
MIT and Advanced Manufacturing Institutes

Education, Practice, and Research

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- From flexible hybrid electronics, to integrated photonic devices, to functional fibers to smart manufacturing, the new U.S. Federal government institutes are advancing new manufacturing technologies and accelerating the pace of manufacturing innovation. This session will **discuss collaborative opportunities for industry partners to participate in education, practice, and research - developing new products and capabilities and people.**

4 Topics

1. What is Manufacturing?
2. Collaborate with MIT in Manufacturing Innovation Education.
3. Collaborate with MIT in the Practice of Advanced Manufacturing
4. Collaborate with MIT in Medical Device Innovation and Manufacturing Research.

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What is Manufacturing?

Is it?

- “Making”
- Machining
- Etching
- Photolithography
- CVD
- Injection Molding
- Materials Processing
- Mechatronics and Robots
- Automation
- Integrated Photonics
- Nanomaterials
- Roll to Roll Processes
- Electron Beam Epitaxy
- Welding
- Supply Chain
- Logistics
- ...

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No...

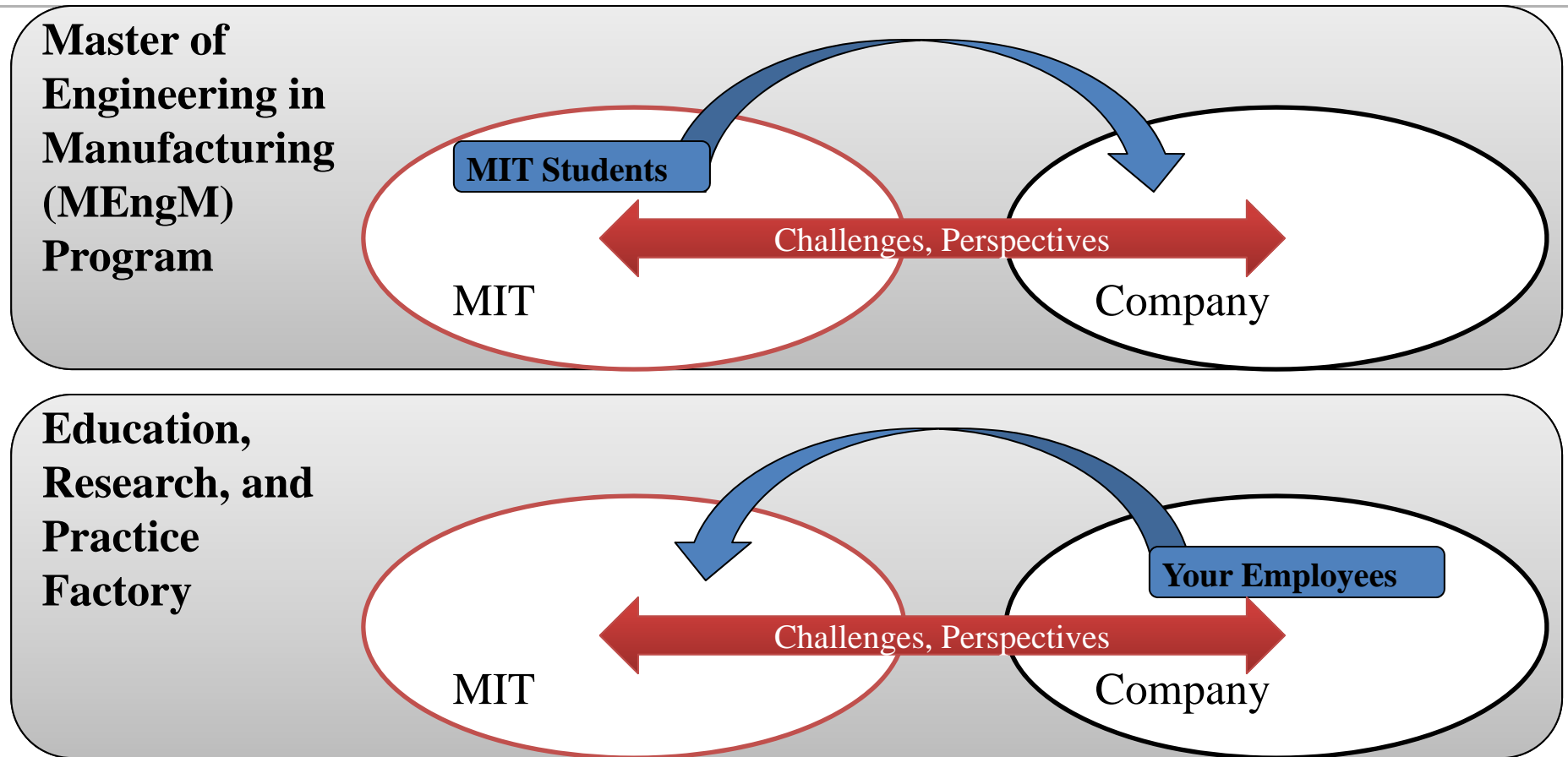
It is

- Making **Products** using Combinations of these **Technologies** to meet commercial drivers of:

- *Demand*
- *Cost*
- *Quality*
- *Flexibility*

... in a complex system where material and information and people are in constant motion and variability must be understood or controlled.

Flow of people in the Manufacturing Ecosystem



How to Collaborate with MIT in

**MASTER OF ENGINEERING IN
ADVANCED MANUFACTURING
AND DESIGN (MENGDM) PROGRAM**

M. Eng. in Manufacturing

- “The Master of Engineering in Advanced Manufacturing and Design is a **twelve-month professional degree** that is intended to prepare the student to assume a **role of technical leadership in the manufacturing industries**. The degree is aimed at **practitioners** who will use this knowledge to become leaders in existing as well as emerging manufacturing companies”

Goals

- Create Technical Leaders for Global Emerging Industries
- Create Engineers with a “Systems” view
- Give a Strong Base for working in any Industry
- Emphasize Math and Science Based Methods for Analysis, Design and Operation of Manufacturing Enterprises
- Create an Understanding of the Global Manufacturing Strategies

What is the MEng in Manufacturing?

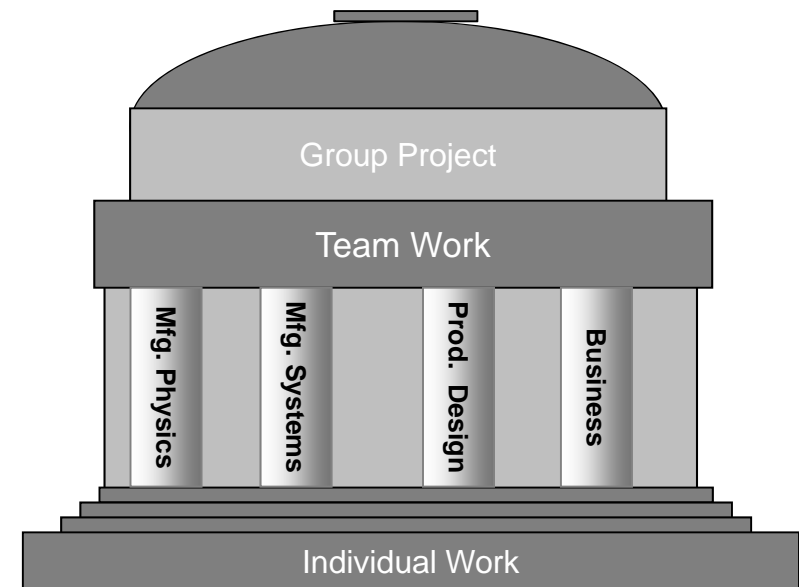
- One Year, **Non-Research** Graduate Degree
- **Comprehensive** Design and Manufacturing Curriculum
- Taken as a **Cohort**
- Emphasis on Using **Engineering** Background
- Introduction of the **Systems** Perspective
- **Project**-Based, and **Team**-Based Curriculum
- Strong **Industry** Connection
 - 8 of 12 Months on Group Project in Industry.

Master of Engineering in Manufacturing (MEngM) Program

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MengM Curriculum Elements

- Design and Manufacturing
 - Design for Manufacturing
 - Product Development Process
- Manufacturing Physics
 - Processes, Machines, Assembly, Process Control
- Manufacturing Systems
 - Factory Design and Control
 - Supply Chain Design and Control
- Management and Global Manufacturing
 - Management for Engineers
 - Seminar in Global Manufacturing
- Group Projects in Industry



Group Projects

- Based in a Company
- Teams of 3-4 Students
- **Solve Problem of Immediate Value to Company and Pedagogically Aligned with the Degree**
- During 8 of the 12 months of program
- Project Definition is Critical

Examples

- Product and Process Design for a Diagnostic Microfluidic Device
- Implementation of RFID (internet of things) for Product and Equipment Tracking in a Factory
- Process Development for a High Volume Factory
- Supply Chain Planning for New Products
- New Product Introduction (NPI) manufacturing line development
- ...



Master of Engineering in Manufacturing (MEngM) Program

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MIT Connected Manufacturing Institutes...

- Photonics
- Flexible Electronics
- Fibers and Fabrics
- ...

all at very different level of starting maturity.

Flexible Hybrid Electronics MII



America's Flexible Hybrid Electronics Manufacturing Institute

NextFlex Mission

Catalyze the development of an ecosystem for manufacturing new forms of electronics that **integrate bulk ICs** and **printed devices** with functions such as power, communications, fluidics, and bio-sensing in **flexible systems** that can bend, fold, stretch, and conform.

Technology Platform Demonstrators

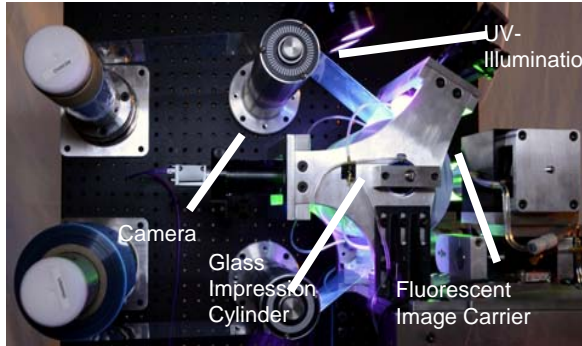
- A. Human Monitoring Systems
- B. Asset Monitoring Systems
- C. Integrated Array Antenna Systems
- D. Soft Robotics



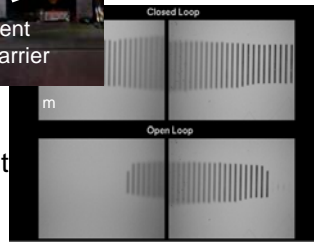
Intended to facilitate the identification of critical and pervasive **manufacturing gaps**. These manufacturing gaps will be addressed by targeted projects addressing one or more of the manufacturing **technical thrusts**.

MIT Expertise and Capabilities

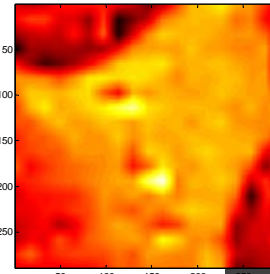
In-situ metrology systems, Precision print-head control



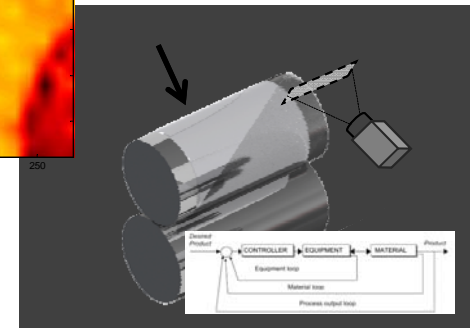
Continuous R2R Contact Tracking, Control, Alignment



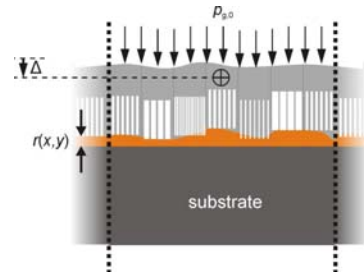
In-Process Control – Pattern Fidelity



Pattern Deformation, or Quality Map

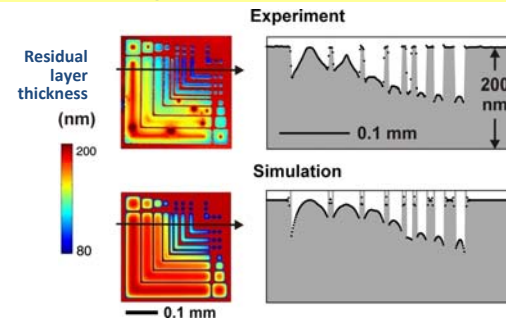


Nanoimprint Spatial Modeling & Design Optimization

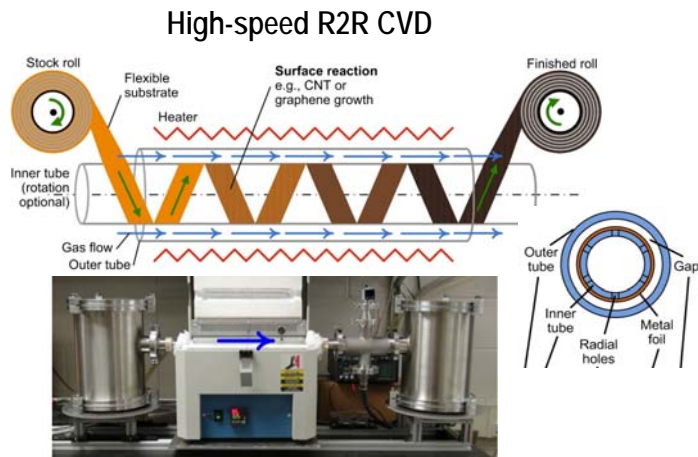


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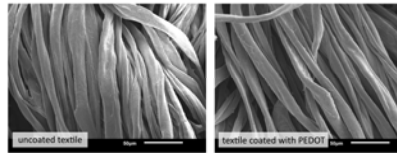
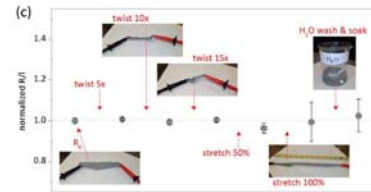
Imprint of 200 nm-thick polymethylmethacrylate
495 kg/mol, c. 165 °C, 40 MPa, 1 min



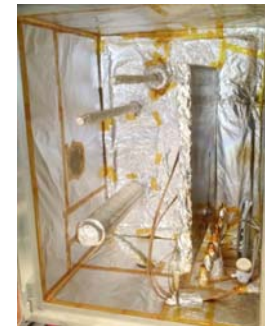
MIT Expertise and Capabilities



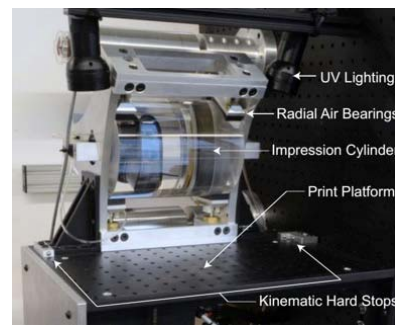
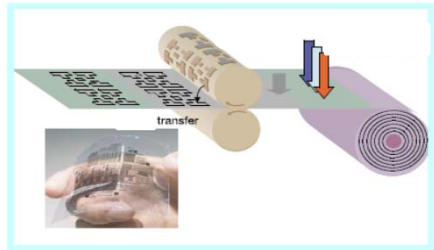
Vapor Printing of Electrodes & Sensors



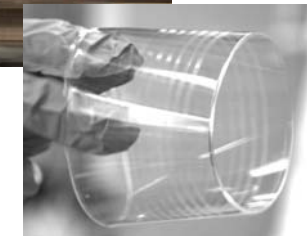
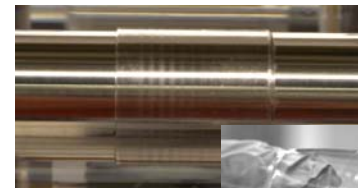
Conformally coated fibers: Breathable electrodes



Roll-to-Roll Microcontact Print (μ CP): Large Area, High Rate – Equipment, and Seamless Stamps

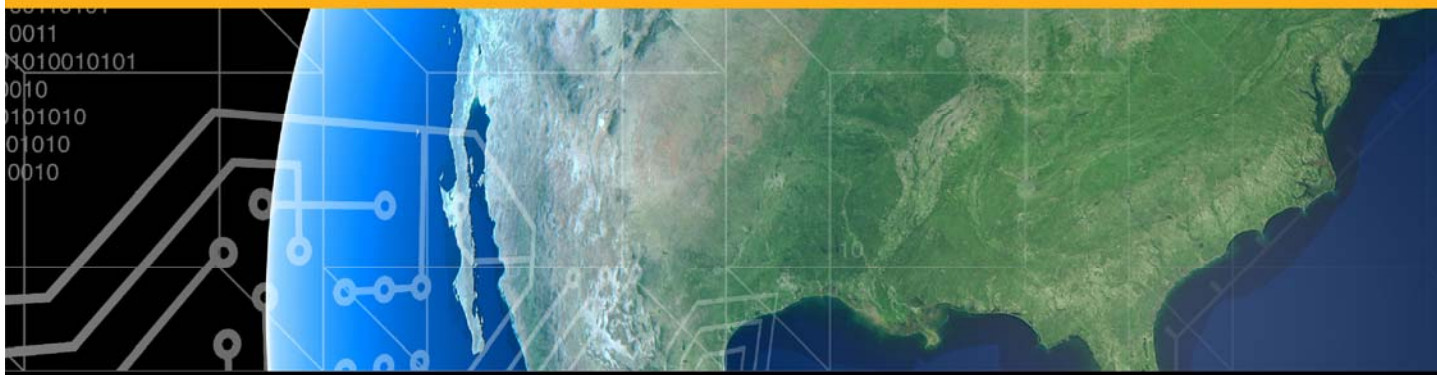


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AMERICAN INSTITUTE *for* MANUFACTURING INTEGRATED PHOTONICS





AIM Photonics Vision and Mission



American Institute for Manufacturing integrated Photonics

- ❑ **VISION:** *Establish a technology, business and education framework* for industry, government and academia to accelerate the transition of *integrated photonic solutions from innovation to manufacturing-ready deployment* in systems spanning commercial and defense applications.
- ❑ **MISSION:** Create a national institute *supporting the end-to-end integrated photonics manufacturing ecosystem* in the U.S. by expanding upon a highly successful public-private partnership model with open-access to world-class shared-use resources and capabilities.



AIM Photonics Academy Vision and Mission

AIM Photonics Academy will provide the unified knowledge, technology, and workforce interface for AIM Photonics.

Support community, careers and investment for US world leadership in Integrated Photonics manufacturing.

- ❑ *Roadmap: supply chain; technology and workforce timelines*
- ❑ *Workforce Development: needs, pathways, practice*
- ❑ *Education: design, content, distribution, practice, certification*
- ❑ *Assessment: workforce, AIM Academy impact, best practices*
- ❑ *Digital Presence: simulation, website, on-line distribution*

AIM Photonics Academy will provide the unified knowledge, technology, and workforce interface for AIM Photonics.

Goals

Radically advance manufacturing education :

- 1) Developing blended (digital and in-person) learning curriculum and programs and
- 2) Designing, building and operate collaborative practice facilities.

Working with industry to Build and Support the Supply-Chain and Workforce in Integrated Photonics Manufacturing



Programs and Practice

- Credentials and Professional Certificates
- Degree Programs in Advanced Manufacturing with Technology Tracks
- Design Automation Software Practice Environment
- Education and Practice Factory – Practice facility

Programs

	Non-Degree Certificate External Focus	Degree Options MIT Students Focus
In-Person	<ul style="list-style-type: none">• Advanced Studies Program *• MechE/Meng Certificate External Program *	<ul style="list-style-type: none">• IP MCore Certificate to any engineering student• “Graduate Minor”• MEng in Manufacturing curriculum with tracks for specialization
On-Line	<ul style="list-style-type: none">• Xseries Certificate *• MIT Professional X *	

What is an Education and Practice Factory

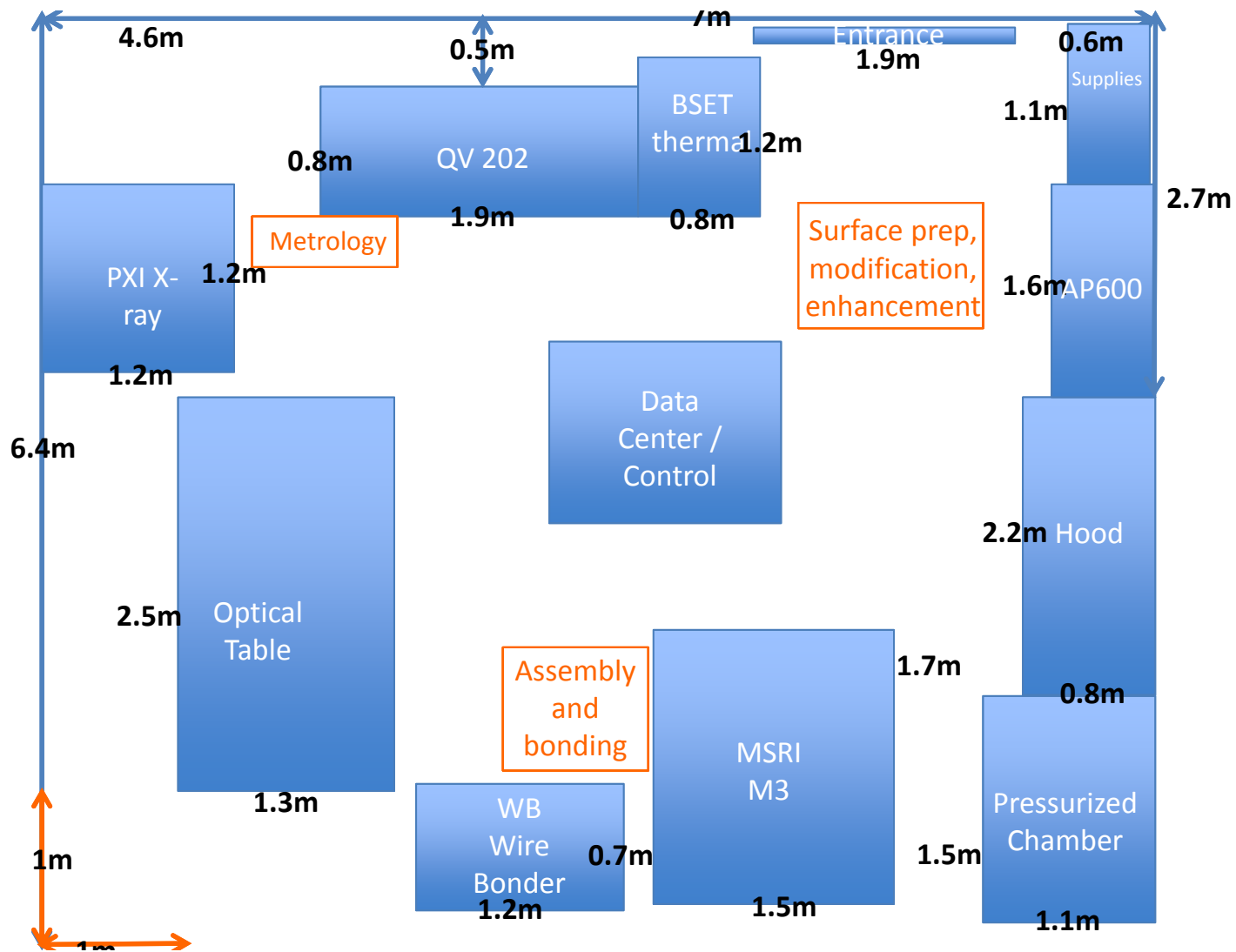
- facilities co-staffed by students, researchers and professional manufacturing staff,
- connected to the commercial and academic needs and environments,
- which will produce - equipment or components - for the **education, research,** and early **scale-up needs** of company partners,
- and which will serve as a **laboratory-factory** to teach and research advanced manufacturing concepts

Thanks to Commonwealth of MA

Education Practice Factory – First Equipment – Thanks to Commonwealth of MA



BSET (E)	Thermal processing system	
Mitutoyo (A)	ATV SRO-700	
	QV Active 202	
MRSI (B)	Ultra precision assembly workcell mrsi-m3	
Nordson (F)	AP600 plasma treatment equipment	
PXI (H)	Pacific X-ray Imaging 130	
West Bond (D)	Die Bonder	



How to Collaborate with MIT in

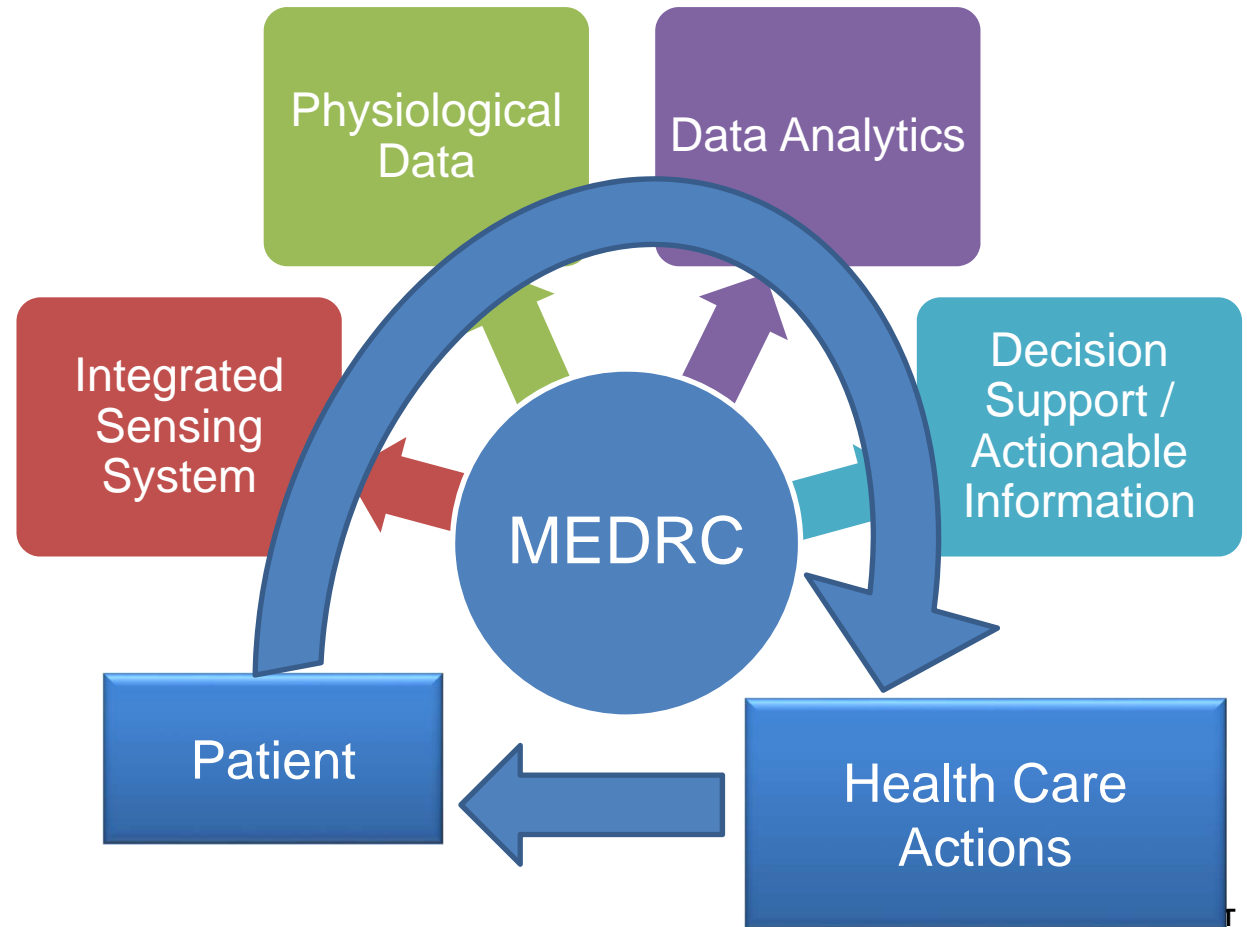
**MEDICAL ELECTRONIC DEVICE
REALIZATION CENTER (MEDRC)**

Medical Devices as Context for Advanced Manufacturing Research

- Manufacturing research without a product focus seldom leads to significant breakthroughs.
- Highly personalized medical devices.
- Advanced technologies, methods of printing flexible electronics and additive manufacturing, integrated photonics make personalization feasible.

Medical Electronic Device Realization Center

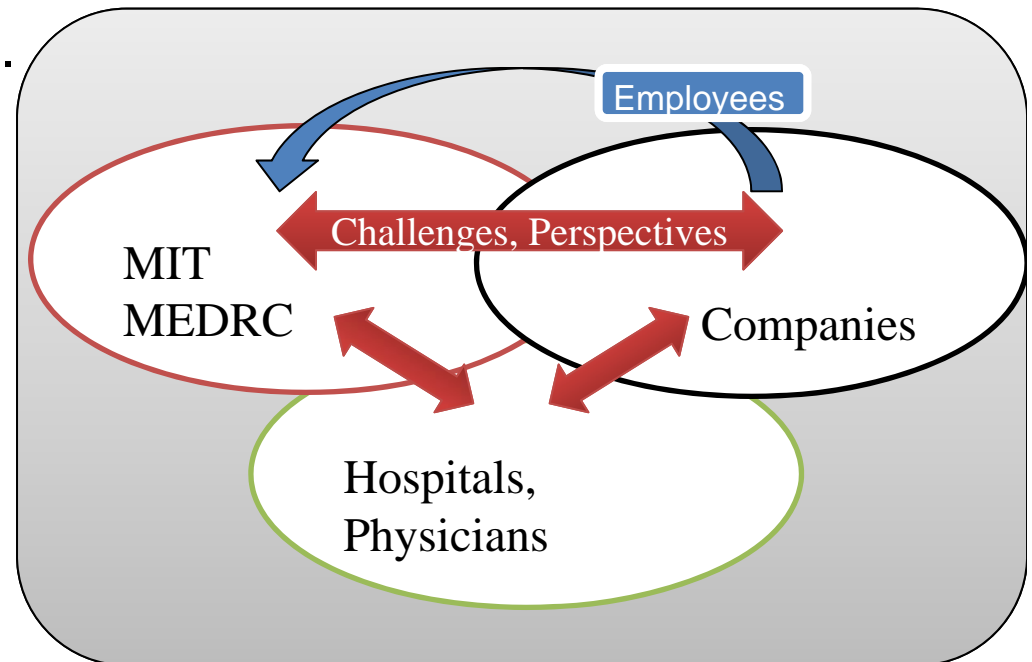
Solving clinical needs, by innovating user-centric manufacturable devices, leveraging the power of the microelectronics industry and Boston / Cambridge Ecosystem.



MEDRC at MIT does Medical Electronic Device Research with **strong interaction** between companies and physicians/clinicians.

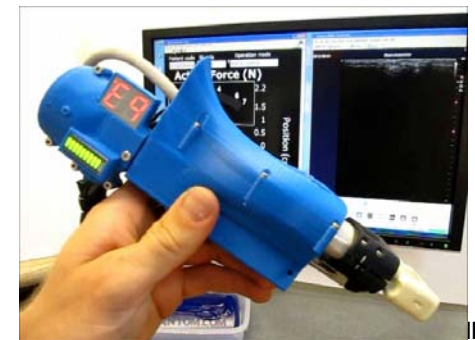
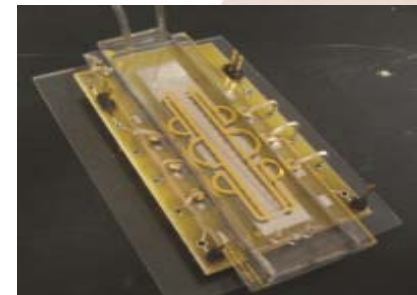
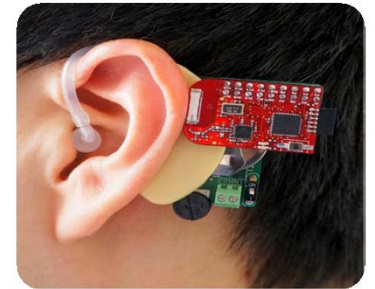
- Each sponsored project *jointly created* by industry, academics, and clinicians → maximizes chance of project success.
- Industrial scientist *on-site* at MIT → company stays engaged, project stays relevant, technology transferred to the company.
- Early prototypes placed in “customers” (clinicians) hands in parallel with research technology development.

MEDRC - Model



Application Areas and Technology Examples

- Wearable Devices
 - Vital signs monitors including cuffless blood pressure
- Minimally Invasive Monitors
 - EEG measurements for Epilepsy patients
- “Point of Care” Instruments
 - “Lab on a Chip” for blood, urine, saliva analysis
- Imaging
 - Smart Ultrasound
- Data Communication
 - Body Area Network
- Pharma
 - Clinical trial of the future



Medical Electronic Device Realization Center (MEDRC)

How to work with MIT

- Host manufacturing **projects**
- **Training programs** at your organization
- **Education and Practice Factory** as a resource
- Strengthen your workforce – **degree programs, training and professional programs**
- Collaborative **Medical Device** research

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Thank you.

Questions?

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