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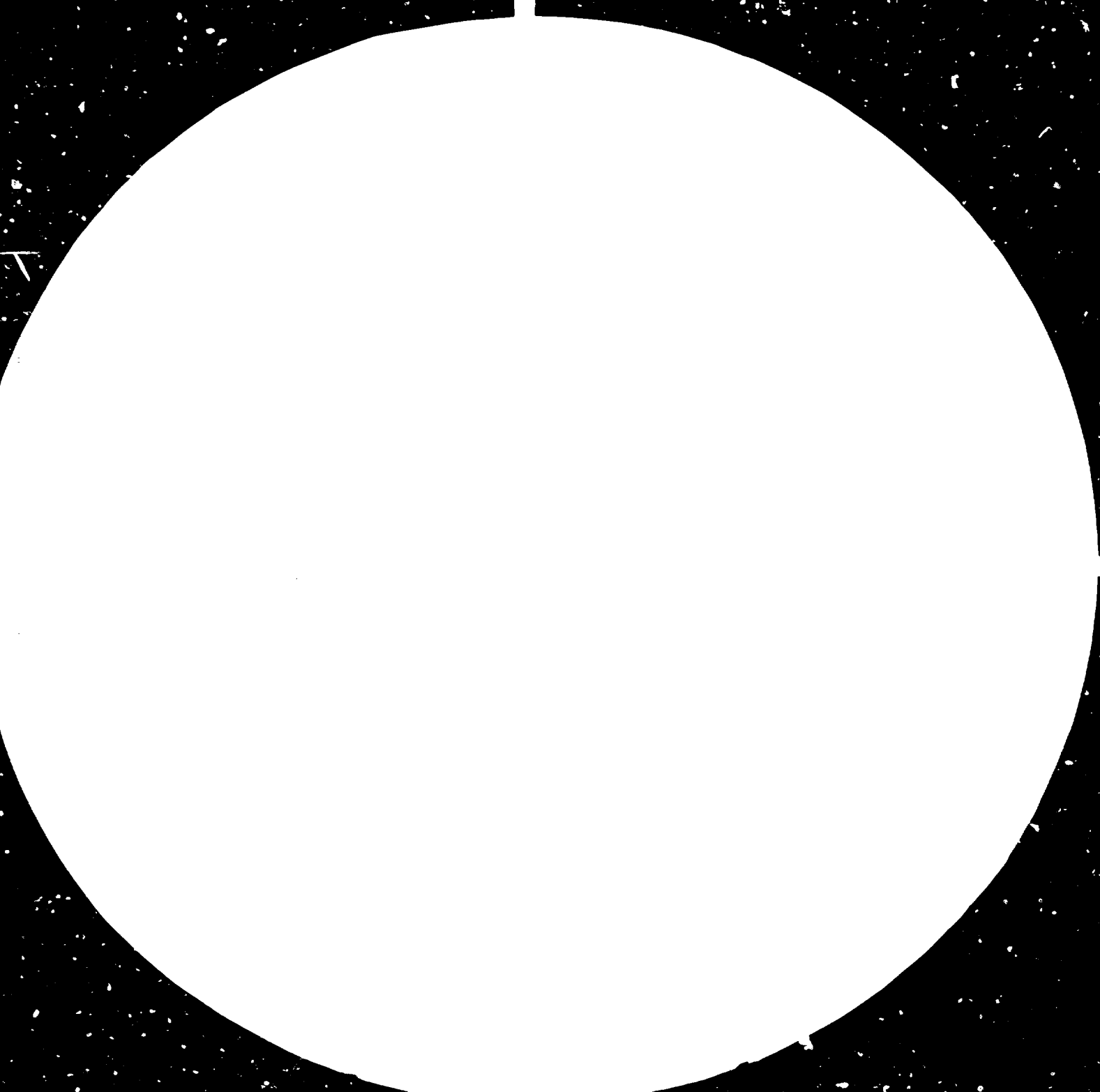

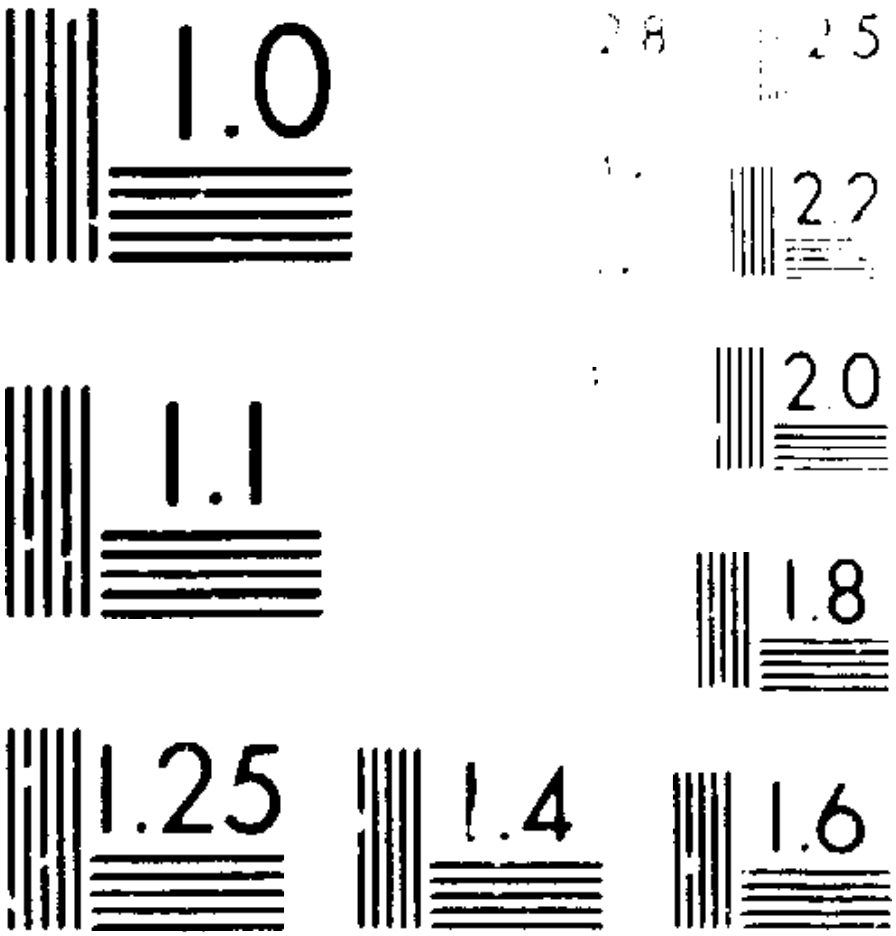
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EXCHANGE OF VIEWS WITH EXPERTS
ON THE IMPLICATIONS OF TECHNOLOGICAL
ADVANCES IN MICRO-ELECTRONICS FOR
DEVELOPING COUNTRIES

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IMPLICATIONS OF TECHNOLOGICAL ADVANCES IN MICRO-ELECTRONICS FOR DEVELOPING COUNTRIES: A SUGGESTED PROGRAMME OF POLICY STUDIES AND ACTION*

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IMPLICATIONS OF TECHNOLOGICAL ADVANCES IN MICROELECTRONICS FOR DEVELOPING COUNTRIES: A SUGGESTED PROGRAMME OF POLICY STUDIES AND ACTION

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1. CRISIS IN THE WORLD ECONOMY: THE ROLE OF ELECTRONICS TECHNOLOGIES

Economic historians have begun to review the last two hundred years of industrial growth in relation to long-run cycles of activity. The most notable of these are the so-called Kondratiev cycles which are supposed to occur at periods of approximately fifty years. The most convincing of these re-interpretations argue that each of these cycles are fueled by major families of technology - the first (starting around 1790) being steam engines and textiles; the second (starting around 1840) being railroads and steel; the third (starting at the turn of this century) being the internal combustion engine and the electric motor; and now the most recent being electronics. Each of these cycles appears to be comprised of an upswing, during which new products are introduced and employment and growth expand, and a downswing when the diffusion of the "heartland" technology leads to greater competition and relative stagnation. In this latter phase, the heartland technology tends to be used for cost reduction and product differentiation in existing industries rather than in product innovation in new sectors.

The rapid growth of many less developed countries (LDCs) over the past thirty years can be seen as occurring in the upswing of the new electronics-fueled cycle. In this period, the technological gap between the developed countries (DCs) and LDCs in pre-electronic technology began to close, and a selected number of LDCs came to assume a partial role (as sources of cheap, unskilled labour) in the product-innovating phase of the new cycle. However, as the world economy moves into the downswing of recession featuring increased competition, with electronics technology diffusing rapidly through DC economies to reduce costs and enhance product characteristics, the sustainability of the progress of these LDC economies could be threatened. There are now unmistakable signs that the technological gap between LDCs and DCs is once again beginning to widen and that LDC economies are faced with a declining role in the international division of labour for manufactured goods. This shift is coming at precisely the time when they need to increase their export earnings to pay for costly imports of energy and capital goods.

Given the probability of a radically changed global economy significantly affected by the diffusion of electronic technologies, many LDCs are therefore faced with the need to restructure their development strategies. In order to do so to the maximum benefit, two sets of issues need to be confronted.

(a) Changes in the International Trading Environment

A number of potential developments in the international trading economy are likely to affect the future ability of LDCs to maintain their rates of industrialisation and exports. Most importantly, it is critical to understand the extent to which there will be shifts in the pattern of comparative advantage, due to the widespread use of electronics technologies in the DCs which will give rise to changing production functions and structures of final output and demand. Given their predominance in global production and trade of manufactures, the attitudes of TNCs to the changing economic environment and the strategies they adopt to adjust to these changes will have significant bearing on the options open to LDCs. So too will the impact of electronics on the concentration of ownership and production in sectors in which TNCs and LDCs play important roles. Of similar importance is the extent to which, recession and unemployment in DCs will lead to more and higher trade barriers being erected against LDC products.

(b) The Relevance of Electronics for LDC Needs

The preoccupation of electronics based innovators is currently focussed on meeting the needs of DC firms and consumers. But there is inevitably likely to be a wide range of LDC needs which could be satisfied by efficient electronics based technologies if adequate effort were to be put into meeting these needs. Equally, the judicious application of electronics in the productive sectors could release debilitating constraints on LDC industrial potentials imposed by the lack of certain skills and inadequate development of information processing and management capabilities. This raises important issues concerning LDC science and technology policies, manpower policies, TCDC, the role of international agencies and the creation of suitable institutions and networks for the development and dissemination of appropriate technologies.

2. THE STATE OF THE ART OF RELEVANT STUDIES

Given the significance of the events and trends described above, it is perhaps surprising that so little is known of the momentous changes which are working their way through the global economy and in particular how these changes relate specifically to LDCs. Three sets of studies are available which throw some light on these issues.

(a) Macro Studies on National DC Policy Alternatives

Most DC governments now have recognised the technological implications of the current world recession. Perhaps the most explicit co-ordinated responses have been undertaken by the Japanese, German and French governments, articulated most persuasively in the influential Nora Report.[1] But many other governments (e.g. the British[2] and the Dutch[3]) have addressed themselves to these issues and their implications for international competitiveness over the next quarter-century.

(b) Sectoral Studies

A number of sectoral studies have begun to appear concerning the impact of electronics on international competitiveness.[4] But most of these relate to the electronics sector (consumer and component industries) and few address the downstream diffusion of these technologies. So far, to our knowledge, only our own studies and those in progress by Jacobssen and Maxwell[5] have addressed the specific implications of sectoral changes for LDCs by reference to empirically generated information on developments in the advanced industrial economies.

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1 Nora, S., and Minc, A., Report on the Computerisation of Society, Paris, France, 1980.

2. (a) Central Policy Review Staff, Social and Employment Implications of Micro-electronics, London, November 1978.

   (b) ACARD, Applications of Semi-Conductor Technology, HMSO, London, 1978.

3 Rathenau, C. W., Social Consequences of Microelectronics, Ministry for Science Policy, Netherlands, 1980.

4 See, for example, the attached list of SPRU research reports.

5 (a) Kaplinsky, R., Institute of Development STudies, University of Sussex, Study on Computer-Aided Design and its Impact on International Location of Production, carried out for UNIDO.

   (b) Hoffman, K., and Rush, H., Science Policy Research Unit, University of Sussex. Study on the Garment Industry, prepared for ILO and UK Overseas Development Administration.

   (c) Rada, J., Impact of Microelectronics, ILO, 1980.

   (d) Jacobsson, S., Research Policy Institute, University of Lund, Study on the use of numerically controlled machine tools in the newly industrialising countries, carried out for SAREC, November 1980.

   (e) Maxwell, P., "Some Aspects of Comparative Advantages in the Argentine Electronics Industry", Buenos Aires, March 1980.

(c) LDC Policy Alternatives

A limited number of LDCs have begun to assess the importance of fashioning policy responses to these changing conditions. Some (e.g. South Korea,[1] India,[2] Brazilian and Mexican national policies on minicomputers[3]) explicitly consider the electronics industry itself; others (e.g. Singapore[4]) relate more generally to the need to move to higher-technology sectors.

3. GAPS IN RELEVANT KNOWLEDGE

So few relevant studies have been undertaken of the impact of electronics on LDCs that it is not even easy to specify which issues require further detailed explanation. On the basis of our own past work and our reading of the general literature, however, we feel that the following five major underexplored issues stand out as being of general importance.

(i) The Impact of Electronics on Market Structure

The origins of many electronics industries through new, innovative, small firms have led some observers to predict an undermining of the dominance and control of older and larger TNC firms, and of those outside the electronics sector itself. But we believe that it is too early to judge whether this popular view is accurate. Either way, the dominance of the TNC sector in the world economy makes it essential to determine which way market structure is being affected, both within the electronics sector itself and in downstream industries.

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1 Republic of Korea, Electronics Industry in Korea, Ministry of Commerce and Industry, Seoul, 1978.

2 Government of India, Electronics Commission, Perspective Report on Electronics in India, New Delhi, 1975.

3 Parthasarathi, A., Electronics in Developing Countries: Issues in Transfer and Development of Technology, UNCTAD, 1978.

ESCAP, Transnational Corporations in the Consumer Electronics Industry of Developing ESCAP Countries, Bangkok, 1979.

4 Dodwell, D., "Singapore: Export Policy Puts Emphasis on Higher Technology", November 1980.

(ii) The Rate and Extent of Diffusion

It is vital to confirm whether electronics is diffusing as rapidly through the world economy and affecting as many downstream sectors as some would predict. If so, then it makes it essential that individual LDC governments and supporting international agencies fashion suitable policy responses as rapidly as possible.

(iii) The Labour Process and the Response of TNC

Much of the successful growth of LDC exports over the past two decades has stemmed from the ability of TNCs to organise the labour process such that the repetitive, semi-skilled manual tasks could be undertaken in low-wage LDCs. But electronics now offers the ability to automate many skilled tasks as well as semi-skilled ones, and this may well affect the extent in which TNCs will continue to use LDC production facilities. Unfortunately little is known of the impact of electronics on work organisation, patterns of employment and the nature of changing requirements for different categories of worker. Nor is there any real grasp of the nature of possibly common cross-sectoral impacts on the labour process.

(iv) Skill Implications

If it is essential for LDCs to use electronics technologies it is important that adequate skills are available. On the electronics side, these include operational, repair and maintenance skills as well as the ability to programme the easily-available and low-cost chips. When it comes to dealing with the incorporation of electronics into products and processes a new configuration of capabilities is likely to be required to deal with the interface problems and the radically new design parameters that can now be achieved. So far, little is known of the precise nature of the skills required nor of the optimal paths to developing them, although each of our respective sectoral studies has attempted to throw some light on these issues.

(v) Systems and Managerial Implications

Increasingly it appears as if the productivity gains afforded to downstream industries by electronics are as much systems gains, as gains in particular sub-processes. This inevitably raises questions

of the organisation of production and it is possible to argue that these systems-changes potentially have both positive and negative implications for the role played by LDCs in the international division of labour. What is required is to assess the extent and significance of these systems gains across various sectors.

4. THE WAY FORWARD ...

In the context of this rather frightening lacuna in our knowledge of the changing processes underlying the diffusion of electronics technology, and on the perceived importance of the policy issues raised for LDC governments and supporting agencies, it is possible to chart a response for a relevant programme of work to be undertaken by researchers from both developed and developing countries which will illuminate the issues raised above. Clearly it makes most sense to build where possible, on the work which has already been completed since it provides both an empirical and a methodological base from which to start. We suggest, therefore, a five point programme-of-action research and institutional initiatives which have direct implications for LDC policy formulation.

(a) Synthesis of Existing DC Macro Studies

As mentioned there have been a variety of macro-policy documents and sectoral studies prepared for particular DC governments and other agencies. The secondary literature (and much of the debate in different forums) has too frequently simply taken the hypotheses and conclusions of these studies and attempted to apply them in a mechanical fashion to the problems faced by the LDCs. The contents of these studies are extremely valuable but they need to be synthesised and distilled to draw out the most relevant implications for LDCs and supporting agencies.

(b) LDC Country Studies

An examination of policies actually undertaken by particular governments both in DCs (such as Ireland, Japan, France and Germany) and LDCs (such as Sri Lanka, South Korea, India, Hong Kong, Brazil and Mexico) will also be valuable in identifying potential policies and pitfalls for other concerned LDCs. By a judicious selection of the countries to be studied, valuable policy relevant information can be generated on the experience of countries with quite different economies and widely varying policy regimes. This would also allow a rigorous comparative analysis of their effectiveness in achieving objectives such as the maintenance and expansion of employment and exports, the creation of backward linkages within the economy and the development of indigenous technical skills.

(c) Sectoral Studies

We believe that at this stage it is through technology-focussed sectoral studies that the policy implications for LDC governments are best identified. It is possible here to identify two sets of 'sectoral' studies which illuminate the relevant issues and would analytically complement each other.

(i) Narrow industry studies

These refer to specific industrial sectors which can be carried out to explore particularly crucial problem areas. They can be divided

Capital Goods	- telecommunications
	- mechanical
	- electrical
	- civil/structural
	- chemical
	- energy
Intermediate Goods	- within electronics (e.g. components)
	- other (e.g. steel, basic chemicals)
Consumer Goods	- food processing
	- durable: electronics (e.g. hi-fi)
	: other (e.g. cars, white-goods, garments

(ii) Broader sectoral studies

The heartland nature of electronic technologies implies a set of cross-sectoral effects and linkages that cannot be adequately captured by traditional industry focussed studies. A set of studies looking at the following areas would illuminate this vital aspect:

Software development
Design
Word processing
Robotics
Industrial control
Communication systems

Clearly it would not be possible to undertake all of these sectoral studies in the short-run but a judicious choice could be made to highlight particular facets of the problem area.

(d) Technical Cooperation between Developing Countries

A limited number of specific technical co-operation exercises can be envisaged. One set would be designed to increase the interchange of experience between LDCs, including higher-level policy forums and more industry-specific workshops. A second set would be to consider the feasibility of LDCs pooling resources in particular sectors to generate appropriate technologies for LDCs incorporating the use of electronics. These workshops, perhaps conducted on a regional basis in co-operation with agencies such as ECLA and ESCAP, could be extremely valuable since many countries as yet lack the precise information on developments in other LDCs and in the international economy necessary for effective policy formulation in this area. To do this successfully, the workshop and the material prepared for them, need to be very specifically focussed on particular problem areas.

(e) Educational Implications

Having illuminated the skills required to make optimum use of electronics technologies, it follows that suitable educational policies should be devised to ensure that such skills are readily available in LDCs. These would be aimed both that LDCs should increase their role in the international division of labour and that through the greater utilisation of efficient electronic technologies, they should be better able to meet the needs of the indigenous population. A number of activities can be envisaged which would generate specific instruments relating to programmes of education and manpower training that could be used by developing countries to meet these objectives.