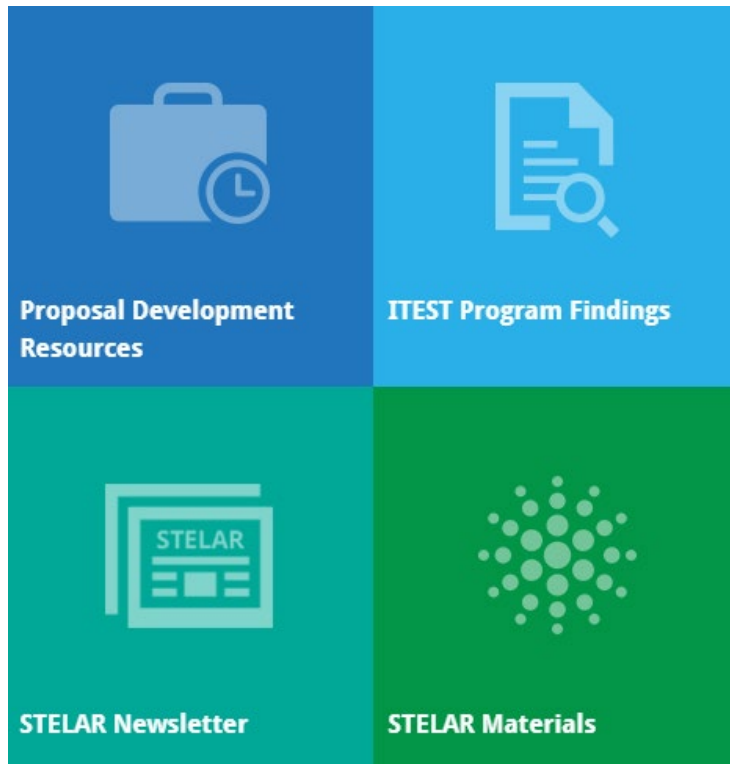
Who STELAR is:

- [Education Development Center](#) in Waltham, MA

- [STEM Learning & Research Center (STELAR)](#) Resource Center for the NSF ITEST Program

- EDC has been supporting the ITEST program and its grantees since 2003, including outreach and support for those interested in submitting a proposal to the program

EDC Education Development Center

What STELAR does:

- Facilitate projects' success through **technical support** with a focus on synthesis of findings

- Inform and influence the field of STEM stakeholders by **disseminating** project findings nationally

- Deepen the impact and reach of the ITEST program by **broadening participation** in the ITEST portfolio

- Assist those interested in submitting an ITEST proposal

EDC Education Development Center

NSF's ITEST Program

- [Innovative Technology Experiences for Students and Teachers (ITEST) Program](#)

- Supports the research and development of innovative models for engaging PreK-12 students in STEM learning

- Builds students interest in and capacity to participate in the STEM and information and communications technology (ICT) workforce of the future

- Current solicitation is under revision, but is expected soon

- **Full Proposal Deadline Date:** August 14, 2019

Event Overview

Charting the Future of Making in STEM Education

NSF EAGER Maker Summit:
Charting the Future of Making in STEM Education

- NSF convening of EAGER Maker funded projects

- Exploration of topics of interest to both NSF and the broader Maker community

NSF 15-086

Dear Colleague Letter: Enabling the Future of Making to Catalyze New Approaches in STEM Learning and Innovation

June 4, 2015

Dear Colleagues:

The National Science Foundation (NSF) has contributed substantially to the development of the US *Maker Movement* and the exploration of *Making* as a pathway to innovations and learning in science, technology, engineering and mathematics (STEM). NSF's strategic fundamental research investments enabled many of the innovations underlying 3-D printing, computer-aided design, geometric modeling and computer-integrated systems. NSF has made a series of investments in the systematic discovery of new knowledge about learning through *Making* in diverse formal and informal settings including fab lab classrooms, television and interactive web media, undergraduate engineering, and the first-ever World Maker Faire.

Today, a growing number of people engage in STEM practices and learning through various forms of *Making*. The *Maker* approach encourages people to understand how things work, to experiment, invent and redesign things through multiple iterations, to democratize and understand processes of engineering, science, and innovation, and to commercialize new products by developing and testing prototypes quickly and in a cost-effective manner. *Making* frequently takes place in social contexts, often called *Maker spaces*, where collaborators, mentors, advisors, and others can be found. These emerging ideas are pointing the way to how the STEM research and education community can both benefit from and contribute to the *Maker Movement*, improving U.S. innovation and STEM workforce development.

EAGER Maker Summit Goals

- Capturing current issues in the Maker movement with respect to education

- Identifying important research issues and trends

- Discussing NSF's investments in the Maker movement

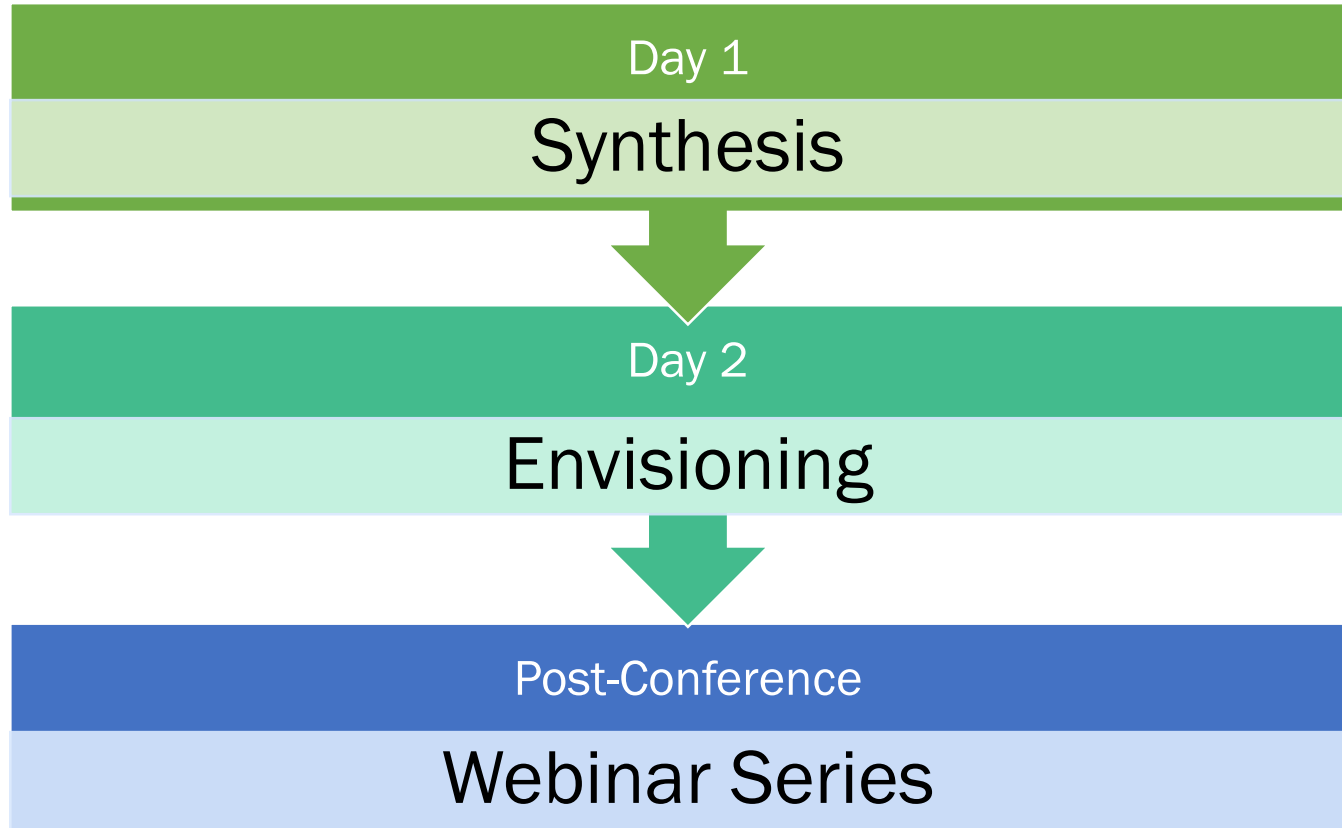- Recommending future directions for NSF research and development

Today's presentations:

- Gül E. Kremer, Iowa State University

- Anthony Dean, Old Dominion University

- Richard Stone, Iowa State University

For more information:

- Email the team at STELAR@edc.org

- Join us for the series:

  - **Webinar 2: Process & Pedagogy,** Friday, April 26 from 12-1 pm ET

  - **Webinar 3 - Research & Evaluation,** Tuesday, April 30 from 1-2 pm ET

  - **Webinar 4 - Broadening Participation,** Tuesday, May 14 from 2-3 pm ET

  - **Webinar 5: Partnerships,** Tuesday, May 21 from 2-3 pm ET

Veteran's Maker Workshop

Our goal was to inspire, engage and connect this vulnerable population with STEM

OLD DOMINION UNIVERSITY
Frank Batten College of Engineering & Technology

125 / 116 Kaufman Hall
Old Dominion University
Norfolk, VA 23529

VETERAN'S MAKER WORKSHOP
FEATURING BIOINSPIRED ROBOTICS

You will learn:

| 3D Printing | Programming of Microcontrollers | Robotic Design Principles | 3D Design |

All completed robots will be donated to Hampton Roads science classes.

Workshop # 2: – OCT. 19th & 20th | 8:00 am – 5:00 pm

* workshop is limited to 10 participants.

EAGER: Understanding the Impact of Making on Veterans in Pursuing STEM Degrees
Project #1749566, Funded by the National Science Foundation

POC: Dr. Tony Dean | adean@odu.edu | 757-683-7121

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Why Veterans?

Each year, [in the Hampton Roads region] roughly 13,000 military personnel leave their respective branches of service and enter the private sector, offering businesses in the region an abundance of skilled, experienced, and highly disciplined workers.   More than over 20% of the entire US Navy is located with in the Hampton Roads area.
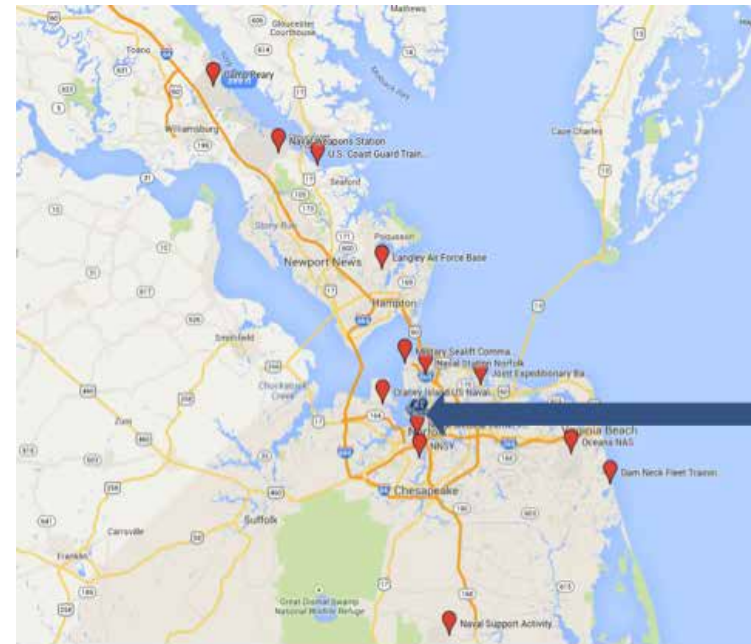
The Veteran STEM Pathway is Unique and Challenging
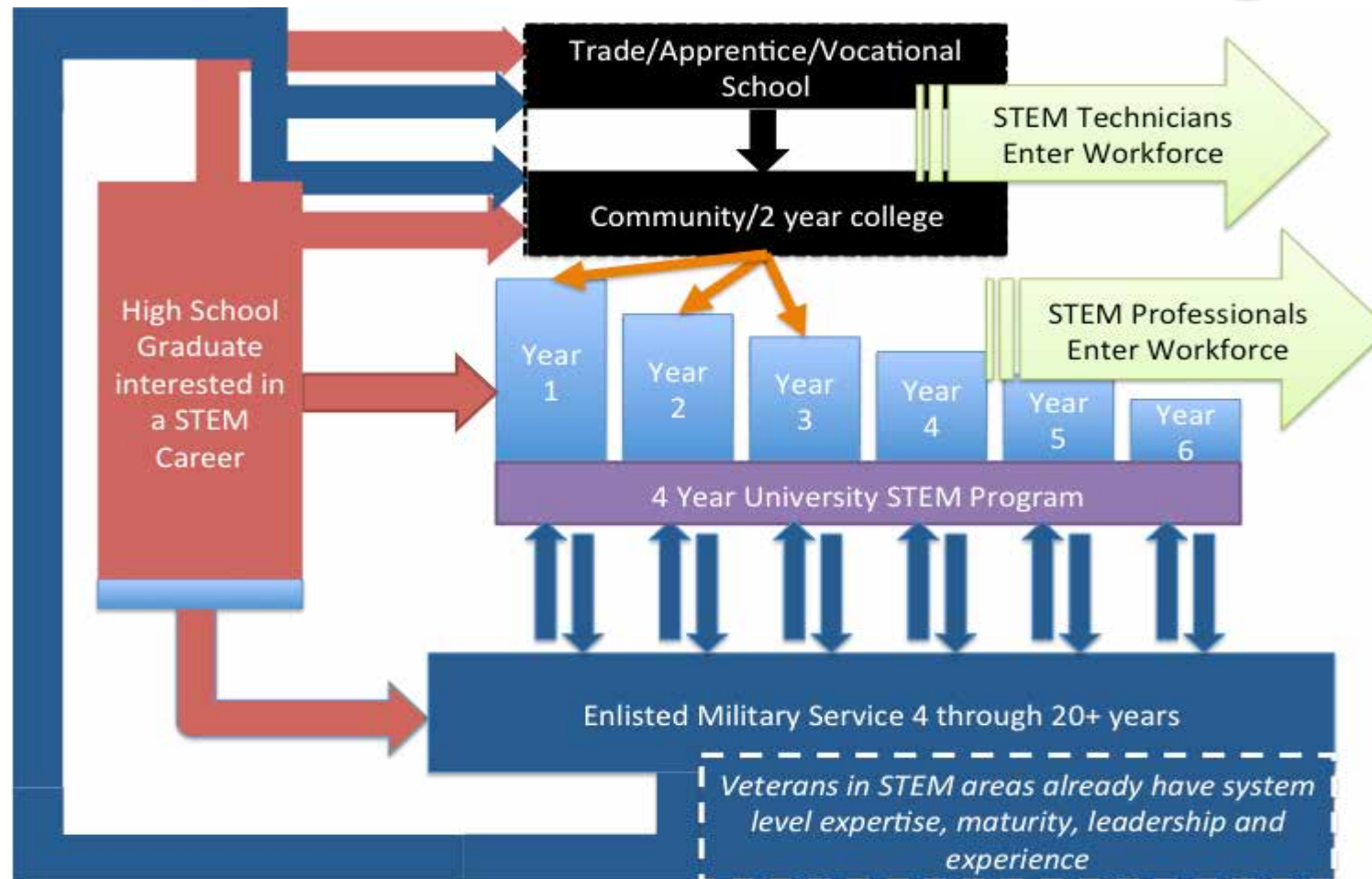
Play Video

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Frank Batten College of Engineering and Technology

QUESTIONS?

Human Centered Manufacturing: How to approach creativity and production design in a maker setting

Richard T. Stone Ph.D.

NSF-EAGER 1723736

Creativity and Workforce Development

- Lack of creativity in engineering shown as major concern (The Commonwealth of Australia, 1999; Tilbury, Reid, & Podger, 2003; Cooper, Altman, & Garner, 2002; British General Medical Council, 1993; White, 2013; Banerjee, 2014; Cropley, 2015)

- Education teaches how to "solve well-defined, convergent, analytical problems" (Cropley, 2015)

- Lack of ability to come up with new designs (Kremer, et al. 2011; Cropley, 2015)

- Human-Centric Design and Manufacturing Course

- Focus on creativity in STEM

- "Making" was fundamental medium to learn and demonstrate learning; allowed for iterative design process

Creativity and Workforce Development

- Creative thinking and iterative design process
  - Brainstorming; mind mapping; TRIZ
  - 9 FDM printers (dual & single extruder); 1 SLA printer
  - Allows use of 'maker space' for more creative designs without worry of failure and equipment damage
- Working with real companies to solve real problems
- Research focus on early stage work with potential to change STEM approach to education and workforce training
- Industrial experience impacted ability to generate and implement creative design solutions

Project Goals & Impact of Industrial Experience

- Lack of creativity in engineering is a real concern

- ¾ of collegiate graduates had skill deficient in problem solving, independent and critical thinking, and creativity [5]

- Time Magazine [15] and Forbes [2] show recent graduates lack creativity and problem solving skills

- "[C]reativity plays a central role in engineering problem solving" [10]
- Creativity based teaching and rapid prototyping

- Holistic approach to engineering; Focus on engendering creativity

- Merging concepts of 3D design, 3D printing, and manufacturing

- Built around human factors, safety, usability, and user experience

Goals
Identify the impacts of industrial experiences on learners' self-efficacy and creative outcomes
Identify the impacts of learning in different programs of study on students' abilities to generate and implement creative design solutions

The Course

- Two Videos
  - https://drive.google.com/file/d/1LHxWfeRiRALTmhGZcIZKwE1cbg7nf_-L/view
  - https://drive.google.com/file/d/1QP4UIdmah34uOLWeCQso4yYhpKgWB81r/view

Initial Results & Engagement

- Control group had significantly more full time industrial experience (p=0.037)

- Design competition metrics trending towards significance in terms of score, creativity, materials, understanding of functions/constraints, marketing, and engineering

- All self-efficacy metrics significantly higher than control group (p<0.05)

- Project and lab scores within subjects significantly different after creativity training

- Difficulty understanding creativity approaches prior to training and in control group

- Multi-disciplinary backgrounds lead to difficulty being comfortable with technology and ability to express creativity

- Technology a large barrier to creativity based projects

Interview Results

- Interviews were conducted on individual participants, at the beginning and end of the course, and groups were interviewed at 5 weeks and then 15 weeks

- Individual: questions related to self efficacy, desire to utilize technology, desire to pursue higher degree and desire to utilize maker approaches in industry were higher in all cases

- Groups: Groups interview revealed a high level of team interaction, a strong level of interaction and a reduced level of team based issues, when compared to mid class interviews

FRONTIERS OF MAKING:
ENABLED BY NATIONAL SCIENCE FOUNDATION

Gül E. Kremer, Ph.D.

- 3D Printing Technologies
- Computer Aided Design software

PART I:
ENABLING RESEARCH & DEVELOPMENT

Enabling technology development started in laboratories across the nation.

Joseph Beaman and **Carl Deckard (Univ. of Texas – Austin)** were the first to demonstrate and commercialize a process known as selective laser sintering, where a high powered laser is used to fuse small particles into precise 3-D shapes.
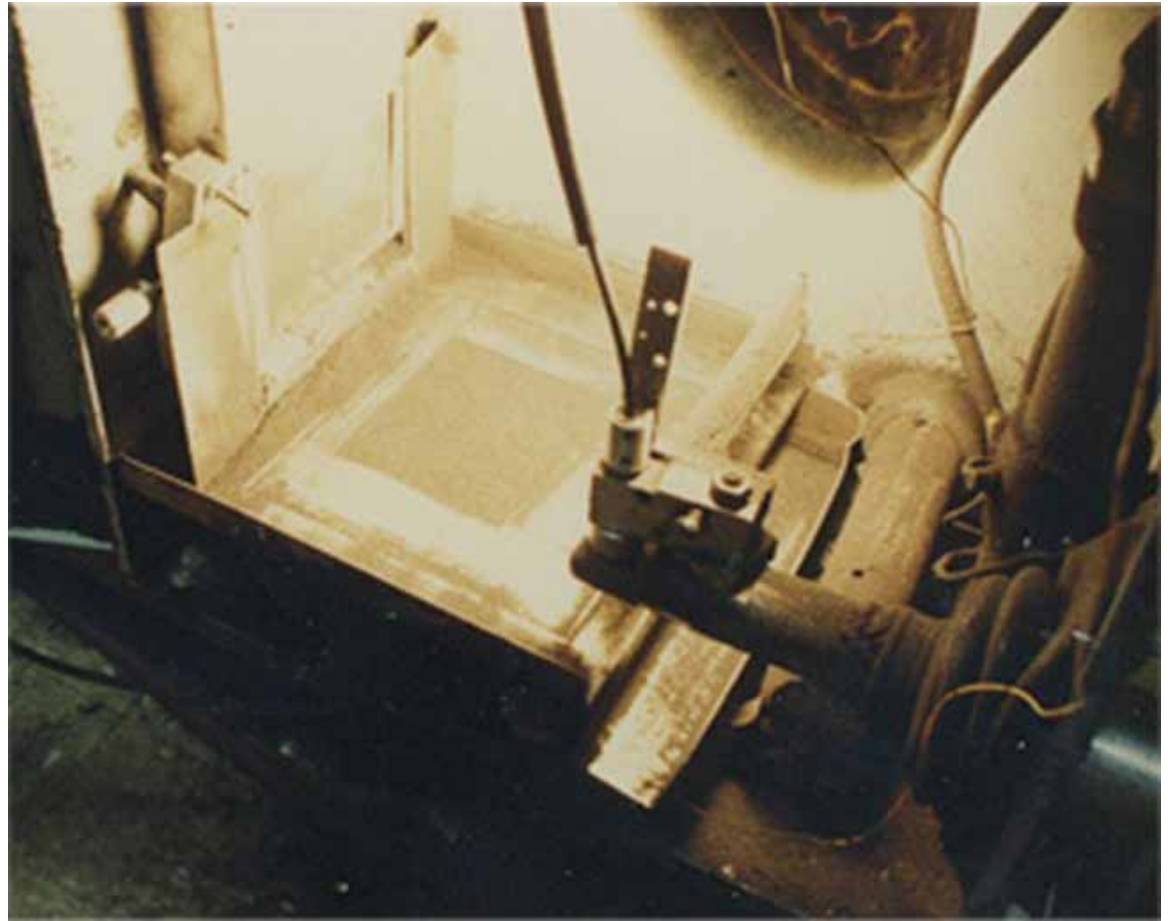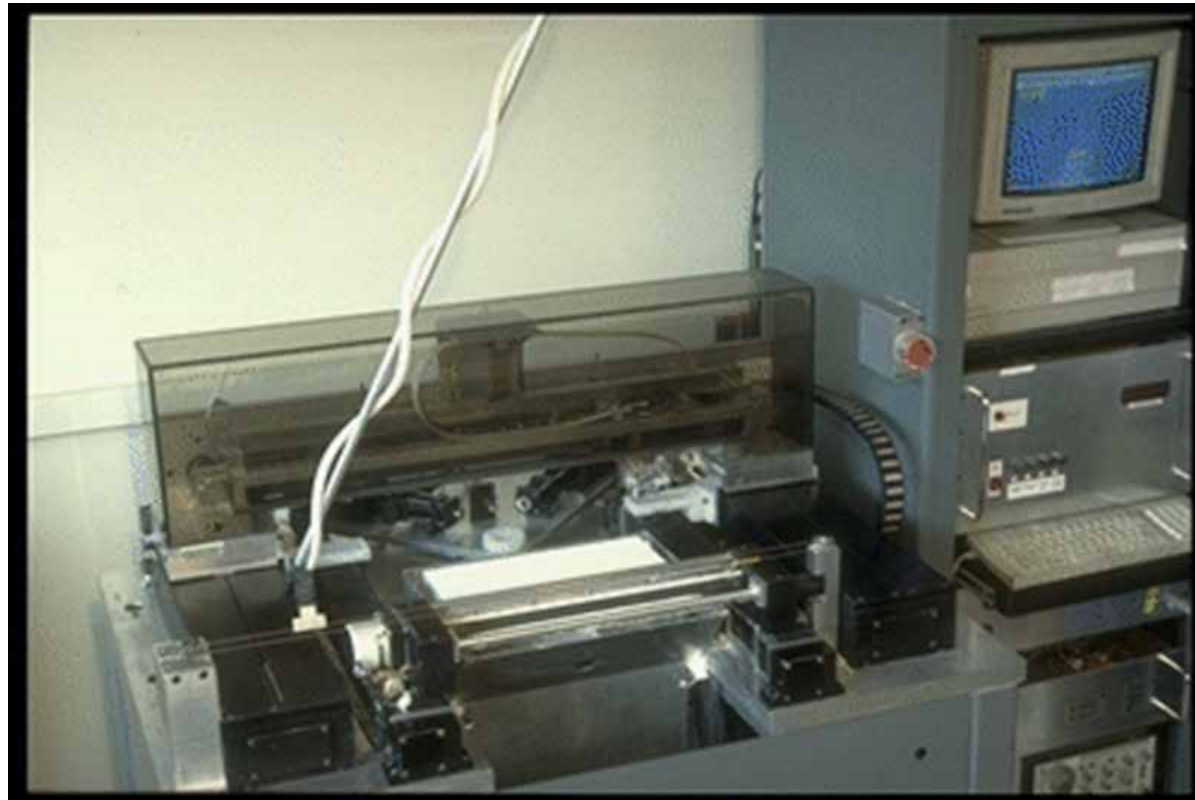
A team led by **Emanuel Sachs (MIT)** developed the technique of laying down a layer of a powder and then squirting a liquid binder on the areas to construct 3-D objects.

The first practical software for three-dimensional modeling was developed in the 1980s at University of Rochester.

- "Support from federal agencies, such as the National Science Foundation (NSF) and the Department of Defense (DOD), was instrumental in the early research and development into additive manufacturing,"

  Government Accountability Office, [Report on 3-D Printing](), June 2015.

- Since 1986, when it first began funding additive manufacturing, NSF has committed more than $200 million to additive manufacturing research and related activities, essentially sustaining and enabling the Maker movement.

Advanced Manufacturing

- **MEP:** Smart Manufacturing of Hybrid Materials with an Exceptional Combination of Strength and Toughness

- **MME:** Scalable Laser Printing of Three-Dimensional Living Tissue Constructs

- **NM:** Ambient Processing and Patterning of Graphene Oxide across Multiple Length Scales

MEP: Materials Engineering and Processing
MME: Manufacturing Machines and Equipment
NM: Nanomanufacturing

- How can we benefit from engagement of youth in making?
- Recent funding figures
- MAKER-DCL

PART II:
COGNITIVE & SOCIAL BENEFITS OF MAKING

Enabling the Future of Making to Catalyze New Approaches in STEM Learning and Innovation

NSF challenges and encourages the community to submit innovative proposals for fundamental research or the integration of research and education that:

Reveal the processes and potential benefits of learning, e.g. design thinking, in the *Maker* context

Leverage *Making* to develop and test its role in improving the effectiveness of formal and informal learning pathways for increasing retention and broadening participation in STEM for students and faculty

Explore new ideas and models of formal and informal STEM learning by leveraging existing knowledge in Making

Enabling the Future of Making to Catalyze New Approaches in STEM Learning and Innovation

Investigate and test effectiveness of new approaches to design and innovation enabled by *Maker* spaces and practices

Enable new tools and knowledge for design and prototyping across all disciplines that can significantly increase *Making* capabilities
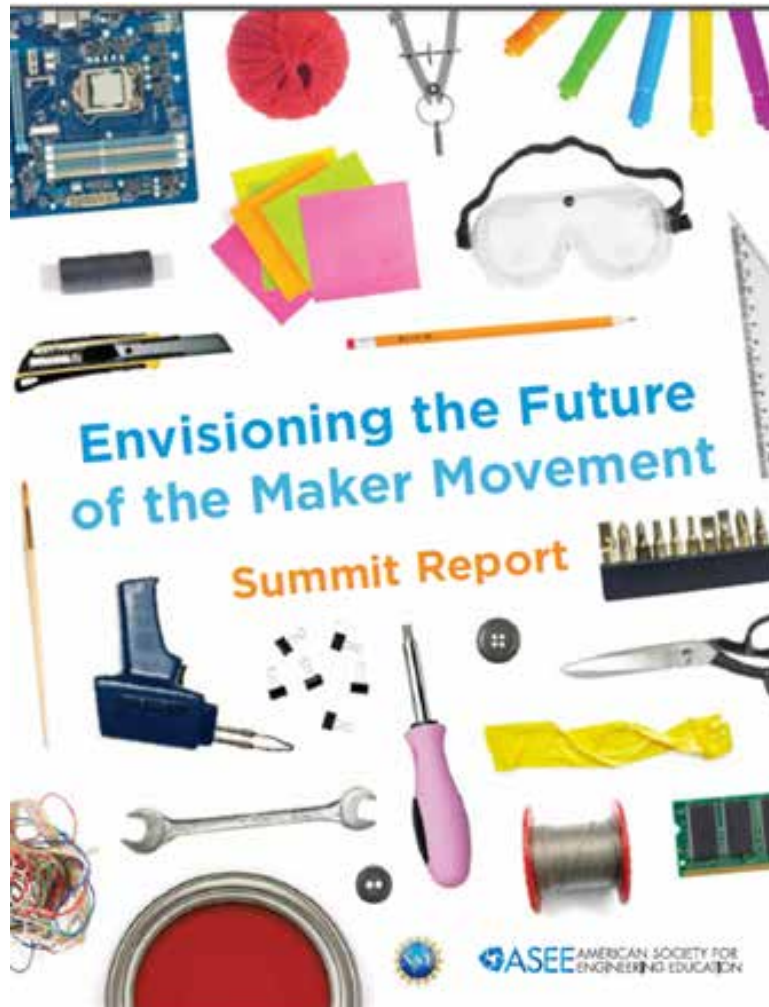
Further the understanding of innovation processes from prototypes through their transition to products that have greater societal and economic impact through enhanced marketability and large-scale market adoption

EEC- 1545614

https://www.asee.org/member-resources/reports/maker-report-2016

Key Findings:

Makers seek stronger networks.

Educators must pursue more organic evaluation efforts addressing practical skills and long-term learning to more effectively assess the impact of Making on learning.

The movement must embrace efforts to increase diversity, accessibility, and inclusion to sustain and impact economic and global workforce advancement.

Makers need greater access to both tangible (3D printers, computer software) and intangible (best practices frameworks, Maker-specific Communities of Practice, targeted opportunities) tools to sustain a strong base of dedicated participants.

Roles and relationships of movement participants and stakeholders (students, educators, government officials, members of the STEM community, manufacturers and industry leaders) must be broadened and Makerspaces must adopt a more holistic, culturally expansive, and community centric role.

Workforce Development

Day 1 – Synthesis: The State of Making

- Explore the innovations and challenges that currently exist in Making projects focused on workforce development

- Share dreams and aspirations for the future of making

Day 2 – Envisioning: Call to Action

- How do we get from where we are now to where we want to go?

- How can NSF support Making projects in working towards these goals?

- Identify gaps in the current body of research

Synthesis: The State of Making

Challenges:

- Understanding workforce needs
  - Skill sets
  - Location barriers
  - Income limitations
  - Financial goals
- Transition from Maker to workforce
- Sustainability models

Innovations:

- Partnerships with Industry/Employers
- Skills translation to careers
- Building self-efficacy
- Informal education opportunities

Synthesis: The Future of Making

- Industry partners to support/sustain small-cottage workforce models.

- Industrial partnerships at a larger scale

- Support the industrial supply chain

- Small batch manufacturing at various machine shops/point of demand

- Digital thread transition from concept to actualization

- Development of skill sets for the workforce and mapping them to jobs

- Maker -mindset to enhance career-long learning and advancement

- Connection of rural makers to the future on-demand delivery of goods

Envisioning: The Path Forward

- Industry commitment to making

- Broader public awareness

- Transitional projects to move from public makerspaces to more formal educational programs that support the 'new workforce'

- Facilitating moving from makerspace to workshop/tradesperson in the future:

  o Changing technology

  o New manufacturing models on small scale

  o Creating a new tradesperson with new skillset

Envisioning: The Path Forward (cont.)

- Facilitating moving from makerspace to workshop/tradesperson in the future:

  o Changing technology

  o New manufacturing models on small scale

  o Creating a new tradesperson with new skillset

- Certifications in areas important to industry

- Engagement and transition of non-traditional students into the 'new workforce' at all levels (adult learners, veterans, under-represented minorities, women and those with disabilities).

EDC Education Development Center

Envisioning: Call to Action

- Involve industry and government agencies (OSD, Navy, Army, Airforce, SBA, NIST) into the discussion

- Formalize pathways from "making" to STEM careers at various levels

- Industry accepted certifications

- Structured approach to learning

- Relationship building with industry (how-to, internships, local business connections)

- Wider access to training and development in "making"

Questions?

Comments?

Other ideas?

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