

Man and Machine: Who Leads Who?

The history of the computer industry has been one of rapid development, with circuit speed growing exponentially and program complexity consistently increasing. This environment of growth has proved itself a fertile ground for human ingenuity – computers are involved in many aspects of human life, from the workplace to the home, and their role continues to grow. At a glance, this rapid growth of the computer industry may seem uncontrolled, as if technology is driving society in new directions, but a more detailed analysis indicates that computer development is actually led by the needs of society. As this document will indicate, society's clearest mechanism for leading the computer industry is market forces; market forces from the missile and space programs enabled the development of the integrated circuit, and consumer demand played a prominent role in the rise and fall of the “.com era”.

After World War II and during the Cold War, the aerospace industry played a critical role in the development of the integrated circuit. For at least a decade after the development of the digital computer, analog computers continued to be used in missiles and spacecraft because they were smaller and lighter. However, digital computers allowed improvements in flexibility, such as rapid retargeting of missiles, and the integrated circuit allowed digital systems to surpass analog designs in terms of weight and power requirements. While integrated circuits were significantly more expensive than discrete components, the military and space programs consumed most of the IC industry's output for years, allowing the construction of Minuteman missiles and the Apollo Guidance Computer (AGC).

Others have considered the relationship between society and the development of the integrated circuit. Ceruzzi analyzes both sides of the argument. On the one hand, he says, “the thousandfold reduction in size and cost of computer circuits, pushed along by Apollo and Minuteman, demand a rethinking of just about every system that could use computers” (Ceruzzi 89, p. 189). On the other hand, “Kennedy's call for a mission to the moon was a result of cold war politicals and a political need to do something spectacular in space” (Ceruzzi 89, p. 189). From this perspective, the development of the integrated circuit was not obvious – ground based control, for example, could have been brought to bare – but rather the IC market succeeded only because NASA and the military decided to invest. In fact, aerospace usage of integrated circuits was not a natural decision; Hall describes becoming “the salesman to convince everybody, including NASA program management, that a change to integrated circuit logic was feasible and was more desirable than core transistor logic circuits” (Hall 2000, p. 28). Thus, cases can be made for society leading computer development and vice versa.

While the development of integrated circuits undoubtedly allowed dramatic societal changes, both within the aerospace industry and in society in general, the new uses of integrated circuits were unquestionably directed by the purchasers, not the

suppliers. The minuteman program specified exactly one type of transistor for use in missiles, allowing commodities of scale to improve device quality and pricing. Similarly, the AGC used only NOR-3 gates, allowing the construction of any computational function but requiring efficient production of only one type of circuit. Since the aerospace industry purchased practically all semiconductor devices during the era, we can assume that the only devices developed in any quantity were those that society, i.e. the aerospace industry, wanted. Since then, ICs have been used in many other types and flavors, but clearly their development path was guided by the needs of industry – the IC industry did not invent microprocessors out of nowhere and instruct the aerospace industry in how to use them. Thus, it was the market demand forces from the Apollo program that allowed ICs to succeed, and integrated circuits did not dictate the success or failure of the program.

In more recent times, the “com era” provides an enlightening example of the interactions between technology and society. The development of the Internet allowed rapid technological development, particularly in the software industry. Companies formed to try to move most if not all aspects of human society online. However, the inevitable burst of the bubble occurred when it became apparent that many of these technological developments were unwanted by society. If nobody wanted to purchase furniture online, “buyexpensiveandlargefurniture.com” would not succeed. Thus, once again, technological developments allowed rapid societal change, but those changes and the technology used to achieve them were dictated by the needs of society.

In conclusion, it seems that society's needs play a larger role in guiding computer development than computer development does in dictating society's needs. Certainly, there is an important interplay between the two, as Ceruzzi indicates, but in the end technological developments only succeed in the marketplace if society actually wants to use them.

Bibliography

Ceruzzi, Paul E., *Beyond the Limits: Flight Enters the Computer Age* (Cambridge, MA: MIT Press, 1989)

Hall, Eldon C., "From the Farm to Pioneering with Digital Control Computers: An Autobiography," *IEEE Annals of the History of Computing* 22 (April-June 2000): 22-31.