**The Invention of the Mechanical Clock**

**机械中的发明**

In Europe, before the introduction of the mechanical clock, people told time by sun (using, for example, shadow sticks or sun dials) and water clocks. Sun clocks worked, of course, only on clear days; water clocks misbehaved when the temperature fell toward freezing, to say nothing of long-run drift as the result of sedimentation and clogging. Both these devices worked well in sunny climates; but in northern Europe the sun may be hidden by clouds for weeks at a time, while temperatures vary not only seasonally but from day to night.

在欧洲，在机械表被引入以前，人们利用太阳（比如棍子的影子和日晷）和水来确定时间。当然，太阳钟表只能用于晴天，而水钟表在水温下降到冻结的时候会出错，会出现没有任何长期漂浮的东西会出现漂浮或者堵塞。这两种仪器在阳光充裕的气候都运行的很好，但在北欧，太阳可能会藏在云后长达一周，同时，温度不仅会在季节中变化，也会从早到晚的变化。

Medieval Europe gave new importance to reliable time. The Catholic Church had its seven daily prayers, one of which was at night, requiring an alarm arrangement to waken monks before dawn. And then the new cities and towns, squeezed by their walls, had to know and order time in order to organize collective activity and ration space. They set a time to go to sleep. All this was compatible with older devices so long as there was only one **authoritative** timekeeper; but with urban growth and the multiplication of time signals, discrepancy brought discord and strife. Society needed a more dependable instrument of time measurement and found it in the mechanical clock.

中世纪欧洲使得可靠的时间变得更重要。天主教堂有每天七次的祷告，有一个是在晚上，它要求了闹钟的设定，在傍晚前叫醒布道师。另外新的城市和城镇，由于其空间的限制，他们必须要知道并且安排时间去组织集体活动和分配空间。他们设定时间去睡觉。所有这些用老的仪器都是可以一致的，只要只有一个权威的时间记录者。但是随着城市的发展和报时信号的倍增，时差导致了不和与争吵。社会需要一个更加可靠的工具去衡量时间，这个仪器就是机械钟表了。

We do not know who invented this machine, or where. It seems to have appeared in Italy and England (perhaps simultaneous invention) between 1275 and 1300. Once known, it spread rapidly, driving out water clocks but not solar dials, which were needed to check the new machines against **the timekeeper of last resort**. These early versions were **rudimentary**, inaccurate, and prone to breakdown.

我们并不知道是谁发明了这个机器，或者在哪。它好像是出现在意大利或是英国（也许是同时发明的）在 1275 年到 1300 之间。一旦被人们所知，它就传播

的非常快，人们不再使用水钟表，但日晷依然存在，并被用来对照这个新仪器与

原来所用最后一种计时法。这个早期的版本是基本的，不准确的，并且有崩溃的

倾向。

Ironically, the new machine tended to undermine Catholic Church authority. Although church ritual had sustained an interest in timekeeping throughout the centuries of urban collapse that followed the fall of Rome, church time was nature’s time. ■Day and night were divided into the same number of parts, so that except at the equinoxes, days and night hours were unequal; and then of course the length of these hours varied with the seasons. ■But the mechanical clock kept equal hours, and this implied a new time reckoning. ■The Catholic Church resisted, not coming over to the new hours for about a century. ■From the start, however, the towns and cities took equal hours as their standard, and the public clocks **installed** in town halls and market squares became the very symbol of a new, secular municipal authority. Every town wanted one; conquerors seized them as especially precious spoils of war; tourists came to see and hear these machines the way they made pilgrimages to sacred relics.

讽刺的是，新仪器有破坏天主教堂权威性的倾向。虽然教堂仪式一直保持着对时间记录的兴趣贯穿整个城市瓦解跟随着罗马没落的世纪，教堂时间是自然的时间。白天和黑夜被分为均等的部分，所以除去昼夜平分点，白天和黑夜时间是不均等的；当然因此，这些时间的长度也随着季节变化。但是，机械时钟保持了均等的小时，这意味着新的时间计算法。天主教天反抗，将近一个世纪不肯转化到新的时间。但从一开始，城镇和城市接受了均等时间作为他们的标准，并且安装公共的时钟在城镇大楼和市场变成了新的世俗市政权威的标志。每个城镇都想要一个；胜利者视它们为珍贵的战利品，在游人去神圣遗骸朝圣的路上，他们专程去看并听这些钟表。

The clock was the greatest achievement of medieval mechanical ingenuity. Its general accuracy could be checked against easily observed phenomena, like the rising and setting of the sun. The result was relentless pressure to improve technique and design. At every stage, clockmakers led the way to accuracy and precision; they became masters of miniaturization, detectors and correctors of error, searchers for new and better. They were thus the **pioneers** of mechanical engineering and served as examples and teachers to other branches of engineering.

钟表是中世纪机械精巧装置的最大成就。它的正确性的不足可以通过简单地可观察的现象来证明，比如日出日落。这样的结果是对技术和设计进步的残酷的压力。在每个阶段，制表人都引领着正确性和精密度，他们成为了微型化的大师，错误的探测器和校正者，更新更好的搜寻者。因此他们是机械工程的先驱，是工程学其他分支的典范和老师。

The clock brought order and control, both collective and personal. Its public display and private possession laid the basis for temporal autonomy: people could now coordinate comings and goings without dictation from above. The clock provided the punctuation marks for group activity, while enabling individuals to order their own work (and that of others) so as to enhance productivity. Indeed, the very notion of productivity is a by-product of the clock: once one can relate performance to uniform time units, work is never the same. One moves from the task-oriented time consciousness of the peasant (working on job after another, as time and light permit) and the time-filling busyness of the domestic servant (who always had something to do) to an effort to maximize product per unit of time.

钟表带来了秩序和控制，既有集体的也有个人的。它的公开展示和私人拥有铺设了短期自治的基础：人们现在可以不用根据上层的命令来调整来和去。钟表也为集体活动提供了时间提示，同时使个人能够安排他们自己的工作，以此来加强生产力。事实上，生产力的准确概念是时钟的副产物，一旦一个人可以将其表现用统一的时间单位衡量，那么工作就永远都不会一样了。人们从农民以任务为导向的时间意识（在时间和光线条件允许的情况下，一件工作接着一件的干）和家奴充满时间的忙碌（总有事情做）转变到了努力去最大化单位时间的生产量。