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## In Greenwich, the science of time is measured in seconds

**Keepers of time already planning for more accurate 3000.**

By Jeremy Pearce  
*The Detroit News*

**GREENWICH, England** – As bells tolled over London, noisily marking the start of a new century, the Royal Observatory computer clock in Greenwich ran on in silence, capturing the moment to a millionth of a second.

Time has been kept here for 325 years, since King Charles II responded in 1674 to a need for better navigation in guiding Britain's navy. Correct time is critical for plotting a safe sea course, he reasoned.

"It sounds a bit dreary, but timekeeping affects navigation, astronomy, technology and engineering," explained Jonathan Betts, the observatory's curator of

horology, which is the study of time-keeping.

"When you actually think about it, there's not a single occupation today without an element of time."

Betts oversees a collection of 1,500 clocks at the Royal Observatory's museum. The collection includes the official millennium computer clock – a far cry from less reliable mechanical clocks that were the standard until recently.

Now, scientists worldwide are working to further refine the keeping of time and cut the margin of error to a billionths of a second. Such exacting accuracy will improve navigation in space and sharpen the speed and efficiency of small laptop computers on Earth.

"All computers run on a very rigid sense of timing," said Dr. Jacob Schwartz, who teaches computer science at New York University's Center for Advanced Technology. "The

clock determines when the computer moves on to the next operation. Without the clock, there would be wild confusion. That's why we want to define time as far as we can – to further billionths of a second."



### From water drops to atoms

During the last 1,000 years, cultures kept time by watching sundials, hourglasses, dripping water and even by burning sticks

of incense. The first known mechanical clock appeared in England some 700 years ago. Now, the recognized standard for time is the atomic clock.

Atomic clocks measure the vibrations of a cesium atom, an element in the form of a metal at room temperature.

The motions of electrons around its atoms are highly predictable – nine billion vibrations equals one second. The measurements, in effect, become an extremely regular “ticking” for atomic clocks.

Those clocks are kept in the United States, France and Germany, and closely compared to each other.

“Thousands of years ago, we used the rising and setting of the sun,” said Dennis McCarthy, director of the U.S. Navy’s Directorate of Time in Washington, D.C. McCarthy’s agency supplies the official time to the Department of Defense, which uses it for timing the nation’s missiles and satellites, among other purposes.

“Then we created the hours, minutes and seconds. Our work now is really just an extension of that.”

### Looking to the stars

Now, the race is on to define the second still further. The answer, say scientists, may lie in space.

Rapidly spinning magnetic stars called pulsars send out pulses of energy that can be picked up by

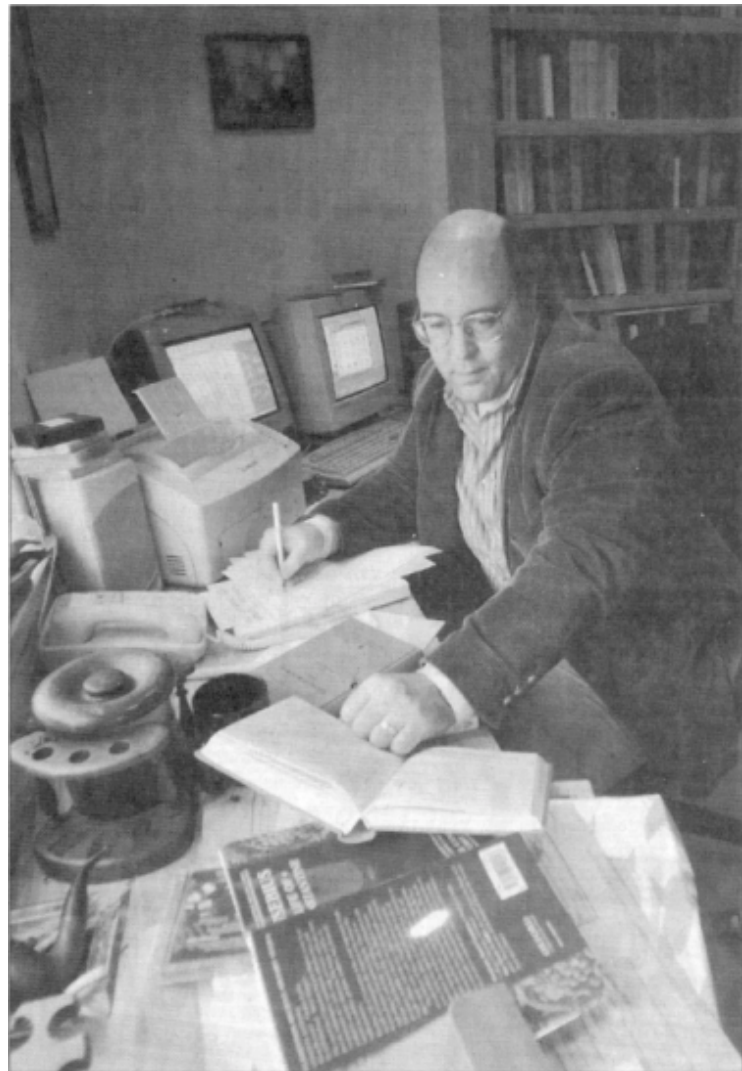
astronomers viewing the heavens on radio telescopes. In some cases, the pulses may be more regular than readings from atomic clocks.

“The pulses are rather like the ticking of a mechanical clock,” said Princeton University astrophysicist Dean Joseph Taylor. “The best pulsars are arguably as good as the best

happen to be traveling in space, navigating between the stars, they’re probably going to be much more useful.”

As the second is divided into ever-tinier units, there are social aspects to timekeeping that may prove as important.

Technology aside, what are the real, uses of time?



atomic clocks. And if you What is civilization

Max Ortiz / The Detroit News

“In short, the millennium we’re celebrating is a fake date. The evidence for the precise year of Christ’s birth is contradictory,” says David Potter, a University of Michigan classics professor who has tried to pinpoint Jesus’ birth year.

recording? What is the meaning of the new millennium? The definition of the second, scientists say, should be tied to the larger calendar.

### **Forever elusive**

Theologians argue the millennium is intended to mark the 2,000th anniversary of the birth of Jesus Christ, although most agree that his actual birth year is unknown.

“Depending on where you lived in the Roman Empire at that time, you could measure the years in

any number of ways – by the reigns of governors or even by tax cycles,” said David Potter, a University of Michigan classics professor who has tried to pin-point Jesus’ birth year.

“In short, the millennium we’re celebrating is a fake date. The evidence for the precise year of Christ’s birth is contradictory. The best guess that we can make is to say it was likely within a range of 10 years or so of the date popularly accepted.”

Other experts push the point further. They say that, even if society’s timing on

Friday night was right, the true end of the millennium shouldn’t be celebrated until the final day of the year 2000.

“You come to see that everything in our calendar is arbitrary,” said J.T. Fraser, a retired philosophy teacher and founder of the International Society for the Study of Time.

“When we forget about all of the clocks and watches out there, we really still live by the light of the day and the dark of the night.”