

THE OXFORD HANDBOOK OF

---

ANALYTICAL  
SOCIOLOGY

---

*Edited by*

PETER HEDSTRÖM

*and*

PETER BEARMAN

OXFORD  
UNIVERSITY PRESS

## CHAPTER 21

TIME AND  
SCHEDULING\*

CHRISTOPHER WINSHIP

## INTRODUCTION

As the *New Yorker* cartoon opposite suggests, coordinating schedules can be a difficult and frustrating experience. The fact that the cartoon is among the *New Yorker's* most famous indicates how ubiquitous such conflicts are. Perhaps more significantly, the cartoon also suggests a possible consequence of scheduling conflicts. It appears that the two individuals on the phone are likely never to get together. A relationship that once existed is about to dissolve.

As Eric Leifer (1990) has forcefully argued, social relations do not simply exist in the abstract. They must be enacted in real time and space. With respect to relations built on face-to-face interaction, there must be both specific times and places at which interaction occurs (Winship 1978). This implies that two or more people need to agree on both when and where to meet. What we see in the cartoon is a

\* Special thanks to Peter Bearman for encouragement in the writing of this chapter. I also owe a singular thanks to Harrison White, who many years ago tricked me into getting started on this chapter by telling me just a month prior he wanted me to give a presentation on scheduling at a conference. Peter Hedström, Peter Bearman, Elizabeth Bruch, and Ezra Zuckerman gave helpful comments on an earlier version of the chapter. Miller McPherson was most generous in helping me understand the relationship between his work and mine. Lin Tao provided able research assistance. Lastly, Genevieve Butler, as usual, provided extraordinary assistance in helping produce the final typescript.



MANKOFF

"No, Thursday's out. How about never—is never good for you?"

Source: Robert Mankoff, *New Yorker*, 3 May 1993

social relation whose enactment appears impossible. More generally, Leifer (1990) argues that enactment can be constrained or even infeasible. Social relations occur in a concrete physical world in which particular patterns of social relationships may or may not be possible.

In this chapter I argue that scheduling conflicts are potentially important barriers to the enactment of social relations. As such, scheduling conflicts have a number of important implications. First, conflicts affect the potential for certain types of groups to exist. A local tennis club's team involving middle-aged men whose matches take place on Saturday afternoons may or may not be viable as a result of conflicts with family commitments. A group of individuals interested in establishing a choral group may struggle with whether there is any regular time during a week when they can all meet to practice. Parents who work different shifts in order to share child-care responsibilities may find themselves more prone to divorce as a result of the minimal amount of time they can find to spend with each other.

In constraining social interactions, scheduling problems also have the potential to affect who interacts with whom. Attempts to synchronize schedules can lead to the segregation of groups of different types of individuals in time, if not in space. Individuals who work different shifts are less likely to become friends, or be able to maintain friendships. Conversely, students who eat lunch at the same time have greater opportunity to become friends, thus potentially interacting with each other at other times. Individuals who are 'morning people' are likely to find it difficult to

work with 'night people' unless they live in different time zones and interact over the phone or the Internet.

At an organizational level, scheduling constraints may limit the types of larger social systems or structures that are possible. A high school may attempt to structure itself so that students are provided with a range of small-classroom experiences across a range of topics with the goal that students take classes with a mixed and diverse group of other students. It may find, however, that because of scheduling conflicts, de facto tracking occurs, with groups of students with similar abilities and interests all taking their courses together. A professional sports association may find it difficult if not impossible to schedule games so that some teams are not disadvantaged by playing a disproportionate share of their games against stronger teams.

Scheduling constraints, however, are less likely to be binding when individuals have identical or parallel time commitments; that is, where there is mechanical solidarity and congruence exists. Children in an elementary-school class may engage in a diverse set of activities, but the fact that they generally do the same activities at the same time obviates scheduling conflicts. Individuals with nine-to-five work schedules may also find it easy to schedule work meetings and family time.

While congruence may solve scheduling issues in some contexts, in others hierarchical structures may make scheduling less problematic. If there is a single top individual whose preferences take precedence, then she or he can independently figure out how much time to allocate to each activity and when to do the activity. Others will then be expected to coordinate their schedules with respect to that individual.

As the above examples show, scheduling constraints have the potential to affect social phenomena at multiple levels and in multiple ways. In this chapter I first explore why scheduling problems logically are so difficult to resolve. A subsequent goal is to then examine the potential consequences of scheduling problems on social life.

Before discussing why scheduling constraints are so problematic, I briefly discuss traditional approaches to the study of time in the social sciences (Sect. 21.1). These include an extensive literature across a number of disciplines on how societies conceptualize time; work that has examined how the organization of time has changed over history; work on the female labor force, the household division of labor, and time budgets more generally; and, finally, research by the Swedish geographer Torsten Hägerstrand and his collaborators that explicitly focuses on the temporal, as well as spatial, location of individuals.

After formally examining why scheduling conflicts are problematic (Sect. 21.2), I examine how they can affect the viability of specific relations and groups (Sect. 21.3). I then discuss how scheduling constraints both are a cause and can be a mechanism

for maintaining, group boundaries and thus groups segregated from each other (Sect. 21.4). I then examine the effectiveness of different types of organizational structures for coordinating schedules (Sect. 21.5).

## 21.1 TIME IN THE SOCIAL SCIENCES

Over the years there have been repeated calls for the establishment of a sociology of time (e.g. Sorokin and Merton 1937; Zerubavel 1981; Hassard 1990). Such a subfield arguably now exists, though it is quite small (see Bergmann 1992 for reviews). More generally, scholars in different social-science disciplines have been concerned with time in distinctly different ways. I briefly review four schools of scholarship that are relevant to the present chapter.

Probably the largest body of research has focused on cultural differences in the conception of time. Key examples would be Malinowski's study (1927) of the Trobriand Islanders or Bourdieu's work (1963) on the Kabyle. As would be expected, much of this research is found in anthropology (see Gell 1996 for a review), though these issues have been of interest to a broad swath of scholars in the social sciences and humanities (see Bender and Wellbery 1991 for papers from authors from a diverse set of disciplines). The key idea in this literature is that time is socially constructed; as such, it may be constructed in a variety of ways. The importance of this line of research here is that this chapter turns the social-constructivist perspective on its head. Without denying the importance of how societies think about time, my purpose here is to analyze how time, because of its physical properties, constrains and affects social interaction by individuals and groups as they attempt to coordinate schedules.

There is also a vast literature on how throughout history conceptions of time, and how it is organized, have changed. The primary focus has been on the Industrial Revolution, with E. P. Thompson's book *The Making of the English Working Class* (1976) providing the classic analysis. Important work, however, has focused on earlier periods, most notably David Landes's *Revolution in Time: Clocks and the Making of the Modern World* (1983). A key theme in this literature is that as society has become more complex, and in order to allow society to be more complex, the technical means needed for people to coordinate their interactions more closely has needed to be invented. Thus, we have had the invention of calendars, clocks, shared time zones, scheduling programs, etc. (Zerubavel 1981; Hassard 1990). What this research importantly demonstrates is how critical and basic the social coordination of time is to social organization. The argument of Thompson and others is that

For the Industrial Revolution to have occurred, it was essential that the way people thought about time, particularly the working classes, had to change, and that there had to be the necessary technical tools (e.g. calendars, clocks, shared time zones) to make coordination possible. One simply cannot run a large factory where the tasks of different workers are highly integrated if people are coming and going at random times. An obvious extension of this literature would consider the importance of alternative means of communication (from mail, to the phone, to email, and videoconferencing) in allowing for more complex organizational forms. I do not pursue this topic here.

Two related literatures have had a more contemporary US focus. With the rise in female labor-force participation, economists in particular have been interested in how adult females decide about how to allocate time between work and family commitments (for a review see Killingsworth and Heckman 1987). For similar reasons, a massive amount of work has been done by sociologists on how the household division of labor has and has not changed with the increased employment of women. In recent years there has been a host of new books by prominent sociologists on this topic: Arlie Hochschild's *The Second Shift* (1989); Jerry A. Jacobs and Kathleen Gerson's *The Time Divide: Work, Family, and Gender Inequality* (2004); *Fighting for Time: Shifting Boundaries of Work and Social Life*, edited by Cynthia Fuchs Epstein and Arne L. Kalleberg (2006); and *The Changing Rhythms of American Life*, by Suzanne M. Bianchi, Melissa Robinson, and John Mikic (2006).<sup>1</sup>

The above research on the family is complemented by a growing literature on how individuals use their time more generally. This research has primarily been empirically driven, involving the multitude of time-budget surveys that have been done in the USA and in other countries. Herz and Devens (2001) and Hammermesh and Pfann (2005b) provide discussions of this data and current research. Hammermesh and Pfann (2005a) provide a collection of recent work by economists in this area.

Common to these lines of research has been the conception of time as a fixed resource: like money, an individual only has a finite amount available for use. The classic analysis of time from this perspective is Becker (1965). Instead of having an income constraint, as is traditional in economics, an individual is faced with a time constraint and a decision about how to divide it between work and leisure. The amount one works then determines the income that is available. Totally absent from this perspective is the notion that doing things in time requires a specific time to do them in. In this sense, time is quite unlike money. Whereas in buying a good it typically does not matter to either the seller or buyer what money is used as long as it is money; in doing something in time, we need to decide exactly what time to do it. Furthermore, if a social interaction is involved, then all parties must agree on a specific time. (For further discussions of the differences between time and money see Melbin 1987 and Winship 1992.) A time-budget perspective only asks 'How much time should I spend doing something?' It does not consider the

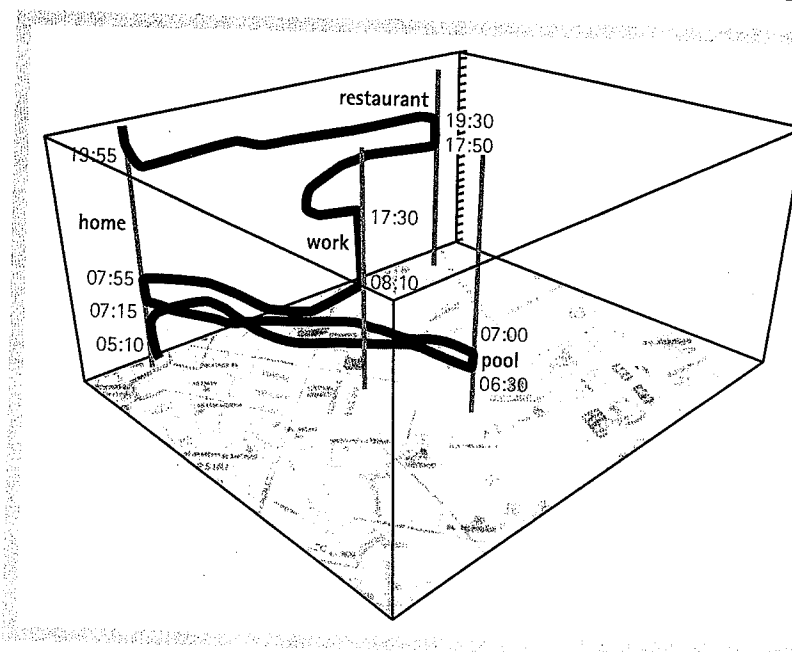


Fig. 21.1 Example of a space-time cube (from Kraak 2003: 1989)

question of 'When should I do this?' It is the later question and its implications that are the focus of this chapter.

Perhaps the research tradition that comes closest to the concerns of this chapter is that of the Swedish geographer Torsten Hägerstrand and his colleagues, with their focus on space-time geography (Hägerstrand 1970, 1973, 1975; Pred 1977; Kellerman 1989). A key assumption in their work is that individuals and individual action are not simply located in space, but also in time. The fact that individuals can only be in one location at any one time is then a critical constraint on social interaction. Most famously, Hägerstrand has represented this idea in terms of what is called a space-time cube. Figure 21.1 taken from Kraak (2003)—which provides a detailed discussion of the importance of the cube—illustrates the key idea that individuals only 'meet' when their positions within the cube intersect both in time and space.

Hägerstrand's group has used this perspective in conducting a host of applied studies investigating issues of accessibility (Miller 1991; Kwan 1998): job opportunities, the coordination of work and family responsibilities, interaction with children (Mårtensson 1979), as well as the role of space and time in creating a sense of place, region, and nation (Pred 1977, 1984; Thrift 1983). In important ways, the goal of this chapter is to bring Hägerstrand's focus on the importance of the intersection of time and space to the sociological study of relationships, groups, and organizations.

## 21.2 WHY IS SCHEDULE COORDINATION SUCH A PROBLEM? FORMAL INSIGHTS

We all experience scheduling conflicts in our daily lives. There may be two colloquia being held simultaneously, both of which we want to attend. More simply, we may have problems finding a time to have lunch with a friend because of each of our individual prior commitments. Often we think of this problem as one of a time-budget constraint—that there is simply not enough time to do all the things we want to do. However, the problem is also potentially one of a scheduling conflict—that other activities are scheduled at the same time. The fact that individuals face time constraints is analogous to the fact that they experience income-budget constraints in making purchase decisions. The existence of scheduling conflicts, however, indicates that individuals potentially face a coordination problem that involves other individuals. The individual in our cartoon is not frustrated because he cannot find the time to have lunch. He is frustrated because he and the person on the other end of the line cannot agree on a specific time to have lunch together.

In order to make the distinction between a time constraint and a scheduling conflict more precise, define a schedule as a two-dimensional matrix where the rows are people and the columns are times or time slots (e.g. 10–10.30 a.m.). Let activities that are done alone be indicated by a lower-case letter. Let unique joint activities be represented by capital letters. In cases where it is useful to use the same letter to represent the same type of activity, for example two colloquia, capital letters may be subscripted, e.g.  $C_1$  versus  $C_2$ .

Consider the following example with three individuals, Tom, Dick, and Harry, and four possible activities, opera (O), symphony (S), theater (T), which are all activities each would want to do jointly, if at all; and a fourth activity, reading (r), which each would do alone, if they were to do it. Assume that there are three weekend nights for these activities: Friday, Saturday, and Sunday. Further assume that, without any coordination, each, in order of preference (e.g. Tom's first preference is opera, then theater), would like to do the activities as shown in Table 21.1.

Table 21.1 Hypothetical event schedule

	Friday	Saturday	Sunday
(1) Tom	O	T	r
(2) Dick	r	T	S
(3) Harry	S	r	O

Table 21.2 Rearranged event schedule

	Friday	Saturday	Sunday
(1) Tom	O	T	r
(2) Dick	r	T	S
(3) Harry	O	r	S

If each individual only wants to do three of the four activities as indicated in the schedule, then none of them has a time-budget-constraint problem. For example, Tom can go to the opera (O) on Friday night, theater (T) on Saturday night, and read (r) on Sunday night. We could say that the above schedule is *individually feasible*. Each individual has enough time to do all activities they would like to do. If, however, one or more of them wants to do all four activities, they are faced with a time-budget constraint. There are four activities, but there are only three time periods available. In this case the schedule would be *individually infeasible*. There simply would not be enough time slots available to do all the activities that were desired.

As I have specified in the above example, the individuals want to do all of the activities *jointly*, except reading (r). For an activity to be done jointly, it must by definition occur at the same time for all individuals involved; that is, it must be assigned to a single column within a schedule. Assume that Tom has no interest in symphony, Dick has no interest in opera, and Harry has no interest in theater. Is it possible for the three individuals in Table 21.1 to do things in pairs if they are willing to be flexible about what is done on which night? Table 21.2 shows that it is.

Tom and Harry can go to the opera on Friday night, Tom and Dick to the theater on Saturday night, and Dick and Harry to the symphony on Sunday night. As such, we can say that the above schedule is not only individually feasible, but is also *collectively feasible*. The schedule is collectively feasible in that it is possible to find a unique common time that is feasible for each individual to do each joint activity. More generally, the schedule is feasible in that it is possible to arrange the timing of events so that each unique joint event is assigned to a single column; that is, a single time slot.

Now assume that opera, symphony, and theater only occur on Friday and Saturday nights. As a result, each individual has Sunday night to read. Without loss of generality, we can simply ignore Sunday. Consider Table 21.3.

It is easy to see that at the individual level the schedule within Table 21.3 is feasible for each individual: each individual has two joint activities that they would like to pursue and two nights (Friday and Saturday) within which to do them.

A closer look at Table 21.3 reveals that there is no way to rearrange the three joint activities so that the scheduling table is collectively feasible; that is, so each joint

Table 21.3 Restricted event schedule

	Friday	Saturday
(1) Tom	O	T
(2) Dick	T	S
(3) Harry	S	O

activity is assigned to a single column.<sup>2</sup> If Tom and Harry go to the opera on Friday night and Tom and Dick go to the theater on Saturday night, there is no night for Dick and Harry to go to the symphony. Because interests in activities overlap, there is no way to find a unique time for each activity. If any two pairs of individuals agree to an activity, there will be no night available for the third pair to go out. There are three overlapping joint activities, but only two time slots available. Thus, although the schedule in Table 21.3 is individually feasible, there is no arrangement of activities that makes it collectively feasible. In general, although every individual may separately have enough time available for the activities that they want to carry out, it may be impossible to find a way to schedule those activities so that they can be done jointly as desired.

Because scheduling involves individuals coordinating times with each other and subsequently affects what times are available for other joint activities, schedules are a type of public good. In our example above, there are in fact only three possible schedules, assuming that individuals do not have preferences over whether an activity is done on either a Friday or Saturday night. As such, the three of them as a group need to decide which one of the three possibilities in Table 21.4 will be agreed to.

The individuals' preferences over these three schedules are shown in Table 21.5. The preferences in Table 21.5 are an example of the classic Condorcet (1785) cycle. There is no equilibrium solution here. Assume that as a group they randomly decide to choose S<sub>1</sub>. Then both Dick and Harry are better off if they defect from the agreement and choose schedule S<sub>3</sub>. Similarly, if S<sub>2</sub> or S<sub>3</sub> is chosen, two individuals are always better off by choosing a third alternative.

Table 21.4 Possible event schedules

	Friday	Saturday
S <sub>1</sub>	O	T
S <sub>2</sub>	T	S
S <sub>3</sub>	S	O

Table 21.5 Preferences over schedules

Tom	Dick	Harry
S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>
S <sub>3</sub>	S <sub>1</sub>	S <sub>1</sub>
S <sub>2</sub>	S <sub>3</sub>	S <sub>2</sub>

A solution to the above problem would be to make the weekend three instead of two nights long—say, going to the opera, theater, and then the symphony. This was the original case that we considered in Table 21.1. In fact, as we know from our personal experience, when there are scheduling conflicts we often simply delay doing something to a later time. More generally, the problem of time conflicts can be resolved by having many possible time slots in which to schedule activities. Dinner and breakfast meetings can be seen as an attempt to accomplish this. In the extreme, any scheduling problem can be resolved by having as many time periods as events and assigning each event to a unique time slot. This, however, is likely to be highly inefficient for individuals. Unless an individual is interested in participating in most events, they will spend much of their time alone. As such, there will be considerable incentive for them and others to get together during times in which they plan not to attend the scheduled event.

More sophisticated and formal analyses of the time-scheduling problem have been carried out in the graph-theory literature in mathematics. The scheduling problem is equivalent to what is known as the vertex-coloring problem in graph theory.<sup>3</sup> The major focus here has been on determining across different situations the minimum number of time periods needed to eliminate all scheduling conflicts. As discussed in the Appendix (see n. 3), there are two key points that are of sociological interest. First, it is the local structure of specific events that is critical. If  $k$  time slots are needed to resolve a scheduling conflict then there must be at least  $k$  events that are each tied to  $k - 1$  other events. Second, it is always possible to construct a graph with a fixed degree of sparseness, defined in a specific way, that needs an arbitrarily large number of time slots to resolve all time conflicts.

Work in operations research on combinatorial optimization has been concerned with finding actual assignments that resolve scheduling conflicts. Most of this literature has considered the problem for universities in assigning exam or class times to either eliminate or minimize the number of time conflicts (i.e. students who are scheduled to take more than one exam or class at the same time). Here the number of exams is typically in the hundreds if not thousands and the number of students is in the thousands if not tens of thousands. As a result, scheduling solutions are typically nonobvious and often the problem is to find solutions that minimize the number of conflicts as opposed to eliminating them. Numerous algorithms have been proposed for finding time schedules that eliminate or minimize the number

of conflicts. Carter (1986) provides a very concise and accessible summary of past work in this area. Typically, when the number of classes and individuals is large, the computer time can be considerable, since computational time grows exponentially with the number of classes. Generally, in large problems algorithms cannot find solutions when the number of time slots available is close to the minimum number that is theoretically needed. If the number of time slots available is nearly twice this, however, at least in random graphs, most algorithms will find a solution (Grimmett and McDiarmid 1975). It seems reasonable to assume that people probably can do no better than computational algorithms and in fact are likely to do worse. Thus, in real life solving scheduling problems is likely to be exceedingly complex either for humans or for sophisticated algorithms implemented on high-speed computers.

### 21.3 SOCIAL IMPLICATIONS I: UNREALIZED RELATIONS AND RELATIONS ABANDONED

If two events take place at the same time, then in most cases an individual cannot do both. A student cannot take two courses that are offered at the same time. A person who works the night shift will find it difficult to be friends with someone who works during the day. Families with children in different schools may find that they are unable to travel together if the schools' vacations occur at different times. Prevention programs may find it difficult to keep individuals from dropping out because of scheduling conflicts (Fox and Gottfredson 2003).

One would expect that the problem of scheduling conflicts would be particularly troubling for voluntary groups, since presumably for many individuals work and family commitments would take top priority, leaving potentially few, if any, time slots available for groups to meet. Several papers (Warrener 1985; Tipps 2003) discuss the challenge of scheduling conflicts to the viability of singing groups. Probably no scholar has studied voluntary organizations more thoroughly than Miller McPherson (McPherson and Ranger-Moore 1991; Popielarz and McPherson 1995; McPherson and Rotolo 1996), who points to the fact that time is an important resource for voluntary groups and time constraints can limit voluntary-group involvement. McPherson and colleagues however do not explicitly consider the implications of time-scheduling problems. As discussed in Section 21.4, scheduling conflicts can lead to group segregation. In McPherson's model, voluntary groups compete with each other over individuals with similar interests and characteristics. Thus, two choral groups in a city might compete over the same individuals and their time. What McPherson doesn't consider is how scheduling constraints may

actually benefit similar groups. In general it is to the advantage of groups that interest very different individuals to schedule activities at the same time, since they are unlikely to lose many interested potential members to the other group. Groups that are potentially attractive to the same individuals obviously should schedule activities at different times. As discussed in greater detail in the next section, the consequence of this is that we may find that similar individuals have similar schedules as do groups which compete for the same individuals and attempt to find nonoverlapping time periods in which to meet. As a result, individuals with similar interests and thus similar schedules may segregate into nonoverlapping clusters of groups.

The organization in which time constraints and scheduling conflicts have been most extensively studied is the family. As noted earlier, the vast majority of work in this area has focused on the constraints in the amount of time family members commit to different activities, rather than examining in detail scheduling conflicts per se. A few studies have looked explicitly at the effects of scheduling conflicts. Staines and Pleck (1983) used the 1977 US Quality of Employment survey, and found that for married couples shift work led to problems in arranging family activities. Moreover, working weekends or rotating days was associated with greater family conflict. Another study, based on a national longitudinal sample by White and Keith (1990), found 'entry into shift-work significantly increased marital disagreements and quitting shift work significantly increased marital interaction and decreased child-related problems. Looking specifically at marital breakup, the investigators found that being a shift-work couple in 1980 significantly increased the likelihood of divorce by 1983—from 7 percent to 11 percent' (Presser 2003: 82–3).

Harriet Presser, in her book *Working in a 24/7 Economy: Challenges for American Families* (2003), provides the most extensive analysis of the effects of shift work on families. Presser is interested in the effects of nonstandard work schedules on American families, both in terms of hours worked during the day, and days worked during the week. Specific to my interests, she examines consequences of nonstandard work schedules along a variety of dimensions when both parents work. Presser's analysis is based on a supplement to the May 1977 Current Populations survey.

Presser first points out that nonstandard schedules are quite common. Approximately 20 percent of Americans do not have fixed daily hours and nearly 24 percent work at least in part on weekends. For dual-earner couples, about one quarter work different shifts. In approximately a third of this group, one spouse, but not both, works on weekends. Furthermore, she finds that having children further increases the chances that parents will work a nonstandard schedule.

In terms of consequences, Presser finds few statistically significant effects, though this may be due to her relatively small sample size and more importantly the detailed way in which she has parsed her data. When a husband works in the evening and wife during the day, as compared to marriages where both spouses

work days, it appears to have no effect on general marital happiness, quality of time together, whether a marriage is perceived to be in trouble, or whether a marriage is perceived to have a high chance of ending in divorce. When this pattern is reversed, however, the couple with the wife working in the evening has a considerably more negative marital outcome, with some differences being statistically significant. The results are mixed when the husband or wife works nights. The marital outcomes are generally quite negative and in many cases statistically significant when either the husband or wife has rotating work hours.

Presser also used the *National Survey of Families and Households* to examine divorce rates. Here the results were also mixed. Only marriages where one spouse had fixed night-work hours or rotated hours were more likely to end in divorce.

Looking beyond marital quality, Presser finds that the more a spouse is at home when the other spouse is at work, the more likely they are to do housework. This is true for husbands as well as wives. Furthermore, she finds that parents who have nonstandard work hours are much less likely to eat dinner, but more likely to eat breakfast, with their children.

Although Presser's results are provocative, they should be interpreted with caution. Obviously individuals within couples are not assigned at random to different work schedules. As such, the associations or lack of associations she finds should not be assumed to necessarily represent causal effects. If possible, couples probably choose work schedules that are most beneficial to their marriages. If this is correct, then one might well find no or little association between couples' work schedules and the quality of their marriages when in fact there are substantial causal effects.

## 21.4 SOCIAL IMPLICATIONS II: SEGREGATION IN TIME

The study of segregation in the social sciences in general and in sociology in particular has almost exclusively focused on geographical segregation, especially geographical residential segregation. As noted earlier in this chapter, the major exception to this is the work of the Swedish geographer Torsten Häägerstand and colleagues. Of course, individuals and/or groups may occupy the same space over the course of a day, but never interact because they are present in that space at different times. In Boston, a park on Washington Street in North Dorchester near one of my field sites is used by day by families with children and at night by drug dealers and prostitutes. Because these two groups are segregated in time (but not space) they seldom interact and thus there is little conflict. Similarly, in office

buildings a white-collar workforce and a predominantly minority cleaning staff may work in the same space, but seldom see or interact with each other, because their work schedules have been purposely designed so that they do not overlap.

More generally, time has the potential to segregate. If science labs and athletic practice both occur on the same afternoons, there will be no athletes majoring in science, and athletics and science majors will have reduced contact. Teenagers may choose to sleep during the day and be active at night on weekends in order to avoid overly controlling parents (Melbin 1987). Within many animal species, sex segregation is maintained by males and females having alternating waking and sleeping hours. (See Ruckstuhl and Neuhaus 2005 for a discussion of the recent literature.)

In the US context, few researchers have examined the importance of segregation in time by contrasting the difference between residential and work segregation. Drake and Cayton's seminal work, *Black Metropolis* (1945), describes the far greater contact between whites and blacks at work than in their residential neighborhoods. Kornblum (1974) made the same observation for a much later period. Much more recently, the geographers Mark Ellis and Virginia Park, using the 1990 Census, have examined the difference in the patterns of residential and employment segregation in Los Angeles (2004). They find that employment is substantially less segregated than residence. This contrast is particularly sharp between whites and Mexicans. For these two groups, as well as all other pairs, they find that the difference in the degree of segregation between employment and residential segregation is far greater for men than women.

Of course, the segregation we observe in time is often not an accident. Zerubavel (1981) discusses a variety of situations in which scheduling conflicts are used instrumentally to create segregation. By segregating groups in time, group boundaries are established and maintained, with the result that in-group solidarity is enhanced. He points to the fact that Benedictine monks were required to rise early in the morning and to retire early in the evening, which minimized the opportunity for contact with the outside world. He describes how early Christian groups purposely declared Sunday as the sabbath, in order to dissociate themselves from Jews, whose sabbath is Saturday. The First Council of Nicaea, in AD 325, declared that Easter should be held on the first Sunday after the full moon so that Easter would be dissociated from the Jewish Passover holiday, despite the fact that the Last Supper was a Passover Seder.

The use of scheduling or time conflicts can be particularly effective in that introduction of one conflict that segregates two groups is likely to create others. If two groups participate in one type of activity at different times, this is likely to lead, and in some cases even force, them to participate in other types of activities at different times. Consider the children of Orthodox Jews in New York. Because of the Jewish sabbath, they cannot participate in the public-sports leagues, which typically have their games on Saturdays. In response, and because there is a significantly large



Orthodox population in New York, the Orthodox Jewish sports leagues have their games on Sundays, the Christian sabbath. Honoring the Jewish sabbath has not only resulted in separating Jews and Christians on Saturdays, but on Sundays as well. (Attendance at Orthodox day schools during the week makes the separation of the two populations nearly complete.) Similarly, it is probably no accident that elite private schools typically choose to have one two-week school vacation in March rather than a week-long break in February and another week in April as public schools do.

More generally, the establishment of separate schedules in the form of different calendars has the ability to nearly totally dissociate two groups. Zerubavel (1981: 80) discusses at length how the Dead Sea sect established a calendar distinctly different from the Jewish calendar, apparently to make it impossible for sect members to participate in Jewish life. He also discusses how both the French and Bolshevik Revolutions attempted to dissociate themselves from the Christian calendar. Specifically, after the French Revolution there was an attempt to establish a ten-day week with one fixed day of rest, the *Décadi*. The specific goal was to make it difficult if not impossible for workers to regularly honor Christian holidays, most importantly the Sunday sabbath (p. 73). Similarly, the prophet Mohammed's establishment of a lunar calendar with a 364-day year led to the dissociation of Islamic holidays from earlier Pagan ones.

The point here is that differences in schedules make it difficult for individuals or groups to interact. This is just the obverse of the point made earlier in the chapter and studied by so many scholars: that synchronization of schedules is critical for social coordination and social interaction. Thus, as many scholars have shown, as society becomes more complex, shared calendars and time-reckoning are essential to people being able to coordinate in time. However, to the degree that individuals or groups are involved in one particular activity at different times, it may be difficult, if not impossible, to engage in other activities at the same time. The commitment to use particular time slots for one activity necessarily implies that the available time slots for other activities have been reduced. The fewer the time periods available, potentially the more difficult coordination becomes.

## 21.5 SOCIAL IMPLICATIONS III: ORGANIZATIONAL FEASIBILITY

It has long been recognized that organizations play critical coordination functions. Perhaps the most well known and celebrated work is Oliver Williamson's book *Markets and Hierarchies: Analysis and Antitrust Implications* (1975), with its

argument that organizations efficiently internalize market-transaction costs. The world of business is of course replete with scheduling problems: time to market for a product; timing of stages in construction processes; maintaining the appropriate flow of goods in time for inventory; product development; the coordination of the timing of different components so the necessary pieces are complete at specified times. The considerable literature on time and capitalism discussed very briefly above can be seen as the story of how different institutional structures and technologies involving time (calendars, time zones, clocks, etc.) developed in order to allow increasingly large organizations to coordinate their workers' schedules.

Obviously most if not all organizations have to solve time-scheduling problems. At a fundamental level, their existence depends on this. Universities need to schedule when semesters will begin and end. Furthermore they need to determine when classes will meet. To be able to offer a large number of classes but be efficient, multiple classes need to be offered at the same time. This of course then means course schedules that involve courses that meet at the same time cannot be realized. At the simplest level, organizations need to schedule meetings. For higher-level executives, this often means having an assistant whose primary task is to maintain the executive's schedule.

It is beyond the scope of this chapter to consider all the types of scheduling problems organizations face and the methods they use to resolve them. This is an enormous area of research within operations research. There is a huge literature within this field, and management systems more generally, that deals with scheduling.<sup>4</sup> My goal in this section is to discuss the implications of a few ideal types of organizational structures for scheduling problems. In doing so, I hope to illustrate several basic principles about what types of structures best facilitate scheduling and what types make it difficult.

Scheduling problems can be trivially solved if individuals have fully congruent schedules. The simplest example is perhaps an elementary-school class. A teacher organizes each day into a set of sequential activities and in the simplest situation all students engage in the same activity at one specific time. The only problem for the teacher is to figure out how much time to allocate to different activities and how to sequence them. She or he faces a time-budget constraint in terms of the total number of school hours in the day. However, there is no scheduling problem in terms of deciding which students will be involved in which activity when.

Perhaps the second simplest type of structure is what might be called a parallel integrated structure. In this type of structure individuals engage in the same type of activity at the same time, sometimes in the same specific activity and at other times not. The standard nine-to-five work week is the prototypical example. In the case where parents both work, they go to work at the same time, but in most cases to separate jobs and organizations. They then come home and share a common period of family time. At the societal level, activities flip between a

distinct set of work groups during the day and a different set of family groups in the evening. With the exception of family businesses, sets of individuals are typically not simultaneously part of the exact same groups. For example, two people are unlikely to both work in the same place and be members of the same family. If one spouse is a homemaker, then that activity becomes the structural equivalent of work. For children, school becomes the structural equivalent of work. Small differences between a child's school and parents' work hours, however, can result in serious supervision problems and the phenomenon of latchkey kids.

Symmetrical scheduling problems, however, do not always have simple, efficient solutions, as we saw with the example of Tom, Dick, and Harry. Although each individual only needs two time periods for the activities she or he is interested in, three periods are needed in order to enact their joint activities. As discussed in the Appendix (see n. 3), situations where there are odd numbers of activities interconnected through joint membership (in graph-theoretical terms, when there are odd cycles) require more time periods to be collectively feasible than are needed to be individually feasible. Thus, in the Tom, Dick, and Harry example we have three activities, symphony, theater, opera, with each pair of activities having one individual interested in both. In this case, it takes three time periods to avoid a scheduling problem although each individual is only interested in two of the three activities.

It is perhaps not surprising that situations in which individuals are in symmetric, equal positions and/or the goal is to produce a scheduling solution with this property are difficult to achieve. In such cases there is no logical way to give any one person's scheduling goals priority. Rissman (2000) describes the attempt to create a new high school in St Paul, Minnesota with small learning environments consisting of heterogeneous mixes of students. He describes how initial efforts failed, primarily due to scheduling conflicts.

Eric Leifer (1990) has examined a related set of issues in depth. Leifer's concern is not simply to find schedules that are feasible in the collective sense defined above, but to find schedules that are fair in that they treat all individuals (units) in the same way. His analysis focuses on the problem of creating a game schedule for the National Football League. The core of the problem is that teams on average are more likely to win when they play at home than when they are away. A fair schedule is one where no team is favored by when it has home games. At minimum this means that each team should have the same numbers of home and away games. Meeting this constraint is not problematic. More demanding is that no team should be favored by having a majority of its home games early in the season. That would create the potential for a team to develop momentum. Leifer discusses cases of particularly successful teams that had most of their home games at the beginning of the season. In general the NFL has never been able to create schedules that are fully fair with respect to this criterion; that is, in any season some teams have had more home-games initially than others. As Leifer reports, the

same two individuals have constructed the schedule every year since 1970, typically spending eight weeks, including evenings, doing so. In his article Leifer describes his attempts to improve on their efforts by using a very sophisticated computer algorithm. Like them, he finds it impossible to create a schedule that is fair in that it provides an equal balance across teams in the sense described above of when teams play home and away games. Leifer's research reiterates the point made earlier when I discussed operation-research solutions to general scheduling problems—scheduling problems are generally extremely difficult to solve even with high-speed computers and sophisticated algorithms.

Hierarchical structures seem ideally suited to solving scheduling problems in that there is an obvious rule as to whose scheduling preferences should take priority: individuals lower-down in the organization should adjust their schedules to those above them in terms of meeting and coordinating activities. In a classic article Schwartz (1974) examines the relationship between who waits in social interactions and power. He looks at a plethora of examples from doctors to CEOs. His basic point is that power determines who waits and who doesn't. It is normative and common for the subordinate who comes to meet with his superordinate to be kept waiting. The reverse, that the subordinate should be late for a meeting, is totally unacceptable and if it happens too often may be grounds for firing. Schwartz provides a detailed analysis of why this asymmetry exists, from differences in supply and demand, who comes to whom, and the ways in which waiting itself defines who is in power.

What Schwartz does not consider is how differences in power, and thus the presence of hierarchy, act to solve schedule-coordination issues. The question of who will or should wait is also one of how scheduling conflicts between two people could be resolved. In the case where there is a clear status differential the answer is obvious. If the higher-status person is not immediately available when the lower-status person arrives, the lower-status person will have to wait; that is, the higher-status person's schedule will take precedence. If the lower-status person would like to meet with the higher-status person, the assumption is that they will adjust their schedule to accommodate to the times when the higher-status person is available.

Winship (1978) showed that where a hierarchical structure existed, not only would an equilibrium exist, but it would be Pareto-optimal. That is, there would be no other agreement about the time pairs of individuals would spend together that all individuals would either prefer or find just as acceptable.<sup>5</sup> Specifically, if we considered a situation in which individual B is said to be dominated by individual A, if in equilibrium B would like to spend more time with A than A is willing to spend with B and this relationship formed a hierarchy (or more precisely a partial ordering), then the equilibrium would be Pareto-optimal. That is, there would be no allocation of time between the individuals that the person at the top of the hierarchy would prefer to the equilibrium allocation.

Undeveloped in that paper is the simple insight that if there were a pre-existing hierarchy (partial ordering), and the people only need to interact with those who are above or below them, then there is a simple mechanism for solving scheduling conflicts. Specifically, the scheduling preferences of the person(s) at the top of the hierarchy should determine when the activities they need to participate in should occur. Taking those times as fixed, the scheduling preferences of the individuals below them should determine when the next set of activities should occur. And so on.

Schwartz's description (1974) of many different settings is consistent with the above allocation mechanism. This mechanism is also consistent with his general insight: that people with power, that is people higher-up in the hierarchy, are able to use their time more efficiently and fully—they will spend less time waiting. What we can see here is that a key reason for this is the way that hierarchies are likely to lead to potential scheduling conflicts being resolved.

## CONCLUSION

Social relations do not simply exist as abstract entities. They need to be enacted in real time and space. In this chapter I have argued that enactment can be constrained and even be infeasible because of scheduling conflicts. Furthermore these constraints can have important implications for social relations, grading, and organizations.

After reviewing previous work on the social science of time, I provided a basic formal analysis of why scheduling conflicts exist and more importantly why they can be difficult to resolve. Because the decision to schedule an event at one time affects the time other events might be scheduled, schedules become a type of public good. As with public goods in general, it may be impossible to determine an allocation that is consistent with individual preferences (Arrow 1951).

I went on to show that scheduling constraints can have important social implications. First, they can simply prevent specific relations or groups from occurring or may cause others to dissolve. A potential choral group that cannot find a common time to practice may simply never come into existence. Two individuals may find it difficult to maintain a marriage if they can never find time to be together. Second, I show how time segregates groups and reinforces group boundaries. Parents with children and drug dealers may coexist peacefully if they use a public park at different times. Calendars may be purposefully structured so that it is difficult for individuals to engage with members of other groups: different sabbaths separate Jews and Christians; different vacation times public- and private-school students. Finally,

I discussed how organizations in order to be feasible have to be able to resolve scheduling problems. Time schedules where all individuals have the same schedule or their schedules have parallel structures are the easiest to manage. More complex forms of equality can make scheduling conflicts difficult to resolve. In contrast, hierarchies provide a simple mechanism for dealing with scheduling issues: the schedules of those higher-up in the hierarchy are given precedence over the ones of those lower-down.

The immediate impact of scheduling conflicts is easy to see: concerts not attended, lunches not had, meetings that take forever to schedule. As individuals we can readily recognize how scheduling conflicts affect our lives. Understanding how scheduling conflicts more generally affect the nature and organization of social relations can be difficult. I have suggested several important ways that they do so. It is to be hoped that other researchers will be able to identify additional ways in which time and our attempt to organize it through schedules shape social life.

## NOTES

1. Both of these literatures are part of an even broader literature on time use. Most important in the last several decades has been the development of time-use surveys (see Herz and Devens 2001 for a survey of recent results).
2. Note that there is no problem with there being multiple events assigned to the same column/time period. Multiple events can occur at the same time. People cannot participate in more than one event at the same time.
3. An appendix to this chapter, which is available on the author's website—<[http://www.wjh.harvard.edu/soc/faculty/winship/oxford\\_handbook\\_analytical\\_sociology\\_appendix.pdf](http://www.wjh.harvard.edu/soc/faculty/winship/oxford_handbook_analytical_sociology_appendix.pdf)>—provides a discussion of some of the basic theorems in this literature.
4. Amazon.com listed more than 3,500 books on scheduling as of February 2008.
5. Winship's result (1978) only examined the problem of individuals allocating time among each other under the constraint that the amount of time one individual spent with another was equal. He did not consider the complicated scheduling problem that is the focus of this chapter.

## REFERENCES

- ARROW, K. J. (1951), *Social Choice and Individual Values* (New York: Wiley).
- BECKER, G. S. (1965), 'A Theory of the Allocation of Time', *Economic Journal*, 75: 493–517.
- BENDER, J., and WELLBERG, D. E. (1991) (eds.), *Chronotypes: The Construction of Time* (Stanford, Calif.: Stanford University Press).
- BERGMANN, W. (1992), 'The Problem of Time in Sociology: An Overview of the Literature on the State of Theory and Research on the "Sociology of Time", 1900–82', *Time and Society*, 1 (1): 81–134.

- BIANCHI, S. M., ROBINSON, J. P., and MIKIE, M. A. (2006) *The Changing Rhythms of American Life* (New York: Russell Sage).
- BOURDIEU, P. [1963] (1990), 'Time Perspectives of the Kabyle', in J. Hassard (ed.), *The Sociology of Time* (New York: St Martin's), 219–37.
- CARTER, M. W. (1986), 'A Survey of Practical Applications of Examination Timetabling Algorithms', *Operations Research*, 34: 193–202.
- CONDORCET, M. DE (1785), *Essai sur l'application de L'analyse à la probabilité des décisions rendues a la pluraliste des voix* (Paris).
- DRAKE, S. C., and CAYTON, H. B. (1945), *Black Metropolis: A Study of Negro Life in a Northern City* (New York: Harcourt).
- ELLIS, M., and PARKS, V. (2004), 'Work Together, Live Apart? Geographies of Racial and Ethnic Segregation at Home and at Work', *Annals of the Association of American Geographers*, 94 (3): 620–37.
- EPSTEIN, C. F., and KALLEBERG, A. L. (2006) (eds.), *Fighting for Time: Shifting Boundaries of Work and Social Life* (New York: Russell Sage).
- FOX, D. P., and GOTTFREDSON, D. C. (2003), 'Differentiating Completers from Non-completers of a Family-based Prevention Program', *Journal of Primary Prevention*, 24 (2): 111–24.
- GELL, A. (1996), *The Anthropology of Time: Cultural Constructions of Temporal Maps and Images* (Oxford: Berg).
- GRIMMETT, G. R., and McDIARMID, C. J. H. (1975), 'On Colouring Random Graphs', *Mathematical Proceedings of the Cambridge Philosophical Society*, 77: 313–24.
- HÄGERSTRAND, T. (1970), 'What About People in Regional Science?', *Papers and Proceedings of the Regional Science Association*, 24: 7–21.
- (1973), 'The Domain of Human Geography', in R. J. Chorley (ed.), *Directions in Geography* (London: Methuen).
- (1975), 'Space, Time and Human Conditions', in A. Karlqvist and E. F. Snickars (eds.), *Allocation of Urban Space* (Farnborough: Saxton House).
- HAMMERMESH, D. S., and PFANN, G. A. (2005a) (eds.), *The Economics of Time Use* (Amsterdam: Elsevier).
- (2005b), 'Introduction: Time-use Data in Economics', in Hammermesh and Pfann (eds.), *The Economics of Time Use* (Amsterdam: Elsevier).
- HASSARD, J. (1990), *The Sociology of Time* (London: Macmillan).
- HERZ, D., and DEVENS, R. M. (2001), 'The American Time-use Survey', *Industrial Relations*, 40 (3): 526–9.
- HOCHSCHILD, A. (1989), *The Second Shift* (New York: Avon).
- JACOBS, J. A., and GERSON, K. (2004), *The Time Divide: Work, Family, and Gender Inequality* (Cambridge, Mass.: Harvard University Press).
- KELLERMAN, A. (1989), *Time, Space and Society: Geographical Societal Perspectives* (Dordrecht: Kluwer).
- KILLINGSWORTH, M. R., and HECKMAN, J. J. (1987), 'Female Labor Supply: A Survey', in O. Ashenfelter and R. Layard (eds.), *Handbook of Labor Economics* (North-Holland: Elsevier), 103–204.
- KORNBLUM, W. (1974), *Blue Collar Community* (Chicago, Ill.: University of Chicago Press).
- KRAAK, M. (2003), 'The Space-Time Cube Revisited From a Geovisualization Perspective', proceedings of the 21st International Cartographic Conference, Durban, South Africa, 16 October.
- KWAN, M. P. (1998), 'Space-Time and Integral Measures of Individual Accessibility: A Comparative Analysis Using a Point-based Framework', *Geographical Analysis*, 30 (3): 191–216.
- LANDES, D. (1983), *Revolution in Time: Clocks and the Making of the Modern World* (Cambridge, Mass.: Harvard University Press).
- LEIFER, E. M. (1990), 'Enacting Networks: The Probability of Fairness', *Social Networks*, 12 (1): 1–25.
- McPHERSON, J. M., and RANGER-MOORE, J. R. (1991), 'Evolution on a Dancing Landscape: Organizations and Networks in Dynamic Bias Space', *Social Forces*, 70: 19–42.
- McPHERSON, M., and ROTOLO, T. (1996), 'Testing a Dynamic Model of Social Composition: Diversity and Change in Voluntary Groups', *American Sociological Review*, 61: 179–202.
- MALINOWSKI, B. (1927), 'Lunar and Seasonal Calendars in the Trobriands', *Journal of the Anthropological Institute of Great Britain and Ireland*, 57: 203–15.
- MÅRTENSSON, S. (1979), 'On the Formation of Biographies in Space-Time Environments', *Lund Studies in Geography*, 47: 151–62.
- MELBIN, M. (1987), *Night as Frontier: Colonizing the World After Dark* (New York: Free Press).
- MILLER, H. J. (1991), 'Modeling Accessibility Using Space-Time Prism Concepts Within Geographical Information Systems', *International Journal of Geographical Information Systems*, 5: 287–301.
- POPIELARZ, P. A., and McPHERSON, J. M. (1995), 'On the Edge or In Between: Niche Position, Niche Overlap, and the Duration of Voluntary Association Memberships', *American Journal of Sociology*, 101 (3): 698–720.
- PRED, A. (1977), 'The Choreography of Existence: Comments on Hagerstrand's Time-geography and its Usefulness', *Economic Geography*, 53: 207–21.
- (1984), 'Place as a Historically Contingent Process: Structuration and the Time-geography of Becoming Place', *Annals of the Association of American Geographers*, 74 (2): 279–97.
- PRESSER, H. B. (2003), *Working in a 24/7 Economy: Challenges for American Families* (New York: Russell Sage).
- RISSEMAN, J. (2000), 'Same As It Never Was: Realizing the Vision of Smaller Communities of Learners at Arlington High School', executive summary, Arlington High School, St Paul, Minn.
- RUCKSTUHL, K. E., and NEUHAUS, P. (2005) (eds.), *Sexual Segregation in Vertebrates—Ecology of the Two Sexes* (Cambridge: Cambridge University Press).
- SCHWARTZ, B. (1974), 'Waiting, Exchange and Power: The Distribution of Time in Social Systems', *American Journal of Sociology*, 79: 841–70.
- SOROKIN, P., and MERTON, R. (1937), 'Social Time: A Methodological and Functional Analysis', *American Journal of Sociology*, 42: 615–29.
- STAINES, G. L., and PLECK, J. H. (1983), *The Impact of Work Schedules on the Family* (Ann Arbor, Mich.: Institute for Social Research).
- THOMPSON, E. P. (1976), *The Making of the English Working Class* (London: Gollancz).
- THRIFT, N. (1983), 'On the Determination of Social Action in Space and Time', *Environment and Planning D: Society and Space*, 1: 23–57.
- TIPPS, J. W. (2003), 'A Preliminary Study of Factors that Limited Secondary School Choral Involvement of Collegiate Choral Singers', *International Journal of Research in Choral Singing*, (1): 22–8.

- WARRENER, J. J. (1985), 'Making Junior-Senior Band Succeed', *Music Educators Journal*, 72 (2): 42-4.
- WHITE, L., and KEITH, B. (1990), 'The Effect of Shift Work on the Quality and Stability of Marital Relations', *Journal of Marriage and the Family*, 52: 453-62.
- WILLIAMSON, O. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications* (New York: Free Press).
- WINSHIP, C. (1978), 'The Allocation of Time Among Individuals', *Sociological Methodology*, 9: 75-99.
- (1992), 'Social Relations and Time', paper presented at the *Sunbelt Social Network Conference*, San Diego, Calif., 14-16 February.
- ZERUBAVEL, E. (1981), *Hidden Rhythms: Schedules and Calendars in Social Life* (Chicago, Ill.: University of Chicago Press).
- (1982), 'The Standardization of Time: A Sociohistorical Perspective', *American Journal of Sociology*, 88: 1-23.