

REVOLUTION IN TIME

Clocks and the Making of the Modern World

REVISED AND ENLARGED EDITION

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Are You Sleeping, Brother John?

It is one of the misfortunes of scholarship that there was only one word for clock in the western Europe of the Middle Ages: (*h*)*orologium*. This generic term referred to every kind of timekeeper, from sundial to clepsydra to fire clock to mechanical clock. So when, in the late thirteenth century, we get an unprecedented spate of references to clocks, we cannot be sure *prima facie* what kind of device our sources are talking about. Not until the fourteenth century do we get our first unmistakable reports of mechanical clocks – namely, the tower clock with astronomical dial built by Roger Stoke for Norwich Cathedral (1321–5); the highly complicated astronomical mechanism that Richard of Wallingford initiated at St Albans around 1330 and that took thirty years to build; and then, completed in 1364, Giovanni de' Dondi's astronomical clock, the marvel of its time. The latter two were described by their authors in such detail that we have been able to make working copies in our own day.¹ (See Figure 15.)

The obscurity of what Needham calls 'one of the most important turning-points in the history of science and technology' has been a fruitful source of legend and speculation. For some centuries it was common to attribute the clock to the canon Gerbert, who later became Pope Sylvester II (999–1003), the Pope of the Millennium. Gerbert was indeed a savant in his generation. He had learnt mathematics and astronomy in Spain, perhaps at the feet of Jewish and Muslim scientists there, and had taken away with him a fund of knowledge and technique that re-emerged in the fourteenth century with the work of Richard of Wallingford and

Giovanni de' Dondi. The historian and monk Richer (tenth century), who was one of Gerbert's students, tells us that his master built a globe, also an armillary sphere for the planets and another to show the motions of the stars.²

Gerbert, then, presumably had the knowledge and skill to build a mechanical clock. But *could* is not *did*. There is no contemporary proof of Gerbert's inventing such a device and some reason to think otherwise: if the oscillating controller and mechanical escapement were known as early as the year 1000, why do we have to wait another three hundred years to see clocks appear in the belfries and towers of town halls and churches? Surely, moreover, if so remarkable an invention had been coming slowly into use, it would have left some literary or pictorial trace, if not some physical remains. Some have suggested that if Gerbert did indeed build a mechanical clock, it must have been suppressed by the Church, which might have seen it as the illicit fruit of intercourse with infidels or as the cunning product of some dark, Faustian compact. Gerbert did eventually acquire the reputation of a sorcerer and heretic – to the point where, in the sixteenth century, militant Protestants exploited his 'infamy' to calumniate the papacy.³ But this amounts to heaping speculation on speculation. Would the Church have wanted to suppress a device so useful in its own management of time? Could it have? I am not a medievalist and am in no position to answer such questions. But the matter is worth investigating.

In the mean time, we are left with over two hundred and fifty years of near-silence, followed by a rush of ambiguous noise. The resulting uncertainty has given negative encouragement and support to a most unexpected interpretation of the invention and development of the mechanical clock. This is the thesis of Derek de Solla Price, co-author with Joseph Needham and Wang Ling of *Heavenly Clockwork* and specialist in the history of ancient and medieval scientific instruments. Price argues that the machines of Wallingford and Dondi were the first mechanical clocks, that the timekeeping components served simply as drives for astronomical devices of a type going back to antiquity, and that timekeeping for its own sake was an unanticipated by-product of this experiment in automation. 'The escapement, which originally gave perfection to the astronomical machine, was also found useful for telling time, and as social development led to an increased social awareness and importance of time reckoning, simplified versions of this part of the astronomical device were made and became widely used as mere time-tellers.'⁴ Price

is hard on 'simplified versions' and 'mere time-tellers': on another occasion he refers to 'degeneration in complexity' and describes the later fourteenth century as a time when the 'tradition of escapement clocks continues and degenerates into simple time-keepers'. To cite his by now well-known metaphor: 'The mechanical clock is nought but a fallen angel from the world of astronomy!'⁵

Now, it is no doubt true that terrestrial timekeeping is less elevated than heavenly clockwork, but 'degeneration' does seem a mite strong.⁶ So do Price's strictures against the other wisdom on this subject, which he finds 'unsatisfying, misleading, and often false'. Earlier students of horology, he warns us, were on the wrong track: 'On no account must we take the easy way out which abandons the history of the clock and talks instead about the history of time-measurement. It is most unfortunate that such a term was ever coined.'⁷ 'What did not happen was that man wanted to measure time and so devised new ways of doing it. What did happen is that in the course of following an old trend, not quite yet extinct, he developed quite sophisticated techniques, important for their technological brilliance, that gave him for the first time the possibility of doing something he had not wanted before it was readily available. This product, timekeeping, caught on, and it is due to this ancient fashion that time became a matter of the deep philosophical and scientific importance it has today.'⁸

Price's thesis, if true, would imply a most intriguing paradox. Here you have two societies, Europe and China, thousands of miles apart, both of them building extraordinary machines to imitate the movements of heavenly bodies, both of them automating these planetaria/astraria by means of clock drives. In both cases, the clock is an accessory, and neither society cares much about time measurement for its own sake. Yet one society, the European, abstracts the time function from its device and starts building a civilization based on pure (simple) time-keepers, whereas the other, the Chinese, does not.

Unfortunately, in both logic and evidence this is an unconvincing, indeed a most surprising thesis. (The exclamation mark in Price's allusion to fallen angels is well justified.) In logic: the normal sequence of technological development runs from simple and rudimentary to complex and refined. To quote Price himself, 'Historically speaking we expect that the further back we delve, the more primitive and simple the technology becomes.' Any alleged deviation from this rule should put the historian on his guard.⁹ And in evidence: we are as sure as we can

be, short of possessing the remains of a very early machine, that there were mechanical clocks before Wallingford and Dondi, hence that simple timekeepers preceded complex, clock-driven planetaria and astraria.¹⁰

It is a fact that no early escapement clock seems to have survived, but then, neither has any medieval water clock. If anything, we should be less surprised by the disappearance of the former than of the latter. The first mechanical clocks were crudely fashioned and liable to break down at any time. They needed continual care, frequent overhauls, and substantial replacement every ten or twenty years. They were made of brass or iron, valuable metals at the time, and we may be sure that clockmakers who repaired them were not inclined to treat discarded parts or machines as junk to be abandoned. Rather, just as roofers today routinely keep and recycle the copper gutters and sheets they replace, so medieval clockmakers must have treated used brass and iron as valuable 'perks' of the trade.

We are thus thrown back on literary evidence, ambiguous at times because of the generic character of the term *horologium*, none of it definitive in itself but collectively decisive. For one thing, there is the abrupt increase in the frequency of references to clocks towards the end of the thirteenth century. Suddenly clocks are news because clocks cost money. Cathedral chapters mention them in their accounts; itemize their repairs; pay people to watch them and keep them going; hire all manner of specialists to replace wheels, paint dials, carve wooden figures. A new profession makes its appearance, that of the clockmaker or *horologeum*.¹¹ There is simply nothing like this for the earlier period. The late British scholar C. F. C. Beeson argued, I think correctly, that this in itself was indicative of a new device.¹²

For another, the new clocks and their associated bells were often sited in high places – the better to hear them. But a tower is no place for a water clock: no one hauls water any higher than he has to, and lofty exposures make it very difficult to keep water from cooling and freezing. Do not imagine, either, that medieval clockmakers were placing clepsydras at ground level and using them to drive or trigger mechanisms thirty or more feet above. Such an arrangement is not inconceivable, but would have been extravagantly costly in the context of medieval metallurgy. We would have heard about it, if only about its breakdowns. The fact is that contemporary accounts make no mention of water in connection with this new generation of timepieces – no concern for freezing, no reference to leaks or evaporation, no hint of rust or corrosion

– nothing. Under the circumstances, all efforts to salvage the clepsydra connection, however ingenious, must be rejected as highly improbable. Indeed, on the principle of Occam's Razor, their very ingenuity makes them suspect.

What we do have in the contemporary sources is a clear sense of excitement and pride. These great clocks were, like computers today, the technological sensation of their time. When a poet like Dante looks to the clock and its wheel train for vivid similes, you know that he is speaking to established and conspicuous sensibilities. Thus in canto 24 of the *Paradiso* (written between 1316 and 1321):

And like the wheels in clock works, which
Turn, so that the first to the beholder
Seems still, and the last, to fly.

*E come cerchi in tempra d'oriuoli
si giran si che il primo, a chi pon mente
quieto pare, e l'utimo, che voli.*

Again, it takes excessive ingenuity to see here anything but the wheel train with reduction gearing characteristic of the mechanical escapement clock.

By the time we get to Wallingford and Dondi, then, the mechanical clock was in its third or fourth generation – at least. Dondi himself must have learnt much of what he knew about these devices from his own father, an astronomer and clockmaker. Both Wallingford and he provide us with careful descriptions of their wheelwork and gear ratios, but neither finds it necessary to say anything about the character and construction of the controller-escapement – that is, the timekeeping heart of his machine. Indeed Dondi explicitly dismisses the mechanical clock as a commonplace, the making of which 'will not be discussed in such detail as the rest, because its construction is well known, and there are many varieties of them and, however it is made, the diversity of methods does not come within the scope of this work'. His own clock, he says, beats at the usual two-second rate; and anyone who is not capable of making a 'common clock' – 'by himself and without written instructions' – should not attempt the rest.¹³

To sum up: the Wallingford and Dondi masterpieces, far from being the first mechanical clocks, made use of an already established technique.

What is more, the use of falling weights as power source made it possible to impart steady drive to more complex mechanisms than could be worked by a clepsydra. It was the clock, in other words, that facilitated and thereby fostered the automated planetarium or astrarium, not the reverse. Indeed, the simple mechanical clock, by opening for the first time serious possibilities of precision timekeeping, eventually laid the basis for modern astronomical science. So much for 'fallen angels'!

The clock did not create an interest in time measurement; the interest in time measurement led to the invention of the clock.

Where did this demand come from? Not from the mass of the population. Nine out of ten Europeans lived on the land. 'Labor time', to quote the medievalist Jacques Le Goff, 'was still the time of an economy dominated by agrarian rhythms, free of haste, careless of exactitude, unconcerned by productivity – and of a society created in the image of that economy, *sober and modest*, without enormous appetites, undemanding, and incapable of quantitative efforts.'¹⁴ Town and city life, to be sure, was different. The city dweller has no natural sequence of tasks to rhythm his day. The very uniformity of his occupation makes him time-conscious; or, if he is moving about, the irregular pattern of his contacts imparts a sense of haste and waste. But urban centres developed late in the Middle Ages, from about the eleventh century on, and already before that there was an important timekeeping constituency. That was the Christian Church, in particular the Roman branch.

It is worth pausing a moment to consider this temporal discipline of Christianity, especially of Western Christianity, which distinguishes it sharply from the other monotheistic religions and has not been adequately examined in the literature on time measurement. In Judaism the worshipper is obliged to pray three times a day, but at no set times: in the morning (after daybreak), afternoon (before sunset), and evening (after dark). A pious Jew will recite his prayers as soon as possible after the permissible time; but if circumstances require, he has substantial leeway in which to perform his obligation. Today some of the starting times of worship are given on calendars to the minute, thanks to astronomical calculations. In ancient and medieval times, however, nature gave the signals.¹⁵ The animals woke the Jew to prayer, and the first of the morning blessings thanks God for giving the rooster the wit to distinguish between day and night.¹⁶ The evening prayer could be recited as soon as three stars were visible; if the sky was cloudy, one waited until one

could no longer distinguish between blue and black. No timepiece or alarm was needed.

Islam calls for five daily prayers: at dawn or just before sunrise, just after noon, before sunset, just after sunset, and after dark. Again, none of these requires a timepiece, with the possible exception of the noon prayer. I say 'possible', because high noon is easily established in sunny climes by visual means. Besides, in so far as the local religious authorities wanted to set times for prayer and used clocks for the purpose, they could easily make do with the sundials and water clocks of the ancients. In most Islamic countries, the sun usually shines and water rarely freezes. Moreover, in Islam as in Judaism the times of prayer are bands rather than points, and local tradition determines how much the prayers may be delayed without impairment. In both religions prayer is a personal act, without clerical or congregational mediation, and worship, with some exceptions, need not be collective and simultaneous.¹⁷

Christianity, especially monastic Christianity, differs from both. The early Christians had no standard liturgy; the new faith was not yet a Church. Usage varied from place to place, and prayer was as much a function of opportunity as of obligation. In so far as the Nazarenes were still Jews, they built on the practices of the older faith, with its morning and night recitations (Deut. 6:7, 'when thou liest down and when thou risest up') or its triple office (Dan. 6:11, 'he kneeled upon his knees three times a day'). But then they added their own devotions, in part to give expression to those praises and supplications that had no place in the Jewish service, in part to distinguish themselves from the 'obdurate' Hebrews. By the early third century, Tertullian, acknowledging the impracticality of the Pauline ideal of ceaseless prayer (1 Thess. 5:17), recommended daily prayers at set times: in addition to the morning and evening prayers prescribed by the Law, there would be devotions at the third, sixth and ninth hours. These were the points that divided the daytime into quarters,¹⁸ and Tertullian asserts that they were recognized as temporal punctuation marks by all nations: 'they serve to fix the times of business and they are announced publicly'.¹⁹ Very convenient: that way there was no problem of knowing when to pray, since civil time signals would serve to summon the faithful.

The setting of prayer times by the clock was no small matter. It represented a first step towards a liturgy independent of the natural cycle. This tendency was much reinforced by the introduction of a night service, which apparently went back to the earliest days of Christianity,

when the Jewish followers of Jesus, having celebrated the Sabbath, met again on Sunday for nocturnal devotions. The choice of hour had some precedent in scripture:

I have remembered Thy name, O Lord, in the night . . .
(Psalms 119:55)

At midnight I will rise to give thanks unto Thee . . .
(Psalms 119:62)

I rose early at dawn and cried;
I hoped in Thy word.
Mine eyes forestalled the night-watches,
That I might meditate in Thy word.
(Psalms 119:147-8)

Scriptural precedent, though, is more often sanction than cause. The early Christians had good prudential reasons for coming together in the night while Caesar slept; also a most potent spiritual motive, namely the hope of salvation. The Gospel speaks of the Bridegroom's coming at midnight (Matt. 25:6), which led the Church in Constantinople to institute a midnight office. Yet such precision was the exception, indeed was deliberately avoided. Uncertainty was preferable, because more compelling. The Lord will come, it is written, 'at an hour you do not expect' (Matt. 24:42-4). 'If he comes in the second watch, or if in the third', blessed are the servants who are watching and waiting (Luke 12:37-8). Nocturnal devotions, then, appropriately called vigils, were a spiritual watch for the second coming (the *parousia*) of the Lord.²⁰ Pliny the Younger wrote of this practice to the Emperor Trajan at the beginning of the second century: 'They are wont to come together before the light.'²¹

For hundreds of years there were no rules, only practices. Rules came with monasticism — with the formation of a regular clergy (that is, a clergy subject to a *regula*, or rule) whose vocation it was to pray and pray often, and in so doing to save that multitude of the faithful whose worldly duties or inconstancy prevented them from devoting themselves entirely to the service of God. The innovator here was Pachomius in Upper Egypt in the early fourth century: against the prevailing eremitic individualism, his new order instituted a minute

regulation of the collective praying, working, eating and sleeping day. 'It was there that for the first time we see realized the practice of an office in the strict sense, recited every day in the name of the Church, *publicum officium*, at set hours.'²² Among the services: vigils, the *officium nocturnum* that was later merged with and called matins. From Egypt the practice spread to Palestine, Syria, Mesopotamia and Europe.

Still, rules varied – 'they were still feeling their way':²³ Temporal prescriptions, for example, may have been looser in the Eastern churches, where the natural diurnal cues continued to play an important role.²⁴ It was in the West, in the Rule of Saint Benedict, that the new order of the offices found its first complete and detailed realization: six (later seven) daytime services (lauds, prime, tierce, sext, none, vespers and compline) and one at night (vigils, later matins). As the very names indicate, most of these were designated and set in terms of clock hours. Hence the very term 'canonical hour', which eventually became synonymous with the office itself: one 'recited the hours'.²⁵

This was around 530. In the centuries that followed, the Benedictine Rule was adopted by other orders, including the great houses grouped around the Vatican and Lateran basilicas, thereby ensuring the eventual normalization of the canonical hours throughout Western Christendom. Progress in this direction was uneven owing to the physical insecurity of a violent age; in many parts of Europe, monastic life was disrupted for long periods by recurrent invasions and internecine strife. Besides, each house had its own interpretation of the Rule: we are talking here about customs (*consuetudines*), and there is nothing so idiosyncratic as custom.

And that no doubt is how Benedict wanted it. The historians show him as a man well aware of human weakness. His Rule imposed a whole array of tasks and obligations; 'and yet, in spite of this passion for detail, the Rule leaves room for development and improvisation'.²⁶

From the tenth century on, the weakening of attacks from outside Europe made possible a resumption of Church activity and new foundations. Cluny, established in 910 and devoted almost exclusively to prayer, took the lead in a monastic revival, at least as measured by creations and buildings. But the British historian Southern maintains that the very wealth and prestige of the Benedictine order, at their peak around the middle of the eleventh century, concealed a deep malaise. Custom became routinized; wealth promoted pomp and ceremony; religious fervour yielded to compliance and boredom, even to a certain cynicism.

The order was caught in a downward spiral and found fewer recruits; gifts and income diminished, further discouraging callings. Some convents would admit only candidates of noble birth, which was hardly conducive to application of the Rule. A house that was run to spoil children of high birth and lead them gently (pleasantly) to salvation was unlikely to impose the rigour of a rule of poverty, humility and unconditional obedience.

It was in this context that the heart and future of monastic life shifted to new reforming orders at the end of the eleventh century. Among these newcomers, it was the Augustinians and Cistercians who led the way. The former went back beyond Benedict to find their guide and model in Augustine who, never a monk, left them a summary Rule, where 'summary' meant incomplete, hence so supple as not to be a Rule. Its great advantage, according to Southern, lay in its omissions. It left so much to the imagination that it could go off in divers directions, as the community desired.²⁷ Some Augustinian houses imposed a strict discipline; they were called the severe school. Others were rather laxist, with all kinds and mix of customs, the better to occupy niches and satisfy the interests of lay society. They were called the broad school.

The Cistercians were very different. Whereas the Augustinians wanted to serve the world around, the Cistercians fled it. They refused the traditional gifts of landed income, fees and tithes. Only land would they accept, not to lease it but to cultivate it themselves. Their Rule obliged them to leave town and castle and set up far from people, on the frontier of economic expansion. Technically they were Benedictines, but not like other Benedictines; dedicated rather to the restoration of the original Rule in all its early simplicity and rigour. They pushed an ideal of humility and poverty; they left the world in order to cultivate spiritual virtues. But this preoccupation with work and material development inevitably encouraged enterprise, technical innovation and an almost military discipline. Southern sees a driving force to Cistercian expansion, derived from neither the ideal nor the corruption of the ideal (p. 253); and he uses the anachronistic term of a typically 'puritan' paradox: the Cistercians growing rich in spite of themselves (p. 257). They suffered, he writes, the penalty of Puritanism, that is, they became rich because they had renounced riches and powerful because they made good investments (p. 260).

The homogeneity and strict hierarchy of the Cistercian order contrasted sharply with the variety and pragmatic improvisation of the

Augustinians. In a world of tangled lines of authority and uneven and irregular surveillance, the Cistercians established a single line of command, enforced by repeated visits. No improvisation; no omissions; no escape from the ubiquitous eye of superiors. The aim was uniformity of practice. Even so, one must not generalize. Usage and custom varied and mattered, and much of the confusion and contradiction concerning the monastic *horarium* is undoubtedly due to these house, regional and national differences. Even so, within each house, the abbot or his representative was personally responsible for the accuracy and enforcement of temporal discipline. 'Nothing, in other words, shall come before the Divine Office,' says the Rule.²⁸ Nothing was as important as the punctuality of the collective prayer cycle.

Why was punctuality so important? In the abstract, because it was precious, rare, unrecoverable. John of Salisbury, churchman and political thinker, made this point explicitly in the first half of the twelfth century. What more unworthy, he wrote, than the man who doesn't care to know himself? The man who wastes time — this precious time, the one thing you can't get back once you lose it. The man who, wasting time, wastes his own life and, so doing, dishonours himself. And John goes on to denounce particularly those of means and command who are ready to wake in the night to engage in hunting and surprise the animals at their rest.²⁹

How common, how typical are such sentiments? After all, John was someone very special, philosopher and moralist writing here for a very small readership of statesmen and men of power. His feeling for time and its importance anticipates in fact the attitude of the Renaissance and might be seen as a kind of intellectual sport, centuries ahead of its day. But note the assurance of these remarks: John obviously felt no need to justify them, but rather treated the value of time as something axiomatic, implying understanding here between him and his readers. The precocity of these written remarks, with their unspoken priors, supports the thesis (much opposed by the historians of scientific instruments) that temporal sensibilities preceded the invention of the mechanical clock; indeed helped create the need and gave birth to its realization.

On the level of practice, the monastic emphasis on time implied, indeed imposed, punctuality. That was the aim of the daily schedule (*horarium*): to profit from this precious gift of time by ordering and using it.³⁰ That is why the day (night included) was divided into irregular intervals bounded by temporal points, and woe to him who neglected or ignored these punctuation marks.

Lateness – God forbid! – might make it necessary to abridge a service, matins in particular. ‘Let great care be taken that this shall not happen.’ These offices were a *collective* obligation, in part, I think, because simultaneity was thought to enhance the force of prayer. That would also explain why prayers were recited or chanted aloud: that way compelled simultaneity. Indeed, praying *together* was the *raison d’être*, the justification for community: the whole was greater than the sum of the parts.

Multiplication of simultaneous devotions – this was the way of salvation for all. Indeed, there were those who would have revived the Pauline ideal of continuous prayer (in relays presumably): thus Benedict of Aniane in the early ninth century and, even more, the monastery at Cluny in the tenth. (The latent purpose – or, if you will, the objective consequence – was, in conjunction with ascetic diet, to promote a state of light-headedness conducive to enthusiasm and hallucinations, or, euphemistically, to illumination and visions.)

The performance of such a demanding sequence, in particular the recitation of the nocturnal office after a period of sleep, imposed a new and special kind of temporal servitude. Unless some member of the congregation were ready to stay awake through the night and watch the clock – a precarious resort, as anyone who has stood sentry duty knows – it was only too easy to oversleep.³¹ In Roman times, some sympathetic or co-religionist member of the night watch may have served as waker; but with the fall of the empire, urban services broke down and watches became only a memory. To replace them, the medieval Church would learn to make alarm mechanisms. Otherwise no one would ever have got any sleep, for fear of failing in his duty and jeopardizing not only his own salvation but that of others. Hence the instructions of one of the Villers Abbey fragments (1267–8): ‘You must do the same when you set [the clock] after compline, so that you may sleep soundly.’³²

This religious concern for punctuality may seem foolish to rationalists of the twentieth century, but it was no small matter to a monk of the Middle Ages. We know, for one thing, that time and the calendar were just about the only aspect of medieval science that moved ahead in this period. In every other domain, these centuries saw a drastic regression from the knowledge of the ancients, much of it lost, the rest preserved in manuscripts that no one consulted. Much of this knowledge was not recovered until re-imported hundreds of years later via the Arabs and the Jews in Spain or, still later, from Byzantium. But time measurement was a subject of active inquiry even in the darkest of the so-called dark

ages. One has only to compare Isidore of Seville's rudimentary notions of time in his *De Temporibus* (615) with Bede's enormously popular textbook, the *De Temporum Ratione* (725) – written in the peripheral, tribal battleground that was Anglo-Saxon England – to realize the progress made in this field.

In large part this progress reflects the Church's continuing concern to solve and systematize the dating of Easter and the other so-called movable feasts. These dates were established in accordance with the lunar as well as the solar calendar – like the Jewish calendar, but different.³³ The principles of calculation, the science known as the *computus*, were sufficiently complex to give rise to multiple solutions, which came eventually to divide different Christian rites from one another. The task of extrapolating these dates into the future was particularly difficult, so much so that a thousand years later even as brilliant a mathematician as Carl Friedrich Gauss was not able to reduce the calculation to a comprehensive algorithm.³⁴

It was in this area that Bede made his greatest contribution, and the rapid diffusion of his work on the Continent testifies to its superiority and interest. Certain monasteries became centres of training and calculation (thus Sankt Gallen and Auxerre) and produced a substantial literature on the subject that was avidly copied elsewhere. The great volume of tables, charts, discussion and diagrams that can be found today in any major manuscript collection testifies to the vigour and creativity of this effort.³⁵

Most of this literature deals with dating, but calendrical concerns invariably spilled over into the area of time measurement, and vice versa. Indeed, I would argue that it was precisely this that made European astronomy and the *computus* so different: the practitioners were interested not only in the moon and the seasons, but in the day and its divisions. In particular, these same monks wanted to know the division of the day into light and darkness, the better to set the hours of the liturgy. The best of them, Gerbert for example, were quite aware that day (and night) did not grow and diminish at an equal rate from week to week, and they worked out the schedule of changing proportions (what they called a *horologium*) by measuring day and night at the solstices and adjusting from there. Gerbert offers one correspondent advice on how to take this measure: use a clepsydra, he says, and collect the water separately for night and day; then pour them together, and if the sum makes twenty-four (equinoctial) hours, you know you have it right.³⁶

This combination of measure and calculation made possible the construction of *horologia* giving night and day for every day in the year. We have one tenth-century table, for example, which gives the division not only by hours (*horae*), but by points (*puncta*, five to the hour) and *ostenta* (twelve to the *punct*). That made each *ost* equal to one of our minutes, and the clocks of the day could not measure that accurately; so the figures in the table were given to the nearest third of a *punct*, that is, four *osts*.³⁷

Time was important for an expert like Gerbert, but also for the ordinary monk, who may well have found getting up in the dead of night the hardest part of monastic discipline. When people spoke of reforming a house, they meant above all, in a practical way, imposing (or re-imposing) temporal constraints. Heavy sleepers were tossed out of bed and sent off to services; and if they dozed during prayers, they were poked and made to stay awake. Where the flesh is weak, temptation prowls. Raoul Glaber (early eleventh century) tells the tale of a demon (devil) who was trying to tempt 'a certain' monk (Glaber in fact) by holding out the lure of sweet sleep: 'As for you, I wonder why you so scrupulously jump out of bed as soon as you hear the bell, when you could stay resting even unto the third bell . . . but know that every year Christ empties hell of sinners and brings them to heaven, so without worry you can give yourself to all the voluptuousness of the flesh.'³⁸ All you need, after all, is a day, even an hour, to win eternal salvation. So take pleasure while you may, enjoy the flesh and its needs, and stop worrying.

The same Glaber admits that once, instead of jumping out of bed at the sound of the bells, he delayed and found himself face to face with the same demon: 'Here I am, here I am, I who take the part of those who stay.' And Peter the Venerable, abbot of Cluny in the twelfth century, tells the story of Brother Alger, who woke, thinking he had heard the bell ring for nocturns. Looking around, he thought he saw the other beds empty, so he drew on his sandals, threw on his cloak, and hastened to the chapel. There he was puzzled not to hear the sound of voices lifted in prayer. He hurried back to the dormitory. There he found all the other monks fast asleep. And then he understood: this was all a temptation of the devil, who had awakened him at the wrong time, so that when the bell for nocturns really rang, he would sleep through it.³⁹

These, I suggest, are what we now know as anxiety dreams. They clearly reflect the degree to which time consciousness and discipline had

become internalized. Missing matins was a serious matter, so serious that it has been immortalized for us by perhaps the best known of children's songs:

Frère Jacques, Frère Jacques,
Dormez-vous? dormez-vous?
Sonnez les matines, sonnez les matines,
Ding, ding, dong; ding, ding, dong.⁴⁰