

# Micromanufacturing

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## Micromanufacturing The WTEC Expert Panel



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## Micromanufacturing -- Summary

### Imperatives

- **Micromanufacturing** should be a **Priority R&D Area**.
- Both **Science and Technology** and **Partnership among industry, university and government** should be **promoted**.
- **A Decisive Role by Government** is important.

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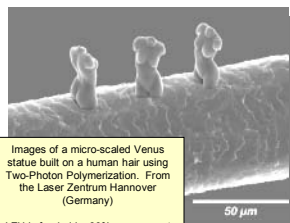
## Micromanufacturing - What is it?

### Manufacture of products with the following features:

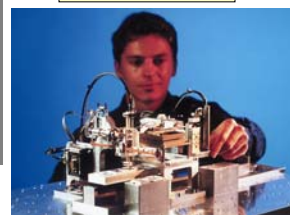
about **1/1000 to about 1/2 inch in size**  
contain very complex **3-D (free-form) surfaces**  
employ a **wide range of engineering materials**  
are **ultra-precise**

### Manufacturing performed by:

**miniaturized machines** and **processes**  
**"Microfactory" (Desktop) manufacturing paradigm**



AIST - Japan  
Micro-lathe



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## Micromanufacturing is critical to ---

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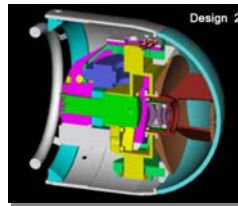
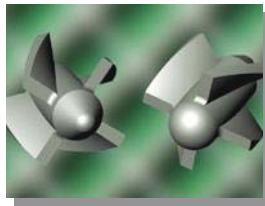
- National security and defense
- Energy
- Healthcare
- Maintaining a domestic manufacturing base

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## Micromanufacturing – Impact on National Security and Defense

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### Next-Generation Weapon Systems and Components



Micro-parts/systems to enable miniaturization and fabrication on warships, battlefield, etc.

- Surveillance system
- Micro-nozzles for high-temperature jets
- Micro-satellites
- Small Unmanned Reconnaissance Planes
- Etc.



Micro-motor

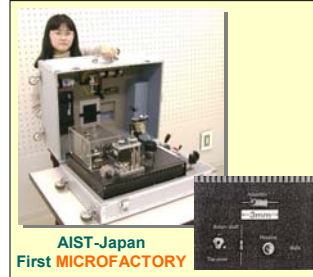
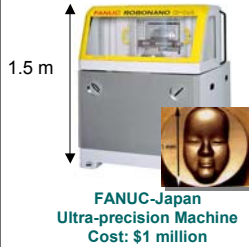


Metallic parts

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## Micromanufacturing – Impact on Energy

### Smaller Machines - Less Energy Consumption



**Micro-fuel cells for the Hydrogen Economy need micro-metallic parts**

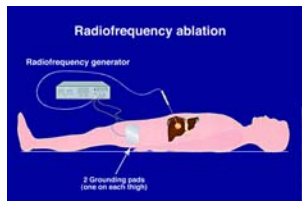
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## Micromanufacturing – Impact on Healthcare

**\$60 Billion Market  
Medical Devices**



**Example: Enable Delivery of Saline Solution in Vicinity of Liver Cancer Tumor for Treatment using High Frequency Electrical Pulses**



250 micron hole diameter

Lincoln's Profile  
On the Penny

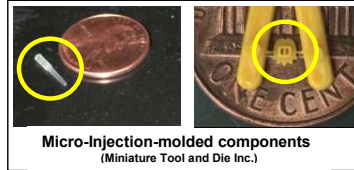
Micro-Machine at EIGERLab in Rockford, IL  
(EIGERLab funded, in part, by SBA Grant and USArmy, Congressman Don Manzullo (R))

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## Micromanufacturing – Impact on Domestic Manufacturing Base

### Markets:

- Micro-injected plastic parts
- Electronics
- Fiber optics systems
- etc.



### Bridging the Gap between the Nano- and Macro-Worlds

Example: laser machining of tiny parts with nano precision for missile guidance systems



Laser gyroscope Ariane IV - Germany



In Vivo Magnetically Guided Micro-Robots  
– ETH - Zurich

**Desk-top machines enable a Cottage Industry**  
Redistribute manufacturing capability from the Hands-of-a-Few to the Hands-of-Many

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## Micromanufacturing – Report Card

Countries	Japan	Taiwan	Korea	Europe	U.S.
<b>Activities</b>					
Government Funding in micro-manufacturing	****	****	***	*****	*
State of the micro-manufacturing technology	*****	****	***	*****	**
Industry/Univer- sity/Govt Partnership	***	***	****	*****	*
Nano- technology	****	**	*	***	*****

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## Micromanufacturing -- Recommendations

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### Program Imperatives

- **Micro- Manufacturing** should be a **Priority R&D Area**.
  - ✓ leverage enormous investment in nano-science to enable broad commercialization
- **Create Programs** that support Micromanufacturing Science and Technology development **and** that partner industry with university research and education programs to **promote both technology and workforce development**.
- **A Decisive Role by Government** is essential to regain US lead.

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***Thank You!***

Questions?

More Information  
[www.wtec.org/micromfg](http://www.wtec.org/micromfg)

## Micromanufacturing Is an Important New Technology Because

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It is an **Enabling Technology** for the Widespread Exploitation of Nanoscience and Nanotechnology Developments

..... **Bridging the Gap between the Nano- and Macro-Worlds**

It is a **Disruptive Technology** that will Totally Change Our Thinking as to How, When, and Where Products Will be Manufactured

..... **e.g., On-Site, On-Demand in the Hospital Operating Room or On-Board a Warship**

It is a **Transforming Technology** that will Redistribute Manufacturing Capability from the Hands of a Few To the Hands of Many

..... **Micromanufacturing Becomes a Cottage Industry**

It is a **Strategic Technology** that will Enhance U.S. Competitive Advantage

..... **Reduced Capital Investment, Reduced Space and Energy Costs, Increased Portability, Increased Productivity**

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## Micromanufacturing What are U. S. Competitors Doing? Highlights of the WTEC Study

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**In both** Asia and Europe, most companies invest a very high percent of their total budgets in R&D Activities

For example, at Samsung in Korea, R&D investment has been 3.9% of their budget (2001), 5.3% (2002), 6.4% (2003), and will level off at 8.5% next year.

**In both** Asia and Europe, government policies on funding R&D encourage strong partnering among government, university and private sectors

For example, the Fraunhofer Institutes funded by the German government are generally co-located with a major university to provide a strong link between the private sector and the university through both short-term and long-term R&D projects

**In both** Asia and Europe, large national projects have been initiated in Micromanufacturing (and in other advanced manufacturing technologies)

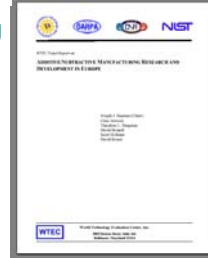
**In both** Asia and Europe, R&D tends to be very product-oriented with patient and sustained efforts aimed at refining the technology; more emphasis on “down-to-earth” as opposed to “blue-sky” initiatives

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## Micromanufacturing What are U. S. Competitors Doing? Highlights of the WTEC Study

The WTEC panel on **Additive/Subtractive Manufacturing** also concludes that:

1. There is substantial funding in Europe for important [manufacturing] process development for technologies that were in many cases initiated in the U.S.
2. There is more innovative and leading-edge R&D in Europe than 5 years ago. Total R&D in Solid Freeform Fabrication (layered manufacturing) is presently higher than in the U.S.
3. As compared to the U.S., there are much closer ties in Europe between university researchers and industrial needs.



**Three recent WTEC studies all reach the unanimous conclusion that advanced manufacturing receives a much higher level of government support in both Asia and Europe than in the U. S.**

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## Micromanufacturing Report Card for U.S. versus Asia and Europe

Visits to (46) company, government labs, and university sites in Japan, Taiwan, Korea, Germany, Switzerland, Austria and the Netherlands have revealed:

- U. S. lags Asia and Europe in the development of Micromanufacturing processes and equipment.
- U. S. is particularly behind in moving R&D results to commercialization
- U. S. gets low marks for ability to leverage University Research through strong industry partnerships
- U. S. National Initiative on Nano-science and Technology puts us in a good position, but at the end of the day, competitive advantage comes from moving good science along the technology-development-life-cycle to commercialization
- The panel found that Asia and Europe get high marks on this latter point

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## Micromanufacturing What the Government Should Do to Promote and Sustain its Growth

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### Recommendations

In another recent study, the National Academy of Engineering Committee on **New Directions in Manufacturing** (2004, <http://books.nap.edu/catalog/11024.html>) of the National Research Council has stated that:



“Innovation, in this case the successful exploitation of new ideas, has many prerequisites. The most important is the new idea itself, which in turn relies on research. **The federal government can facilitate innovation in the manufacturing sector by establishing policies that encourage basic science and, at the same time, implement programs that share the risk of development with the private sector. This type of public-private partnership can be very effective in accelerating the transition of new technology concepts.** For all the partners to interact effectively, it is important to establish responsibilities for the intellectual property and standards for research, product development, and product realization.”