

MANUFACTURING EDUCATION FOR THE **21ST** **CENTURY**

*Volume I:
Curricula 2002 Report*



Sponsored by the
Society of Manufacturing Engineers

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Published by the
Society of Manufacturing Engineers
One SME Drive, P.O. Box 930
Dearborn, Michigan 48121 U.S.A.

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SOCIETY OF MANUFACTURING ENGINEERS
DEARBORN, MICHIGAN 48121-0930

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International Standard Book Number: 0-87263-463-9

Manufactured in the United States of America

Chapter 7: Manufacturing Education in a Global Context

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7.1 Manufacturing as a Societal Issue ...

Manufacturing professionals in the industrial, academic and governmental sectors increasingly view the manufacture of goods as a vital issue for all of society. In classical economic terms, manufacturing is one of the few commercial activities which creates wealth [as opposed to transferring wealth, as in, say, banking services], and is the only wealth-creating sector of the economy which has the capacity for expansion to sustain an increasing standard of living for a growing population. It has also been established that high-caliber service industries [such as transportation, insurance and finance] are more viable in a strong manufacturing economy. Thus, the health and profitability of manufacturing industries are vital for the continued, long-term prosperity of the general population. The "information age" must be viewed as an enabler of the manufacturing sector, not as its replacement.

From nearly its inception in 1983, one of the fundamental tenets of the Society of Manufacturing Engineers' Curricular Models Project has been that the health of manufacturing industries is in direct proportion to the quantity and quality of graduates from manufacturing programs in the nation's universities and colleges. The intervening decade has seen substantial growth in university-level manufacturing education throughout the country. During this same period, American manufacturing industries have experienced a dramatic turn-around, rebounding from a nearly moribund state to a resurgent dynamism not seen for nearly half a century. While a cause-and-effect relationship remains to be established, American industry has become highly vocal in demand for more and better output of manufacturing professionals from schools, colleges and universities.

The Curricula 2002 Workshop is the latest in an extended series of events sponsored by the Society of Manufacturing Engineers [SME] for the purpose of assisting colleges and universities in developing new manufacturing programs and in improving existing ones.

Throughout this series of efforts, the foundation stone has been the direct linkages from quality manufacturing education to industrial vitality to societal well-being. The current event in this Project has made significant progress in providing frameworks for increased vitality and relevance in manufacturing education at all university levels. It remains to place this work in context with our global partners and competitors.

At this date³⁷, the global economy is more competitive than at any time in history, and all signs suggest that the competition will become even more heated in future months and years. Heretofore, the brunt of the competitive burden has been borne by the corporate world. This is their heritage and life-blood. Over the past three federal administrations, government has attempted to provide assistance in the form of relaxation of bureaucratic restrictions, more aggressive trade policy and enhanced investment in the technological infrastructure of the nation. Universities are only beginning to enter the competitive fray.

7.2 Competitive Comparisons in Manufacturing Education ...

The notion that the caliber of manufacturing education in a nation is related to that country's industrial vitality suggests that universities and industries in the United States should turn attention to a comparison of international practices in preparing manufacturing professionals. If this presumed relationship does indeed hold, then much is to be learned about the competitive environment of the future by benchmarking the manufacturing educational practices in the principal manufacturing nations of the world.

Indeed, SME has anticipated this reasoning by undertaking an international benchmarking project of original conception and substantial magnitude. These activities integrated with the on-going Curricular Models Project and are scheduled for completion in 1994 and 1995. The Society is assembling a compendium of manufacturing education practices from the principal manufacturing nations of the world. This book will be published in late 1994. As a follow-on, SME is sponsoring an international conference on the subject of manufacturing education in the Fall of 1995.

This report of the deliberations of the panels of the Curricula 2002 Workshop will be seen as an extensive and articulate statement of the visions held for manufacturing education in the United States. Early papers exchanged with correspondents in Europe, the Pacific

³⁷ This was written in mid-1994, but it would be equally appropriate for any date in the past half dozen or so years -- and forward into the foreseeable future!

Basin and the Western Hemisphere suggest that the urgency becoming apparent in U.S. manufacturing education has been a standard backdrop for many of our partners and competitors for some time. The caliber of the international educational challenge is formidable, indeed. It is noteworthy that impressive educational systems for preparing manufacturing professionals are strong and growing in both the nations traditionally known for global manufacturing leadership and those which are just emerging as significant industrial powers.

7.3 Outlook and Call to Action ...

The collective insights contributed by the panelists of Curricula 2002 and contained in these pages indicate that significant energy is being aroused in U.S. universities for an extension of both quality and quantity in manufacturing education. Likewise, there are indications from both governmental and industrial sectors that support for high-quality initiatives to enhance manufacturing education is becoming recognized as a continuing factor in policy and budgeting deliberations. If the vision represented by the Curricula 2002 panelists can be sustained, the competitive race for manufacturing leadership may not be as daunting as it has been in the past decade or so.

As with the marketplace for industrial goods and services, the challenge for manufacturing education is multi-faceted. It is clear that manufacturing industries require professionals with a range of strengths. Most of the commentary centers on applications of technology in the factory and on linking production operations with customers and with other functions in the business enterprise. This scope is of very great breadth, indicating defined needs for highly-skilled and technologically-advanced professionals in all aspects and types of manufacturing processes, all elements of the product realization process and all components of the manufacturing infrastructure. This suggests a requirement for a broad and dynamic range for manufacturing education programs -- stretching from highly-applied, operationally-oriented and/or process-specific programs in Manufacturing Engineering Technology to scientifically-founded, conceptually-oriented programs in Manufacturing Engineering -- and embracing an extended spectrum from associate through graduate levels.

Even this great breadth, however, understates the true need. There remains a powerful requirement to enhance the growth and development of manufacturing science. Discovery and development of new methods of processing materials into useful and cost-effective products remains as highly important to continuance of competitive advantage. This

suggests educational programs which emphasize a scientifically fundamental approach to the processing of materials -- in turn, suggesting an important sub-set to Manufacturing Engineering.

Equally important, the work of integrating the manufacturing business enterprise remains far from completed. It is apparent from the advice offered by virtually every industry that one of the chief and deeply-felt needs is for new-century manufacturing engineers who are simultaneously adept in technology, human interaction and business function. This suggests a need for balanced educational programs which may involve joint ventures or other combined approaches with complementary engineering or engineering technology disciplines, business colleges, arts and letters colleges, separate educational institutions in the United States and in other nations, and/or interactive industrial partnerships.

The requirements of society describe an urgent need for a very wide array of manufacturing programs in the nation's colleges and universities. There are [at least] two conflicting imperatives: On the one hand, the needs and wants of the nation's industrial firms define graduating students with enormously deep, broad and rich capabilities. In order to provide for a much-enhanced agenda for learning and subject mastery, it has been argued that there must be an extension in the length of study at both undergraduate and graduate levels. On the other hand, state legislatures, industrial and foundation contributors, and the general populace who support the costs of higher education have been becoming increasingly critical of the cost-effectiveness of university education. Both of these are legitimate concerns, but equally, they are at cross-purposes.

In recent years, the nation's colleges and universities have been gravitating towards a blended educational system, incorporating both the horizontal and vertical diversification discussed in the introductory chapter of this book³⁸. This trend has been both particularly evident and conspicuously effective in the field of manufacturing. Both Manufacturing Engineering Technology and Manufacturing Engineering are growing in vitality and relevance across the United States. A hallmark of manufacturing education has been its effectiveness in developing definitions of an essential core of required topics necessary in order to be considered as 'manufacturing', while embracing a variety of specialties which permit individual programs to focus on particular details of the spectrum of manufacturing profession needs.

³⁸ See Figure 1.1, page 3.

It is suggested that the central challenge for manufacturing educators is to develop and apply more effective methods for teaching and learning. The most crucial characteristic of any manufacturing education program is a clearly defined vision and mission. No program can be all things to all people, and it is fundamental that the leadership and faculty of every program embrace soundness of knowledge and understanding of manufacturing, along with intellectual breadth to conceive and execute a unique mission and purpose for the individual program with respect to the academy, the industrial customer and the society at large.

The challenges for industry and society are to enhance the effectiveness of both involvement and perspective. It must be recognized that the development of new manufacturing professionals requires time and vision. Today's demands in the factory and the marketplace cannot be solved by people just now beginning in the educational process. The guidance, advice and tangible support provided to educational institutions must be couched in terms consistent with the learning process. The industrial employer is the principal customer of the manufacturing education, and the goal is to define customer needs from few to many years into the future.

Moreover, it must be recognized that effective manufacturing education of the sort being so assiduously sought by both industry and society is expensive. Real manufacturing equipment is necessary for effective learning, and virtually all such apparatus is costly, requires large facilities and has a rapid obsolescence cycle. The accelerated pace of technological progress also demands that faculty spend a significant portion of their time in continuous learning, in order to maintain effectiveness as teachers, coaches and mentors. Complexity and integration of knowledge are most effectively pursued by modes of teaching and learning which are time-intensive for faculty, and are not well-served by large classes or automated instruction, beyond the basic skills. Large class sizes, heavy teaching loads and minimal operating budgets are counter-productive.

Thus, the challenges for manufacturing education are shared by the academy, industry and general society. The societal context must begin with recognition of the importance of manufacturing education to social well-being, extend from there to informed and perceptive involvement in the educational process and embrace the necessity for tangible support for

college and university education³⁹. The industrial customer's share of the task lies in perceptive and far-sighted vision and advice, willingness to enter innovative partnerships with long-term pay-off, and a variety of means for direct and indirect support. The academy bears the largest share of responsibility. Administrations and faculty must become and remain at the forefront of knowledge and understanding, create clear and challenging visions, establish articulate and unique programmatic missions and objectives, and continuously improve the methods and effectiveness by which learning is acquired.

³⁹ A tacit assumption here is that society will also address the problems of primary and secondary education. Much of the energy of post-secondary education is dissipated in attending to preparations in academic and intellectual abilities and in conceptual grasp of and ability to learn which are effectively provided in pre-college work in our competitor countries.