



# COMPUTER-AIDED DESIGN

Electronics, Comparative Advantage  
and Development



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Electronics, Comparative Advantage  
and Development

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A UNIDO Study  
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Development Organization



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## **PART I: THE SIGNIFICANCE OF ELECTRONICS**



## 1 INTRODUCTION

Developments in the global economy over the past thirty-five years since the end of the war can be viewed in a variety of contrasting ways. At one extreme, little appears to have changed. The mass of the world's population continues to subsist at, or near, the bread line, and most of these people live in less-developed countries (LDCs). LDCs continue to rely on developed country (DC) technology and the flow of trade is predominantly one of DCs exchanging manufactured goods and technology for LDC primary products. But a contrasting – perhaps less pessimistic – view is also possible. Granted, LDCs continue as a whole to rely on DCs for technology, and LDCs continue to export predominantly primary products and import manufactures and technology. Yet within these overall trends, important changes have been taking place in the international division of labour. The share of LDCs in global manufacturing value-added has grown from around 7 per cent in 1965 to nearly 10 per cent in 1979 (UNIDO, 1980). And, no longer do LDCs continue to export primary products alone, for as the years have progressed so have their manufactured exports. By 1975 over 40 LDCs each exported over \$100 million of manufactures, while aggregate LDC manufactured exports increased from \$4.6 billion in 1965 to \$55 billion in 1977 (Hoffman and Rush, 1980).

This growing participation of LDCs in global industrial output and trade reflects two inter-related tendencies in the world economy. The first concerns the specific attempts made over the years by newly independent LDCs to foster industrial production, which was seen as the source of future wealth. This involved the protection and subsidization of production, initially largely for local consumption and then subsequently destined for global markets. And the second factor fostering LDC industrialization was the growing presence of TNCs, actively seeking new markets in the face of fiercely competitive oligopolistic markets (Knickerbocker, 1973).

Associated with these changes has been a growing capability by LDCs in the realm of science and technology. In the early post-war period educational facilities in almost all LDCs were minimal and an expansion of the numbers of educated, and an improvement in their quality, became a priority for most of these countries. This growing presence of skilled manpower in LDCs fostered and facilitated the

transfer of technology. So (despite the inherent difficulty in measuring these phenomena), it seems as though the technological gap between DCs and LDCs began to narrow over the years. One indication of this has been that LDC manufactured exports have progressed beyond the 'mature' labour-intensive traditional industries (*à la* Vernon, 1966) and have increasingly come to encompass a variety of technology intensive goods (Lall, 1979; Katz 1978; O'Brien, 1981).

As a consequence of these developments there has been optimism that LDCs will be able to maintain their growing presence in the international division of labour in industry – the 1978 UNIDO Lima Conference, for example, set a target for LDCs of 25 per cent of global value added in manufacturers by AD 2000 (UNIDO 1979).<sup>1</sup> But this horizon has in recent years become clouded both by the persistent and worsening recession in the world economy and by the rapid diffusion of efficient electronics-related technologies in DC manufacturing enterprises. These technologies not only tend to save labour (supposedly the source of LDC comparative advantage), but also provide other substantial benefits to innovating enterprises. So their differential diffusion in the world economy is likely to significantly affect the ability of non-innovating enterprises to compete in global markets. If this differential diffusion takes the lines of a DC-LDC split, then the technological gap, which appears to have narrowed in recent decades, may once again widen. In which case, the anticipated role of LDCs in the global division of labour in industry is likely to be less favourable (from the LDC point of view) than current perspectives suggest.

So far, however, all this is conjectural. Many observers, including those writing to the specific brief of DC governments (e.g., Nora, 1979; and Barron and Curnow, 1979), believe that electronics related innovations provide very substantial benefits to innovating enterprises. But little is known of the extent and nature of these benefits. Other observers (Rada, 1979; Kaplinsky, 1981) have argued that there is likely to be a differential diffusion of these technologies through the global economy, but once again little information has been available to back-up these assertions. It has become imperative, therefore, for more substantive evidence to be provided which might illuminate these generalized assertions.

It is in this rather striking context of our ignorance of the detailed impact of electronics technologies that this case-study on computer-aided design (henceforth referred to as CAD) should be seen. Although this sectoral study comprises an analysis of the specific origins, developments and uses of CAD technology as a sector in its

own right, it more importantly illuminates general aspects of the origins and diffusion of electronics technologies, the benefits which arise from their use and the effect which they will have on the international division of labour. We believe that it is not possible to understand either of these issues (i.e., both the sectoral and the global trends) in isolation. But readers who prefer to confine themselves to the specific characteristics of the CAD sector might wish to limit their reading to Part II (chapters 3 to 8) and those with a wider interest in the impact of electronics on the global division of labour will find Parts I and III more to their interest. Essentially, however, the detailed analysis on the CAD sector provides incidental evidence to further discussion on the impact of electronics technologies on LDCs.

Before we proceed to the wider discussion on the relevance of electronics to the international division of labour (Chapter 2) it is necessary to explain briefly why the CAD sector has been chosen to illuminate these issues. This sector is peculiarly well-suited since it involves consideration of many of the more relevant issues. Thus, because of its downstream links with computer-aided manufacture (CAM) and information management, optimal use of CAD leads to *systems gains* in productivity. These systems gains — which arise from organizational re-structuring and optimized information management — lie at the heart of the 'electronics revolution', leading to the convergence of hitherto disparate processes such as communications and information processing and spawning a new family of jargon (e.g. 'telematics', 'informatics') and a restructuring of major TNCs (e.g. IBM and Xerox). The second advantage arising from a study of the CAD sector is that it illuminates the origins and development of *high-technology electronics sectors* which have, hitherto, almost all emerged out of the links between the United States defence, aerospace and electronics industries, initially in the form of small, independent firms and latterly as emerging TNCs themselves or as part of existing (not necessarily American) TNCs. And, thirdly, CAD technology is an excellent example of the *downstream diffusion* of electronics technologies to manufacturing industries where it is used to counter competitive pressures in the global market, partly arising from the growing exports of newly industrializing countries (NICs).

In order to explore both these particular facets of the CAD industry and the wider implications of electronics technologies in general, this study is separated into three sections:

- (a) Part I is concerned with situating the development and diffusion



of electronics technologies in a broader sweep of history. Electronics is considered in relation to long-run cycles of economic activity, and the discussion concludes with an assessment of the potential role which electronics technologies will have on the international division of labour in manufacturing. The major point made in this section is that electronics-related innovations are not merely one of a series of minor, unrelated technological developments. They represent a major set of new technologies which are of particular relevance to LDCs in their quest to become significant industrial producers.

(b) Part II is concerned with a detailed analysis of the CAD sector. In Chapters 3, 4 and 5 the origins, development and emerging market structure of the CAD sector are explored, together with an assessment of the significance of CAD for the wider diffusion of automation in manufacturing industries. This analysis is based upon field visits to suppliers, users and observers of the CAD industry in the United States and Europe.<sup>2</sup> Chapter 6 is based upon a series of interviews conducted with CAD users in the United States and Europe, and comprises an investigation of the benefits arising from the use of CAD. Of particular interest to LDCs is the question of whether CAD should be evaluated as a pure choice of technique capital/labour substitution decision (and if so, at what factor prices it becomes optimal), or whether it enables designers to achieve results which are not possible with manual design/draughting systems. The rate and direction of the downstream diffusion of CAD technology is then considered in Chapter 7, in which particular attention is paid to the industrial sector, and the types of benefits reaped by innovating enterprises in different branches, particularly those of relevance to LDCs. Then, given the imperative, if any, to the use of CAD technology, Chapter 8 assesses the skills required and the nature of the learning curves involved. The analysis is based upon evidence gathered in field visits to users and suppliers of CAD technology.

(c) Part III concludes the study with a discussion of the specific sectoral and more general policy implications for LDCs of emerging electronics technologies. It concludes with an assessment of the wider impact which electronics related innovations are likely to have on the international division of labour in industry.

Care is required in reading this study. As already pointed out, the analysis is ultimately aimed at exploring the likely impact of electronics related innovations on the international division of labour in industry. This is the primary subject matter of Parts I and III. But in order to fully assimilate the lessons to be learned from this sectoral