**PROCEEDINGS OF THE
TWENTY-SECOND INTERNATIONAL
MACHINE TOOL DESIGN AND RESEARCH
CONFERENCE**

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CONFERENCE**

*held in Manchester
16th-18th September 1981*

Edited by

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**DEPARTMENT OF MECHANICAL ENGINEERING
UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY
MANCHESTER**

in association with

THE MACMILLAN PRESS LIMITED

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**Department of Mechanical Engineering
University of Manchester Institute of Science and Technology
1982**

Softcover reprint of the hardcover 1st edition 1982 978-0-333-32767-8

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**First published 1982 by the
Department of Mechanical Engineering
University of Manchester Institute of Science and Technology
P.O. Box 88, Manchester, M60 1QD**

in association with

**The Macmillan Press Ltd
London and Basingstoke
Companies and representatives throughout the world**

ISBN 978-1-349-06283-6 ISBN 978-1-349-06281-2 (eBook)
DOI 10.1007/978-1-349-06281-2

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CONTENTS

Opening Address: Dr. D. F. Galloway, CBE, WhSch, CEng xi

THE WORKING ENVIRONMENT

Chairman: Prof. B. J. Davies
(UMIST)

The changing nature of hazard — the effects of the electronics revolution C. W. PERKINS and J. B. WHITEHOUSE	3
Effects of noise on human psychology and performance: a critical view M. S. J. HASHMI and B. ZAMAN	11
The Lucas hearing conservation and noise control program M. F. RUSSELL	17

PROCESS PLANNING & CONTROL

Chairman: Prof. J. L. Burbidge
(Huntingdon, Cambridge)

A contribution to the development of process planning method in industrial environment V. R. MILAČIĆ	29
An interactive job shop control system H. JAGDEV and B. J. DAVIES	39
Interactive scheduling procedures for flexible manufacturing systems J. McCARTNEY and B. K. HINDS	47
Computer-aided design of a typified optimum manufacturing process GHERMAN DRĂGHICI	55

CAD/CAM

Chairman: Dr. E. Merchant
(Cincinnati Milacron Inc.)

Recent advances in the development of CAD/CAM systems for the machine tool industry R. G. FRANCIS	63
Computer aided draughting system 'ALODS' for machine tool structures YOSHIO SAITO and YOSHIMI ITO	69
The CAD of feed drive control systems H. FILIZ, P. LEANEY, T. UGUR and R. BELL	77

MANUFACTURING ORGANISATION

Chairman: Dr. R. G. Hannam
(UMIST)

Group technology — the first ten years of practical experience in indian engineering firms P. M. VENKITADRI and B. G. KEMSHETTI	87
New methods of organisation to improve production efficiency JOHN L. BURBIDGE	95
Ability and opportunity the microchip and future patterns of employment R. S. JOHNSON	101

MACHINE DESIGN

Chairman: Dr. M. Thorneycroft
(T. I. Churchill Ltd.)

A case study on a use of anaerobic adhesives in machine tool assembly R. G. HANNAM	109
The influence of housing and shaft configurations on the performance of rolling bearings by finite element analysis M. M. A. TAHA	119
A roller screw with special qualities P. MUNN	127
Theoretical expressions for the normal and tangential stiffness of machine tool joints S. N. SHOUKRY and R. H. THORNLEY	131

ACCURACY & MEASUREMENT

Chairman: Dr. M. Burdekin
(UMIST)

Metrological inspection of machining centres, jig boring machines, and measuring machines, through a statistical approach J. J. GUYE	141
Effect of slideway wear on machining accuracy of lathes Ö. ANLAGAN and F. INSEL	147
Analysis of machining error in face milling Y. TAKEUCHI and M. SAKAMOTO	153

MEASUREMENT TECHNIQUES

Chairman: Dr. A. Cowley
(UMIST)

Measurement of the static, dynamic and thermal rigidity of machine tool structures using holography Y. TAN and E. W. SMITH	159
On-line gauging by microcomputer M. WALKER and T. R. THOMAS	173
Optical technique for in-process measurement of surface roughness during ACC grinding J. Y. ZHU and A. A. SHUMSHERUDDIN	177

NUMERICAL CONTROL

NC Economics & Adaptive Control

Chairman: Dr A. A. Shumsheruddin
(Cranfield Institute of Technology)

Economic considerations in adaptive control A. LEWIS and B. K. NAGPAL	187
The economics of numerically controlled punching and nibbling machines P. R. CAVE and T. NEUGEBAUER	197
Adaptive control for a CNC lathe G. E. WILSON and A. J. WILKINSON	205

Microprocessor Applications & Automation

Chairman: Prof. B. J. Davies
(UMIST)

The application of a modular multiprocessor NC system G. STUTE and P. KLEMM	215
Microcomputer based drill wear on-line monitoring T. P. McDUNN, D. S. BRAY and S. M. WU	223
Fully automated CNC turning cell incorporating closed loop post operative gauging M. THORNEYCROFT and C. ATKINSON	227

METAL CUTTING

Tool wear in metal cutting

Chairman: Prof. P. L. B. Oxley
(University of New South Wales, Australia)

The wear of high speed steel cutting tools under the action of several different cutting fluids T. KURIMOTO and G. BARROW	237
On the tool wear during face turning A. S. JHITA, V. K. JAIN and P. C. PANDEY	247
Choice of wear-criteria in fully automated turning A. KINNANDER	255
In-process detection of cutting tool damage by acoustic emission measurement I. INASAKI and S. YONETSU	261

Performance & Mechanics of Metal Cutting

Chairman: Dr. G. Barrow
(UMIST)

The influence of tool design and operation on the performance of polycrystalline diamond tooling D. K. ASPINWALL	269
A mechanics of machining approach to assessing machinability P. L. B. OXLEY	279
An investigation on metal cutting dynamics and its optimum control based on modern control theory G. P. YANG, X. WANG, Q. X. ZHANG and H. H. YANG	289
Cutting action of blunt tools M. SARWAR and P. J. THOMPSON	295

GRINDING

Performance & Control of Grinding

Chairman: Dr. G. Sweeney
(Technical Consultant, Macclesfield)

- Increasing of the metal removal rate by optimal setting conditions in CBN — grinding
E. SALJÉ and H. HEIDENFELDER 307
- Crush dressing of grinding wheels for plunge cut cylindrical grinding
N. N. Z. GINDY and T. J. VICKERSTAFF 315
- Strategy for controlling the grinding process by CNC
K. SANDRASEGARAM and A. A. SHUMSHERUDDING 323

Mechanics & Accuracy in Grinding

Chairman: Dr. T. J. Vickerstaff
(University of Aston in Birmingham)

- An investigation on the accuracy of the double disc grinding
Z. H. LIN and C. H. KU 329
- The mechanism of metal removal in grinding of tools and cutters
G. J. TRMAL 335
- Centerless plunge feed with additional high friction damping
A. Y. CHIEN 343

ELECTROCHEMICAL MACHINING

Performance of Electrochemical Machining

Chairman: Dr. C. N. Larsson
(Strathclyde University)

- Accuracy problems of the pulse electrochemical machining
JERZY KOZAK, KONRAD LUBKOWSKI and JAN PERONCZYK 353
- Aspects of drilling by electrochemical arc machining
T. H. DRAKE and J. A. McGEOUGH 361
- The surface finish resulting from peripheral electrochemical grinding
J. ATKINSON and C. F. NOBLE 371

Tool Shape & Control of ECM

Chairman: Dr. J. A. McGeough
(Aberdeen University)

- Computer aided design of ECM electrodes
P. LAWRENCE 379
- Electrochemical machining of complex shape parts and holes (Mathematical modelling and practical experiments)
L. DABROWSKI and J. KOZAK 385
- Micro-computer control of an electrochemical machine
C. N. LARSSON and S. ZHU 393

ELECTRICAL DISCHARGE MACHINING

Wire EDM & GAP Control

Chairman: Dr. C. F. Noble
(UMIST)

- 3D wire travel EDM — the state of the art
G. N. LEVY 403
- A physicist's view of wire EDM
K. E. TREZISE 413
- Dynamic characteristics of interelectrode gap controller in EDM
JERZY CYKLIS and ANTONI SZYMCHAK 421

Inter-electrode medium in EDM

Chairman: Dr. G. N. Levy
(A.G.I.E., Switzerland)

- The colloid system between the electrodes in EDM
CHEN ZHAN-QING and LI MING-HUI 429
- Investigation of the use of water as a dielectric liquid in EDM
A. ERDEN and D. TEMEL 437
- Machining characteristics of EDM using water as dielectric fluid
T. MASUZAWA 441

METAL FORMING
Tool Design for Metal Forming
Chairman: Prof. J. M. Alexander
(University College, Swansea)

Computer aided design of dies for a horizontal forging machine YIN GUANG-FU and YVES VAN HOENACKER	451
Computer aided sequence design for hot upset forgings M. I. GOKLER and T. A. DEAN	457
Computer-aided design and manufacture of high speed cropping tools S. W. LUI and M. K. DAS	467
Analysis of the stress distribution in a die assembly for cold extrusion processes G. PEROTTI and G. MURARI	475

Cropping & Forming Processes
Chairman: Prof. W. Johnson
(Cambridge University)

Warm forging of stainless steel components JENS O. R. HINTZE	481
The study of precision bar cropping under axial load CHEN JIN-DE, ZHANG ZIAN-RU, ZHANG ZI-GONG, TANG ZHAO-JUE and YU DE-HONG	489
Rolling of thin and thick sheets between a flat roll and a roll with balls of different diameters and spacings embedded around its surface N. R. CHITKARA, K. T. TASPINAR and M. M. NORDIN	497
Radial thickness distribution around hydraulically bulge formed annealed copper T-joint: experiments and theoretical predictions M. S. J. HASHMI	507

Metal Forming Analysis
Chairman: Dr. J. B. Hawkyard
(UMIST)

Estimating the curvature of bars after cross-roll straightening T. X. YU and W. JOHNSON	517
Study on non-symmetric extrusion and drawing M. KIUCHI, H. KISHI and M. ISHIKAWA	523
Metal-forming analysis on desk top microcomputers using non-linear elastic-plastic finite element techniques M. FADZIL, K. C. CHUAH, P. HARTLEY, C. E. N. STURGESS and G. W. ROWE	533
Finite element analysis of clamps for continuous hydrostatic extrusion M. E. SAID, G. N. PANDE and J. M. ALEXANDER	541

Computer Control in Metal Forming
Chairman: Prof. J. M. Alexander
(University College, Swansea)

The application of microprocessors to the automatic control of strip feeds for power presses B. S. BAGHSHAHI, D. R. H. BAGGS and A. D. HOPE	555
Computer controlled plate forming for pipes and vessels R. ADOLFSSON	563
Some preliminary considerations for a computer-aided billet volume control in bar cropping C. L. CHUAH and M. K. DAS	573

OPENING ADDRESS

PRESENTED BY DR D F GALLOWAY, CBE, WhSch, CEng
16 September 1981

The long association of UMIST with *Machine Tools* is part of a much wider contribution which UMIST has made to the general field of MANUFACTURING TECHNOLOGY. For that reason I have given this opening ADDRESS the title

PROFITABLE MANUFACTURE

Since the founding and early development of C.I.R.P., many of its distinguished members have been associated with centres of excellence in Machine Tool Research, Design, Development and Manufacture, and others, like Bézier at Renault in France and various members at Phillips in Eindhoven have contributed much to the more cost-effective use of machine tools in the factories of leading industrial countries. Moreover, despite the lowly position from which manufacturing technology first emerged its potential economic significance on a National and International scale was apparent, but the realisation of that potential in the second half of the 20th Century has been greatly influenced by senior members of C.I.R.P., throughout the world - Merchant, Shaw, Opitz, Kienzle, Tlustý, Nicolau, Zorev, Tornebohm, Kobayashi of Japan, Bickel, Splir and many others. These engineers developed ideas which went far beyond the boundaries of their home countries, and two of them who changed their home country (fortunately for us choosing Britain as their new home) were Koenigsberger and Tobias, who among their distinctive contributions to manufacturing technology founded this series of Conferences now in its 22nd year.

Despite critics, the Conferences have survived, and have carved a place in the history of the advance of manufacturing technology. Moreover, the organisers and authors have shown sufficient flexibility to accommodate the many changes that have arisen on the industrial scene, either through changes in manufacturing activities and products, or through the emergence of new scientific discoveries in fields such as materials, electronics, etc. And today, once again, the wide spectrum of subjects chosen for the papers to be discussed during the next three days shows that you who are working in this field take a commendably comprehensive view of the opportunities and responsibilities facing technologists in a changing industrial environment where economic and social factors must be considered side-by-side with technological developments.

Against this background any suggestions I may imply in these few short comments are therefore made (and I hope will be accepted) as a small contribution to the overall pattern of success of these

International Machine Tool Design and Research Conferences which I am sure will continue to grow in the years ahead.

As one who has not played any significant part in the development of these Conferences, I see them - (their subjects, papers, authors, and contributors) from the viewpoint of an international observer of manufacturing developments, and it seems that the treatment of the subjects over the years, and the interests of the authors and contributors cover three main areas:

- 1 Research and Design
- 2 Education and Training
- 3 Technology Transfer to which either make or use machine tools

RESEARCH AND DESIGN:

The ultimate objective of machine tool research and design is "Profitable Manufacture". The people concerned with this research and design know very well that machine tools are either directly or indirectly linked to the cost effectiveness of most manufacturing activities, and also that the "Profitability" of those manufacturing activities is the ultimate objective. Although "Management by Objectives" is an old concept it is nonetheless still valid, and those concerned with the selection, planning and execution of machine tool research, design and development activities might, with advantage, re-consider whether they really are on course for that main objective.

The spectrum of manufacturing activity and machine tool functions is so wide that no country can afford to investigate all the research problems that arise. So a choice must be made, and the basis of that choice must increasingly be steered toward "investment appraisal" of each R & D project with much greater emphasis being placed on realistic market research which identifies the basic needs of the customer in his efforts to attain product quality assurance at competitive prices.

The choice of specific R & D subjects merely because they happen to be fashionable, or exotic, or because they have been developed in some other country and are mistakenly assumed to be a prime cause of that country's success should no

longer go unchallenged. It is rather pathetic to see research and design teams racing on down parallel streams of development (attempting to catch leaders who are years ahead and travelling very fast), and not even pausing to glance sideways at the vast pockets of opportunities in which there is more than a chance of taking the lead, and thus seizing a market lead, thereby eluding the mark of mediocrity, and making a profit for themselves, their company, and their country.

Over a period of years I had the opportunity and responsibility for examining the scientific, technological, and financial details of many very successful inventions originated, developed, manufactured and sold by British companies. Several outstanding examples were clearly the result of lateral thinking - the multi-disciplinary approach, and definitely not the result of following the crowd. One such example in engineering was the invention, development, manufacture and successful marketing of "NETLON" by Mr Mercer of Blackburn. Mr Mercer not only found an elegant solution to an age old problem of how to make netting without having to fix single strands across one another, but he had the breadth of vision and motivation to translate his invention into an entirely new industry with world-wide sales of around £100 million. He envisaged the product namely integral plastic netting without knots in a great variety of shapes and sizes, he devised the double contra- rotating die heads which continuously extruded both the strands and the junction points so that in a single extrusion process nets of many forms were produced direct from plastic granules. The other facets of his multi-disciplinary approach enabled him to convert his invention and engineering design success into a business organisation success. A manufacturing success, and finally a marketing success in 23 countries, including the United States and Japan. His versatile mind continually moved forward developing varying materials, mesh shapes and sizes, filament thicknesses etc., until today the results of that lateral thinking are commercially used not only for packaging, for crop protection and for fish farming, but also for air and liquid filtration, for dialysing coils in artificial kidney machines, for road and embankment stabilization, for land drainage, and for many other purposes.

Of course we all know that automation and controls have an important place in industrial development, and the design of the machines essential to that development. Maybe in the present frenetic chase for "chips with everything" some fortunes are being made, but case histories such as that of Mr Mercer and his NETLON clearly prove that the nature of materials, old and new, and the ways in which they can be formed and cut and

efficiently utilised, and the shapes, the accuracies and the finishes of component parts, how they are designed for efficient assembly or joining as well as for final function, these and many more such subjects present vast areas for profitable exploration for those prepared to look aside from that main stream rush.

There seems to be a need for more leaders of research and design to have a much more comprehensive outlook on manufacture as a whole. The claim they often make to a comprehensive outlook, which in fact is nothing more than a "Technologically Comprehensive" outlook, wastes time and money, and misses the real objective by a substantial margin, whether you judge it by what if anything ends up in the Market Place, or the time taken to get it there. The right goods, at the right time, in the right place, at the right price is still a worthy objective - even for R & D. What is needed in research and design leadership is balanced judgement based on a real understanding and experience of ALL the essential ingredients of profitable manufacture, including financial, organisational, marketing, and so on. That way we will at least start by asking the right questions!

EDUCATION AND TRAINING:

In recent years at this Conference, comments on the policies and practices of Education and Training, and on the problems and opportunities that occur have been made by various well informed engineering educationalists with whom I am in virtually 100% agreement.

In a country where the dire need to improve overall industrial performance has existed for so many years, and where at the same time the expenditure on the educational system has expanded to around £1,000 million a year, surely there is some justification for slightly changing the balance of expenditure to ensure the motivation of the right people to teach and be taught so that the highest quality of thought; and skill can be continuously available to enlarge the wealth earning capacity from which much of the £1,000 million is directly or indirectly derived. Despite the INERTIA in parts of the educational system (at all levels) resistance to change can be overcome by realistic incentives to teachers, students and companies so as to ensure that the right persons are available as teachers for the right kind of students who eventually join the right kind of companies.

We know very well that reasons for inaction abound. One is social balance. Suggestions that people so educated are on average less likely to be well balanced, members of a democratic society than those educated in arts, social, political and other disciplines. The contention has no foundations in fact. There is ample evidence that many engineers have widely diversified interests and make substantial personal contributions to the improvement of society at large.

Another excuse for delay is engineering status, or lack of it. The tendency to bemoan the relative status of engineers in Britain by comparison with successful countries in Europe and elsewhere is merely a consequence of history - something is being done about it, but it won't change overnight. The job in hand, namely, improving Education and Training so as to aid improvement in industrial performance and profitability can proceed without waiting for such psychologically based changes. We need more profitable manufacture in the next five years. We could go bankrupt waiting for the psychological/social reaction needed to bring about a status change.

Yet another reason for inaction is the supposed inadvisability of Britain adopting the philosophies of other nations (like for example the work ethic), because of undesirable social effects. We do not have to adopt another nation's whole philosophy, but be they West or East there are often sections of their philosophy which can be followed with obvious advantage, may be on the Eastern principle of

"Adopt - Adapt - Advance"

avoiding, if possible, repetition of our own errors, not the least of which was "Too little - Too late" - a trait which was tiresome 20 years ago, but could be fatal a few years' hence.

A variety of schemes have already been tried to resolve this education and training deficiency, the results are interesting but hardly match the scale of our problem.

Improving the Education and Training of engineers of all disciplines and at all three levels was a major objective of the small group of engineers who eventually brought together the 50 Institutions to form the Engineers Registration Board. In its six formative years I had the opportunity as Chairman to observe the remarkable degree of cross-fertilization of ideas which quickly brought about a sufficient degree of co-ordination to merit a complimentary sentence or two in the "Finniston Report" and ensure that ERB in some form will survive in the future structure of the profession. So far as the Education and Training interests of this Conference have manifested themselves in former years it seems to me that the ERB cross-fertilization feature most pertinent is the development of practical experience, the increasing importance of inculcating an appreciation of physical realities and financial consequences. There's still some relevance in the old saying:

"They hear, and they forget"
 "They see, and they remember"
 "They do, and they know".

TECHNOLOGY TRANSFER:

Technology Transfer may be considered to overlap with Education and Training. In fact, Technology Transfer in relation

to manufacture can be achieved in many ways, varying from the slow and often unfortunately very ineffective transfer by printed advertising and propaganda, right through to the massive Technology Transfer achieved in many Turn Key Factory Projects such as when whole plants and processes are sold from one country to another, not necessarily because they involve some special or patented processes, but because of the sheer production efficiency of the factory which is duplicated overseas.

However, in my experience the type of Technology Transfer which has by far the highest overall potential for widespread and continuous improvements in manufacturing productivity and profitability is the direct transfer of technology on improved methods and equipment to key production personnel who are operating at decision making levels in large numbers of individual factories. Frequently these recipients of the Technology Transfer are already well trained and experienced in the particular type of manufacture concerned.

This type of Technology Transfer usually involves 3 or 4 steps. The 3 main steps are:

- A. Diagnosis
- B. Prescription
- C. Implementation which desirably should be followed by
- D. Economic evaluation and "follow up".

Diagnosis involves identifying the real causes of difficulties or opportunities for improvements, in a factory all against the background that most factories are unique because of differences in product mix, locations, markets, equipment, financial status, labour relations, etc. Prescription is to specify the right answers. Implementation is the practical introduction of the improved techniques, equipment, etc., and evaluation gives the opportunity for finer adjustments leading to further improvements, and the very valuable accumulation of Case History Data, if possible quantitative rather than merely qualitative.

If this type of Technology Transfer is used to solve specific, accurately defined faults in factories, then specialists can be of value because, in effect, general diagnosis is regarded as unnecessary. But in most cases this is not so, and assistance from a production engineer with comprehensive experience is likely to produce better results even if occasionally advice from a specialist is added. A very high level of professional competence and experience is required to carry through the diagnosis and prescription, and then to gain the confidence and support of the resident staff and experts in the implementation stage.

Sometimes this kind of Technology Transfer can be heavily dependent on the evaluation of various designs of machine

tools in relation to the products and the overall company and factory conditions involved in particular plants. In the early days of NC my colleagues and I were involved with this type of Technology Transfer in a scheme financed by the UK Government to accelerate the effective use of NC Machine Tools in British factories. The basis of the project was realistic investment appraisal to assess pay-back period, return on investment, DCF rate of return, increased productivity, etc., all in relation to the product mix, the batch sizes, the market forecasts, etc. In this way the relative merits of various types of NC machines and corresponding conventional machines were evaluated so that those which were not only technologically suitable, but would also give the best return on investment for that company at that time could be installed. The overall result of the scheme was that appropriate NC machines were recommended and installed in hundreds of factories, and a subsequent Survey showed that these machines increased productivity and profitability to such an extent that the estimated net cash gain was about 30 times the expenditure on the Technology Transfer Scheme.

One lesson of Technology Transfer which was demonstrated on a number of occasions in this Scheme was the damage that can be done to a technological advance when for various reasons users are persuaded to buy equipment which is technologically feasible but economically a failure. Whether in regard to machine tool selection or not, an important function of good Technology Transfer, with a realistic investment appraisal content, is to prevent wrong action. A technological mistake is much less likely to give real trouble than an economic mistake because the technological mistake tends to show up quickly, but usually the economic error does not become apparent until later, sometimes too late.

In any case it is well to keep in mind that although there are obvious reasons for trying to reduce the labour content of manufacture, if this is done by profligate use of capital and energy it can be too expensive for overall economic justification.

Unfortunately for the machine tool makers much manufacturing Technology Transfer does not involve the installation of new machines. Sometimes financial constraints require that capital expenditure be kept to a minimum. Moreover, in considering the total spectrum of manufacture of any country such as Britain with tens of thousands of factories, (and even some developing countries have 50,000) there is always a very wide range of conditions and performance levels. Some factories are very good, some mediocre and some very bad. But to improve the economic performance of a country's manufacturing industries as a whole in a way which will significantly improve the economy of that country it is necessary to raise the average performance, not merely the

performance of the best factories. Thus, so far as machine tools are involved we are concerned with the total active machine tool population, not just the 10% of modern sophisticated machines at the top. We are also concerned with the rate at which machine tool replacement takes place in practice. Various factors - not least the cost of capital, dictate that replacement even in advanced countries is much slower than is often supposed. Consequently the average age of the active machine tool population is high, and in practice this means that for most of the next decade more than 3/4 of our manufacture will inevitably have to be achieved on conventional machines - many of them relatively old. Unfortunately most manufacturers do not get the best out of these older machines, and Technology Transfer can help lift the average performance considerably.

This may not be as exciting as developing still more sophisticated machines and machine controls, but on the basis of sheer balance of production activity influenced it could be far more rewarding to the country and to many individual companies. There is a mass of evidence that the deployment of technological resources for this purpose produces results and pays well. Among several National Schemes I was responsible for developing and implementing, one produced improvements in several thousand factories with fully authenticated net returns of £22 million for an expenditure of about £1 million. These results, when verified by Government, resulted in increased support (about £2 million per annum) for MAS (Manufacturing Advisory Service) which we based on the same principles, and which has now produced similar results in hundreds of factories for about 4 years.

The contents of papers in this Conference this year and in previous years demonstrate a scope of technology which could obviously contribute much to the broader concept of Technology Transfer relating metal cutting, metal forming, assembly, terotechnology, etc., to the marketing and financial aspects of our manufacturing industries, and the result would undoubtedly enlarge our wealth earning capacity. The excellent track record of these Conferences through the three channels :

Research and Design

Education and Training

Technology Transfer

will undoubtedly have an increasing influence on the wealth earning capacity of UK industry, and on our co-operation with other countries. I wish you every success in this 1981 Conference, and thank you for inviting me to present this Opening Address.