

CMOS pioneer developed a precursor to the processor

Electronic engineers under the age of 40 or so may not even know that RCA was once a player in the semiconductor market. But RCA made a variety of semiconductors and was the leading supporter of CMOS back when those in the industry considered CMOS a slow technology that was suitable only in specialty, low-power applications. RCA engineers not only designed CMOS-logic chips, but also were headed toward a microprocessor, as this account in 1970 from an early International Solid-State Circuits Conference indicates.

RCA in 1968 introduced the first CMOS ICs—the 4000 series of logic ICs. The series included functions similar to the 7400 series of TTL ICs. But CMOS, which RCA called COS-MOS at the time, offered far lower power. CMOS had other advantages, as well. The 4000 series could operate from supplies of 3 to 15V and could handle a fan-out of 50 or more devices, whereas TTL could handle a

maximum of 10 devices. But early CMOS was far more susceptible to electrostatic discharge than TTL. And, when RCA introduced it, the 4000 series could operate at only 1 MHz, whereas TTL ICs could operate at 10 MHz.

The account of RCA's bit-slice development clarifies the early performance issues. (You can read the full story by checking out the online ver-

sion of this article at www.edn.com/060622mtm). The RCA engineers claimed that their copy of the PDP-8 would run at 250 kHz or perhaps 500 kHz. The early PDP-8 operated at 666 kHz.

In the early days of the microprocessor, bit-slice approaches such as the RCA example were popular. A bit-slice design could offer performance advantages in operating frequency and allowed designers to customize the instruction set.

This milestone also provides another example of how important a role NASA played in driving semiconductor developments. It's likely that NASA needed the low-power capabilities that CMOS delivered. And the semiconductor wizards that make our industry so much fun ultimately figured out how to make CMOS blazingly fast as it came to dominate first the 7400 series of logic and then processors, and it today serves even in analog and mixed-signal designs.

04.01.70

COS-MOS Could Put Computer Slice on a Chip


 FROM
 THE
 VAULT

PHILADELPHIA - One direction in which LSI may take off in the next few years was dramatically illustrated at ISSCC by a description of a complete 4-bit slice of a computer's arithmetic section built for NASA by RCA.

The 775-transistor COS-MOS (Complementary Symmetry MOS) LSI chip described by Allan Alaspa and Andrew Dingwall of RCA impressed experts at ISSCC because it showed that it is now feasible to cram all the control and temporary storage registers and arithmetic logic needed for a 4-bit slice of a parallel arithmetic process into a "sensible" monolithic unit.

The chip has a sensible size—146 by 155 mils. It has a sensible number of input/output (I/O) pins—just 27. It has very sensible power requirements—only 10 mW for a 250-kHz operating rate. It has sensible chip interconnections—only one layer of metallization. Perhaps most sensible of all, it has application flexibility. One chip can be used in a wide range of slow-speed computer architectures.

EDN asked Allan Alaspa what it would take to build a complete computer of these powerful chips.

"I and another engineer have been playing around with that very idea on our lunch hour," he said. (RCA's contract with NASA has been completed and NASA has what it

needs for its onboard data reducers for scientific satellite experiments.)

"We have taken a PDP-8 computer as a proposed goal. We estimate that it would take 12 of the 4-bit processors to make up the basic four registers, each with 12-bit words. Then we would want to add a couple of dozen ROMs (read only memories) to carry some 100 instructions, and then a half-dozen RAMs (random access memories) and four buffer arrays to hold the data in transit between the processors and memories and input-outputs. We would, of course, put the ROMs and RAMs on similar-sized LSI chips as we expect their integration to be much less of a problem than that of the processor chip.

"All in all, we think between 50 and 100 chips of this LSI level might be needed to construct a medium-sized computer with PDP-8 capabilities. Of course, fewer chips would be needed for minicomputers and desk calculators, but our present processor chip really has more computing power than is needed for these smaller machines."

Cost of this imagined LSI PDP-8 would be the same or better than that of the present PDP-8, Alaspa is convinced. With sales volume, the LSI version ought to cost significantly less.—EDN, April 1, 1970