Competency Based Modules for Semiconductor Manufacturing Education and Training

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http://matec.org
ERC Teleconference: April 12, 2001
• Some slides that indicate industry trends and demand factors
• MATEC as an organization
• Curriculum Modules
  • Design and Delivery System
• Role of simulations and incorporation into modules
• Opportunities for collaboration/co-operation
The graph illustrates the growth of the semiconductor industry from 1959 to 2003. It shows the dollar billions spent each year and the percentage growth rate. The graph indicates that the industry returns to a 17% CAGR trend.

Source: SIA June 2000 Forecast
Top 10 Semiconductor Growth Applications

- xDSL Modem
- DVD Player
- Cable Modem
- Auto GPS
- LAN Switch
- Workstation
- Digital Cordless
- Digital Set Top Box
- Optical Disc Drive
- Remote Access

5 yr CAGR - 1999 - 2004

Source: Dataquest
## Semiconductor Content for Computers

<table>
<thead>
<tr>
<th>Computer Type</th>
<th>S/C Content ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainframe</td>
<td>8 – 10%</td>
</tr>
<tr>
<td>Midrange Systems</td>
<td>10 – 14%</td>
</tr>
<tr>
<td>Workstations</td>
<td>15 – 18%</td>
</tr>
<tr>
<td>Personal Computer (PC)</td>
<td>30 – 35%</td>
</tr>
<tr>
<td>Personal Digital Assistant (PDA)</td>
<td>40 – 50%</td>
</tr>
</tbody>
</table>

Source: Integrated Circuit Engineering Corp.
PC and Communication Chip
Comparative Growth Rates

Communications are growing 2X PC chips

Source: SIA
Transistors Per Person

![Bar chart showing the growth of transistors per person from 1995 to 2008, with a significant increase in 2008. The y-axis represents millions of transistors.]
And Growth Means….More New Jobs!

Since 1992, employment in the US.. semiconductor industry has increased by 69,000 jobs, or 32 percent.

Sources: US.. Bureau of Labor Statistics
High Demand for Skilled Technicians

• Evolving Nature of Workplace
  - Work station owners
  - Technician of the future

• Role of Education and Training
  • Technical knowledge
  • Critical thinking and learning skills
The Problem

- Industry Growth and Technology Changes Create Need for:
  - More Workers
  - More, Skilled Workers
  - More, Differently Skilled Workers

- Projected Demand Exceeds Supply

- Technical Enrollments are Down in Some Cases
## High-Technology Degrees Conferred
### 1990 vs 1996*

<table>
<thead>
<tr>
<th>Degrees</th>
<th>1990</th>
<th>1996*</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Degrees</td>
<td>1.9 million</td>
<td>2.1 million</td>
<td>+14%</td>
</tr>
<tr>
<td><strong>High Tech</strong></td>
<td>229,000</td>
<td>218,000</td>
<td>-5%</td>
</tr>
<tr>
<td>Engineering</td>
<td>74,000</td>
<td>71,000</td>
<td>-3%</td>
</tr>
<tr>
<td><strong>Engineering Technology</strong></td>
<td>58,000</td>
<td>49,000</td>
<td>-16%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>45,000</td>
<td>45,000</td>
<td>-1%</td>
</tr>
<tr>
<td><strong>Business Info. Systems</strong></td>
<td>13,000</td>
<td>16,000</td>
<td>+24%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>21,000</td>
<td>19,000</td>
<td>-9%</td>
</tr>
<tr>
<td>Physics</td>
<td>7,000</td>
<td>7,000</td>
<td>-5%</td>
</tr>
<tr>
<td><strong>Medical Technology</strong></td>
<td>6,000</td>
<td>7,000</td>
<td>+16%</td>
</tr>
<tr>
<td>Communications Technology</td>
<td>4,000</td>
<td>3,700</td>
<td>-16%</td>
</tr>
<tr>
<td><strong>Science Technology</strong></td>
<td>900</td>
<td>1,000</td>
<td>+12%</td>
</tr>
</tbody>
</table>

*1996 data are the most recent available.

*Source: U.S. Department of Education; AEA*
Educational Requirements for High Technology Occupations

- Science/Math Foundation
- Communication Core
- Technical Skills
MATEC Was Created to Help Address This Issue

- Education/Industry Consortium led by Maricopa Community Colleges
- Collaboration for a Grant from the National Science Foundation
- Industries were able to establish a pre-competitive level of cooperation
MATEC as an Organization
Maricopa Advanced Technology Education Center (MATEC)

- Center opened March, 1997
- A Permanent Center for Education and Work Force Development in the Semiconductor Industry
- With Significant Initial Funding from the National Science Foundation
Advanced Technological Education Centers

• Seed Funding from the National Science Foundation

• Focus on Technician Preparation

• Systemic Improvement in Science, Math, Engineering and Technology
Member of a Network of Centers

• Currently 11 Nationwide
  • Information Technology
  • Telecommunications
  • Sustainable Resources
  • Marine Science
  • Environmental
  • Biotechnology
  • Advanced Manufacturing
  • ……

• www.nsf.gov/ate
Center Activities

• Curriculum and Materials Development

• Faculty and Trainer Development

• Workforce Development
  - Awareness of opportunities
  - Increase number of skilled workers
Network of Partnerships

- Currently 110 National and 12 International Partners
MATEC International Activities

• International Partners
  • IMT Akademie-Technik und Wirtschaft - Germany
  • Institute of Technical Education, Yishun - Singapore
  • Konig Wilhelm I – The Netherlands
  • Nanyang Polytechnic – Singapore
  • Ngee Ann Polytechnic – Singapore
  • North Tyneside College – United Kingdom
  • Northern Alberta Institute of Technology – Canada
  • SOFI – Universitaet Goettingen - Germany
  • Temasek Polytechnic – Singapore
  • Universidad Autónoma de Guadalajara – Mexico
  • Swinburne University of Technology, Victoria – Australia
  • Victoria University, Victoria – Australia
MATEC’s Approach:

Provide Educational Resources for Faculty and Trainers
Premise

• High Technology Industries World-Wide Face The Need for a Skilled Workforce

• Educational institutions Can Answer This Need If …..
Learner Centered Education

- Gives Learners Skills and Competencies
- Provides an Educational Foundation for Life Long Learning
The Learner Centered Model

- Motivation
- Knowledge Building
  - addresses different learning styles
- Practice
  - Hands-on
  - Simulations
- Assessment
Modules for Educators and Trainers

(Think of a Module as a 5-8 Hour Training Segment)
MATEC Curriculum and Materials Development

Provides curricula and materials that are responsive to industry needs and consistent with high academic standards:

- Complete
- Accurate
- Timely
- Relevant

Uses state-of-the-art educational technologies to advance curriculum delivery
Curriculum Development Process

1. Establish Needs and Priorities for Curriculum
2. Establish Competency-Based Curriculum Model
3. Conduct Technician Task Analysis
4. Content Experts Define Course Competencies
5. Define Terminology and Module Specifications
6. Develop Instructional Materials
7. Oversee Development of Modules
8. Convene and Train Curriculum Design Teams
9. Establish Policies and Procedures for Teams
10. Organize Curriculum Delivery System
11. Develop Module Assessment Record/Plan
12. Submit Modules for Peer Review & Industry Review
13. Field Test Modules
14. Distribute Modules
15. Review & Revise Periodically
Curriculum Development Process (short form)

1. Establish Competency-Based Curriculum Model
2. Conduct Technician Task Analysis
3. Define Student Competencies
4. Define Module Specifications
5. Organize Curriculum Delivery System
Competency:

A competency is a major skill, knowledge, attitude or ability needed to perform a task effectively and efficiently.
Modular Approach to Curriculum

- Adapted for Local Context
- Maximizes Return on Investment for Educators and Trainers
- Internet Delivered
- Unique Hybrid Web/CD-Rom System
Interesting Screen Messages

The Web site you seek cannot be located but countless more exist
Interesting Screen Messages

Chaos reigns within
reflect, repent and reboot
order shall return
MATEC EPSS Model
Electronic Performance Support System

• Technical Advisor
  • Inform about the industry process/products
  • Update on industry changes

• Teaching Associate
  • How to teach/manage a classroom setting
  • How to teach competency-based, learner-centered modules
MATEC Implementation: EPSS
Electronic Performance Support System

- Context Sensitive Learning Opportunities
- Delivered to the “Job Site” -- Instructor Office
- Learning on Demand
- Learning on an “As-Needed” Basis
MATEC EPSS Model

Electronic Performance Support System

Curriculum Delivery System

- Module Narrative
- Learning Plan
- Lesson Plans
- Support Materials
- Media and Simulations
- Performance Assessment Task

Faculty Performance Support System

- Teaching Assistant
- Technical Advisor
Module Development (Process Set)

- Crystal Growth
- Diffusion
- Implant
- Lithography
- Oxidation
- Metallization
- Etch
- Deposition
- Planarization
- Assembly & Packaging
- Test & Sort
Unique Features of MATEC Modules

- Motivation
- Knowledge Building
- Practice
- Performance Assessment
  - Laboratory based
  - Simulation Based
Unique Features of MATEC Modules (continued)

• Focus on Learning Activities
  • Addresses different learning styles
• Embeds work place skills
  • Teaming, communication, interpersonal, informal learning, training, self-assessment
Focus on Learning Activities

- Motivation
- Development of Job Aides
- Team work with self assessment
- Knowledge games
- Equipment research, study and simulations
- Informal and interactive lectures
Role of Simulations

• Particularly Important for High technology Equipment Skills
• Basis for Performance Assessment
• “Pre-Staging” on CD Important for Bandwidth Issues
Collaboration

- Currently working with Gary Rubloff, U Maryland
- Incorporating subsets of EquipSIM
  - Vacuum, CVD
- Provides important transition from the learner’s knowledge basis
- Sets up further work in the laboratory or a specific tool simulation
  - CBTs from SpeedFam-IPEC, AMAT
Strong Industry Interest and Move Toward Simulations

• Provides an opportunity for leveraged development
• Provides relevancy
• There is always a question of the level of the intended audience
Opportunities for Collaboration

• Creation of Unique Materials for Training and Education
• Input and Subject Matter Expertise
• Creation of Customized Modules/Media
Advantages of Collaboration

• Key National Visibility With Industry Leaders in Industry and Education
• Workers Trained With Awareness and Knowledge of Technology
• Trained and Knowledgeable Workforce
Final Thoughts

• If we don’t succeed we run the risk of failure – Gov. GW Bush
Summary - Instructional Materials for Trainers

• Currently 39 modules
• Reduce development time
• Increase instructional quality
• Opportunities for customized delivery and development of student materials
Summary

• MATEC was created as a permanent center to address the needs of a highly skilled workforce.
• A unique System for the delivery of instructional materials for educators and trainers has been created.
• This system can work in collaboration with genuine hands-on learning to provide the knowledge, skills and abilities that are needed.
Acknowledgements

Cathleen Barton and Daryl Hatano of the Semiconductor Industry Association for use of their data and slides
Our Web Site

http://matec.org
“Before I came here I was confused about this subject. Having listened to your lecture I am still confused. But on a higher level.” - Enrico Fermi