COMPUTER TECHNOLOGY IMPACT ON MANAGEMENT

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Sperry Univac, Roseville, Minnesota

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Acknowledgment

The motivation for writing this book came from many long and fruitful discussions of EDP applications with computer users around the world. It is therefore to computer users that this book is dedicated. Although my work for the last decade has been in the design of large scale computer systems, my work for the previous decade was in computer applications. Therefore, I still identify strongly with the community of computer users.

In the rapidly changing environment of business and applications requirements on one hand, and computer technology on the other hand, computer users need considerable visibility into future technology to adequately plan their system evolution. The process of providing the computer technology trend information to a number of users to assist in their planning provided the forcing function to document the material contained in this book. These same discussions with users, many of whom have equipment from several major computer manufacturers, provided considerable material for this book, including most of the case studies and examples; their contribution is hereby acknowledged.

The many contributions to this book by my colleagues at Sperry Univac, who are too numerous to mention by name, are also gratefully acknowledged. Much of the material on hardware and software technology trends came from associates who are active in each of these fields.

Special thanks and recognition are due to G. J. Hommes who took the raw text input and did the necessary production work to convert it into camera ready copy. Of course, the responsibility for any errors remains with myself.

Finally, I would like to thank my wife Barbara, and children Renee, Mark, and Lisa for their continuing support which made this book possible and worthwhile.

George Champine Roseville, Minnesota March 27, 1978

The views expressed in this book are those of the author and do not necessarily reflect those of Sperry Univac

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1. Introduction

Change in technology always has a large impact on society in general and on organization and management in particular. This is true not only of the classical technologies such as fire and the steam engine, but also of more modern technologies such as the automobile, airplane, and radio. The technology of solid state electronics is no exception. The world has never been the same since the invention of the transistor in 1948 — and the impact of the ensuing technology grows larger each year. In contrast, the remaining impact of the largest contemporary event, World War II, seems small and diminishing only three decades later.

As an indication of the "quantum jump" that has already taken place in the economics of computing, consider the following comparison:

> *In 1940, the cost of one man-hour would buy the execution of about 800 (arithmetic) instructions, and data could not be stored for fast access. In 1960, the cost of one man-hour of labor would buy the execution of 1.4 million instructions or the storage of one megabyte of data on direct access storage for two days. In 1977, the cost of one man-hour of labor would buy the execution of 225 million instructions or store one megabyte of data for 15 weeks.*

It has been said that any time a characteristic in technology changes by a factor of ten, it causes a revolution in life style. In transportation, a horse walked at five miles per hour, an automobile moved at 50 miles per hour (in 1895), and a commercial jet airplane moved at 500 miles per hour (starting in 1960). Thus, there were two life–style revolutions spaced 65 years apart. In computers, as the 1940 to 1977 illustration above shows, there have been two revolutions in the last 17 years. The first one provided a factor of 1000 improvement, and the second one provided another factor of 100 improvement before the first one could be absorbed. In contrast to the popular expectation that the rate of technology advance will slow due to the approach of fundamental physical limits, at least two more orders of magnitude of improvement are coming, based on techniques already developed.

Data processing technology is probably unique among all technologies that management deals with in that efficiency and productivity are increasing. It is absolutely and without parallel that improvements are occuring in cost/performance of data processing at a rate of a factor of ten each decade. Because of this, computer technology must be managed and exploited differently from all other technologies. The pressure from computer technology for the continued rapid change in management comes from the following interdependent circumstances:

- Labor and material are becoming more expensive at the rate of general inflation, approximately six per cent per year.
- Approximately half of the labor force in the Unites States and Western Europe is engaged in data handling in the broadest sense. This data handling is susceptible to substantial improvement in productivity through EDP methods.
- For a given cost, EDP systems are increasing in capability at a rate of about 18 per cent per year compounded.

The result is that users are under considerable, and growing, pressure to further automate their operations to control costs by substituting more EDP technology, which is increasingly cost effective, in place of labor and materials, which are decreasingly cost effective.

As an indication of how far technology has come and of advances yet to come which can be forecasted with a reasonable degree of confidence, the following examples are provided:

Example — One of the first large scale computer was the UNIVAC® 1103. Developed during the early 1950's, this machine was the most powerful of its day. It used vacuum tube and magnetic core technology, occupied a room 33 feet by 60 feet and used 30 kilowatts of power. It had 10,000 logic gates in the processor, and 1024 (36-bit) words of main storage. Technology now in product makes it possible today to put the entire computational capability of the 1103 processor on just one semiconductor device 6 mm (0.25 inch) square, and the entire capacity of the 1103 main storage on a second such semiconductor device. Current technology makes it possible to put an entire main frame having the complexity of the 1103, including support logic, I/O, and power supplies into a large briefcase — and it is twenty times faster.

Example — A few years ago, Herb Grosch referred to the "hand-held 1108", perhaps somewhat in jest. If he was referring to something the size of a pocket calculator, the technology to build that is not yet in sight. However, technology now visible at an engineering level will make it possible to put an 1108 capability into a (large) suitcase by the 1985 time frame — thus putting into the portable, if not 'hand-held' status, an equivalent 1108 computer.

Although the state of the art of computer hardware technology appeared to stagnate in the early 1970's, it is advancing faster now than ever before. Semiconductor devices now in production have 30,000 transistors on a silicon chip 5 mm square (0.2 inch), with very high probability of providing 300,000 transistors on the same size device in the next five years. This rapid advance is making a large impact on the way computer systems are designed, and will have a large impact, in just a few years, on the way computer systems are used.

Because of the rapid change in computer technology currently, straight-line extrapolation is no longer an acceptable method of estimating future characteristics of computer systems. For example, a large government agency used that method recently to size a building to house the computer system for a particular application, but because of the rapidly shrinking physical size of the actual system, they over built by a factor of three.