had made its name machining helicopter rotor blades, and was looking to get into the business of machining wing sections for new Air Force prototype airplanes. Parsons believed that by using punched cards to feed information to machine tools he could increase both the accuracy and speed of production. The partnership between Parsons and MIT coined the phrase numerical control, or NC, to describe the operation at hand. NC became the heart of computer-aided manufacture. With NC, each part to be machined could be described mathematically. The machine tool's motions were controlled by servomotors, which responded to digital commands programmed into the machine to determine a path for the cutting head to follow.

Parsons dropped out of the project in 1950 when he realized that fulfilling his Air Force contract did not entirely mesh with MIT's plan to fully automate machining using digital servo control. Still, he is rightly credited as the inventor of NC. Work on the automatic milling machine continued at MIT until 1956. Under MIT's direction, research into automation of machine tools focused more on control and feedback systems than on machining. Still, MIT's system of automation became commercially available in the early 1950s, through a Cambridge, company called Ultrasonic, with very close ties to the servo lab.

Like FEA, the diffusion of NC machining initially stayed close to the defense industries from which it was developed. Only with the development of cheaper, more powerful computers could NC become common outside the rarified atmosphere of military contracts.

CAD/CAM

In the 1970s, cheaper, more powerful minicomputers meant that many engineering companies were using the same computer to design and manufacture parts. The common use of computers led to the marriage of CAD and CAM, so that the information produced in the design of a component could be directly transferred through the computer to the shop floor. The graphical representation of components on the computers played a key role in putting CAD and CAM together. Engineers laid out a part on the computer in order to perform various analyses on it; that same information could then be used to set up an operation for producing the component. Again, the Air Force played a central role as a powerful proponent of CAD/CAM with its $100 million integrated computer–integrated manufacturing, or ICAM program. Through ICAM, the Air Force was able to foster corporate and academic, leading to faster, less risky development and dispersal of new CAD/CAM technology.

At the turn of the twenty-first century, parts as varied as airplane wings and fishing rods are designed and manufactured using desktop computers. CAD/CAM stands for a different way of making artifacts, as well as an integration of conceptual design and shop floor production. It has also ushered in a new method of oversight, whereby one individual can supervise and control both design engineering and manufacture on a single computer.

Ann Johnson

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Computers, Analog

Paralleling the split between analog and digital computers, in the 1950s the term analog computer was *a posteriori* projected onto pre-existing classes of mechanical, electrical, and electromechanical computing artifacts, subsuming them under the same category. The concept of analog, like the technical demarcation between analog and digital computer, was absent from the vocabulary of those classifying artifacts for the 1914 Edinburgh Exhibition, the first world's fair emphasizing computing technology, and this leaves us with an invaluable index of the impressive number of classes of computing artifacts amassed during the few centuries of capitalist modernity. True, from the debate between "smooth" and "lumpy" artificial lines of computing (1910s) to the differentiation between "continuous" and "cyclic" computers (1940s), the subsequent analog–digital split became