WTEC Micromanufacturing

Conclusions

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CONCLUSIONS

- √ **Micromanufacturing Trends**
- √ **University Research**
- √ **Government Labs**
- √ **Industry**

Micromanufacturing Trends

Desktop Manufacturing. Trend toward miniaturization of machines is evident in both Asia and Europe, with commercialization of desktop machine tools, assembly systems, and measurement systems well underway.

"Microfactory Paradigm" more evident in Asia than Europe with several concept systems developed as far back as ten years ago; In Europe focus is more at the machine/process level.

Worldwide Micromanufacturing Initiatives: Emerging miniaturization technologies are clearly driving developments in micro-scale processes, machines, metrology; lots of activity in both Asia and Europe.

University Research

Research-to-Technology Refinement-to-Commercialization appears more organized and funded for the long-term at the federal government levels in Asia and Europe than the U.S., resulting in more sustained efforts to refine and fine-tune new developments.

Leveraging of University Research. University/Industry connection and interaction is less apparent in Asia than in Europe, where it is very strong.

Emphasis of University Research. In both Asia and Europe, university research tends to be more device development oriented with longer-term projects. Activity in the areas of process fundamentals, particularly, modeling and simulation, were less evident

Government Labs

Government-funded Laboratories in Asia. AIST and Riken in Japan, and KAIST and KIMM in Korea appeared to have missions heavily oriented toward R&D for industrial applications and both had major efforts directed toward micromanufacturing. In all labs, the R&D programs are producing very sophisticated, complex, and highly innovative processing methods.

Government-funded Laboratories in Europe. In Germany, the "Fraunhofer System" is a major driver of micro-manufacturing research, technology development, and commercialization. With strong ties to the university system and industry, the Fraunhofers unite the three partners and the results are impressive. Efforts tend to be long-term, sustained, and lead to commercialization. State-based Institutes are also common in Germany, again usually co-located with a local university.

Industry (1/2)

Industry Leadership. The companies that have been strong over the past two-three decades in manufacturing leadership, e.g., (FANUC, controls), Carl Zeiss (Metrology), Matsushita Electric (consumer products), Mitsubishi Electric (electronic products, devices) and Olympus (optics), seem to have invested heavily in micro-manufacturing technologies continuously over the last fifteen or so years.

Notable examples are the microfactory concept developed by Olympus, primarily as a micro-level, automated assembly system, the "Robonano" machine tool developed by FANUC that costs approximately $1M, and the F25 CMM at Zeiss.

Industry (2/2)

Industry Approach to Commercialization. In **Japan**, it is interesting to note that the majority of the micro-manufacturing equipment developed by Japanese companies could be classified as somewhat exotic in nature, directed toward sophisticated, low-volume, high precision needs of specific products and devices, and requiring a significant investment – costing in the several $100k to $1M range. On the other hand, there was little evidence found to support the notion that Japan might be considering the development of lower-cost, higher volume commodity micro-manufacturing equipment.

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In contrast, in Germany, there was abundant evidence of the desire to commercialize smaller Micro-Manufacturing machine tools and accessories on a commodity basis, examples including Kugler's Flycutter and MicroTURM machines, Carl Zeiss F25 Small-scale CMM, and Klocke Nanotechnik micro-scale robotic systems.

Thank You!