Abstract

This chapter deals with some temporal features of group work, and with how those temporal matters are affected when technological tools are added. The first section deals with matters of temporal structure, such as stages of group development and phases of group task performance, treating those issues in terms of a new time-based theory of functional groups. The second section deals with matters of temporal patterning, giving special emphasis to entrainment processes. The third section considers an array of potential technological tools that can mediate and modify cooperative work in groups. Those tools are discussed in terms of how they might aid or hinder the temporal flow of communication and work in groups. That last section also poses some key questions for research.

The questions addressed in this book are, preeminently, matters of time: Groups develop and exist in a temporal context. Work is planned and carried out on real time schedules. Human behavior—at work and otherwise, alone and in groups—is temporally patterned in complex ways. And the introduction of technological tools, above all else, tampers with the time and space of it. So—to expand the pun of the title—this chapter will explore some temporal matters involved in the work of groups, and will try to show how such temporal matters do matter, both when people work together on common tasks, and when technological tools are added to the mix.

Issues regarding the temporal structure of group behavior have been raised at each of several levels of temporal scope. At the most macro level, the
level of the “life cycle” of a group, temporal issues have been studied in the context of developmental stages of groups. Here, the key questions relate to whether there is a systematic sequence of structural-functional states through which groups of various kinds progress; that is, whether there is a general sequence of developmental stages for the “species” Group. That stage idea is embodied in Tuckman’s (1965) description of four stages of group development, cleverly paraphrased as: “forming, storming, norming and performing.” At a less macro level, the level of conduct of a concrete task or project, group researchers have asked whether groups exhibit a systematic series of problem-solving or task execution phases. That idea is embodied in the work of Bales and Strodtbeck (1951) on the phase sequence in single-session problem-solving groups, and related work on phases sequences in long-term groups (e.g., Landsberger, 1955; Psathas, 1960; Stock & Thelen, 1958).

At a still more micro level, the level of the group’s ongoing interaction process, researchers have begun to ask questions about the rhythms or other temporal patterns by which groups synchronize their activities. That work is exemplified by studies dealing with patterning of sounds and silences in group conversations (e.g., Dabbs, 1983; Dabbs & Ruback, 1984; Jaffe & Feldstein, 1970; Warner, 1979, 1984, 1988), by studies analyzing temporal flow of the content of group interaction and mutual interpersonal influence (e.g., Gottman, 1979a, 1979b; Kerr, 1981), and by studies of internal and external influences on temporal patterning or synchronization of interaction (e.g., Kelly, 1988; Kelly & McGrath, 1985; McGrath & Kelly, 1986; McGrath, Kelly, & Machatka, 1984; Warner, 1979, 1984, 1988).

Both temporal structuring of the group’s context (issues of stages and phases) and temporal patterning of the group’s action (issues of synchrony) are important aspects of the study of groups, and both have implications for the effect of technology on work by groups. Therefore, the three sections of this chapter deal, respectively, with three clusters of temporal matters related to cooperative work. The issues of temporal structure, of stages and phases, are addressed in the first section, by means of a time-based theoretical perspective on what groups do and how they do it. The issues of temporal patterning, of synchrony, are the focus of the second section of the chapter, with special emphasis on entrainment processes. The third section considers how technology and time are likely to interact to affect communication in groups, and how we might modify some features of those technological tools so that they benefit, rather than disrupt, communication in groups.

The latter discussion, especially, will raise far more questions than it settles. For many issues, the impact of technological tools cannot be reckoned in any concrete way on the basis of current evidence. But the discussion of time and technology in the final section of the chapter, as well as the discussion of a number of temporal issues throughout the chapter, will both serve the twin objectives of this chapter: (a) to sensitize researchers to a number of important temporal issues involved in groups at work, including those that are influenced by use of new technologies; and (b) to provide a partial agenda for research that could increase our knowledge about those issues.

### THE TEMPORAL STRUCTURE OF WORK IN GROUP

In earlier treatments, both developmental stages and problem-solving phases were often construed as involving different specific types and patterns of activity in a fixed and more or less inexorable temporal sequence. But the temporal parameters of those phases were only crudely specified. For example, the time periods for Bales’ problem-solving phases within a single “session” of a group’s life were obtained by simply dividing up whatever period of time the group had worked on its problem into the desired number of temporally equal parts (e.g., dividing an hour-long group session into the initial, middle, and final 20 minutes segments). In many of the early studies on developmental stages in groups, the specification of time intervals for stages of group development was done in terms of successive meetings of the group, without much regard for comparability of the length and agenda of the various meetings of any one group, much less for comparability of those matters across groups. It is hard to replicate hypothesized temporal stages or phases based on such imprecisely specified temporal intervals—and even harder to refute them.

More recent work treats such stage and phase ideas more fully in their temporal contexts, and in considerably more sophisticated ways. Moreland and Levine (1988) used the stage idea in considering, simultaneously, both the temporal patterning of group development and the temporal course of socialization of members into a group. Wicker and King (1988) applied the stage idea in the context of the “life cycles of behavior settings.” Both of these treatments try to tie down the temporal structure of group behavior with sharper definitions, and explore it within more elaborate relational nets.

Furthermore, Gersick’s (1984, 1988) work has placed the question of the temporal structure of group action in a new light. She studied eight groups, each of which had a single mission and a predetermined life span, throughout their entire life course. The eight groups varied in life span from a few days to 14 weeks, but each had, from its “birth,” a definite time deadline and an expected product (a report, a set of recommendations, a plan, etc.). Her most striking finding was the way every one of the groups made a major shift in what it did and how it did it at a point almost exactly halfway through its life-
span. However much progress a given group might have made vis-à-vis its
task during the first half of its group life, each group had a more or less
dramatic meeting at about the midpoint of its projected lifespan, and as a
result changed the whole course and pattern of its activity. Before the
midway point, many of the groups had seemed to flounder, or at least they did
not seem to be moving efficiently toward their stated goals. After that midlife
crisis, so to speak, each group moved fairly directly to an execution of the
tasks that constituted project completion. This is a kind of phase movement,
to be sure, but it is certainly a far cry from the kinds of temporal patterns
implied in either Bales' or Tuckman's benchmark early works.

In the present context, one way to express Gersick's findings (and other
studies of temporal patterning that will be discussed in the second section) is
to say that the temporal patterning of group performance is relative to the
task and to the time constraints under which the group is operating. In other
words, there are temporal patterns in how groups go about their work, but
those temporal patterns are not fixed in time in the sense that a given set of
actions does not always last a certain number of minutes.

To take that dictum to heart and work through its implications, however,
requires that we have a substantially different conception than we have had
in the past about what groups are like, what group tasks are like, and how
groups go about doing what they do. I have been trying to develop such a new
formulation of groups, one that will let us deal more adequately with these
and other time-based issues. Much of that new formulation is presented or
implied elsewhere (e.g., Futoran, Kelly, & McGrath, 1989; McGrath, 1984,
1986, 1987; McGrath, Futoran, & Kelly, 1986). Here, I sketch only its key
ideas, as a base for discussion of the stage/phase issues and other temporal
matters in groups.

Outline of a Time-Based Theory
of Functional Groups

In my time-based theory of functional groups, a group is regarded as an intact
social system that carries out multiple functions while partially nested with-
in, and loosely coupled to, surrounding systems (e.g., an organization). It is
assumed that groups have similar partial inclusion and loose coupling relations
with their components (members).

Multiple Functions

Groups are multifunctioned. They do things, and the things they do make
contributions to the systems in which they are embedded, to their compo-
nent parts, and to the group itself. The first of these, the group's contribution
to its embedding systems, is here termed the group's production function.

The second, the group's contribution to its component parts, is referred to as
the group's member support function. The third, its contribution to its own
system viability, is labelled the group's well-being function.

The things groups do that make such contributions also cost—in time,
energy, and other resources. Some of the costs accrue to the embedding
system, some to the members, and some to the group itself. Therefore, we
need to reckon the value of a group's activities in terms of its net contribu-
tions (gains relative to costs) to the embedding organization, to the mem-
bers, and to the group itself. (These three functions are similar to the three
criteria set forth in Hackman, 1985, for assessing the success of groups in
organizations). These three functions are separable for analytic purposes, but
are intimately intertwined in any concrete instance; all three functions are
always being enacted to some degree.

Units of Group Activity

We can regard the group's activities at three partially nested levels:
projects, tasks, and steps. A project is a mission. It involves a set of activities in
the service of a goal(s), a set of actions intended to produce a given outcome
(Little, 1983). Groups usually have multiple projects going on at any one
time.

Projects consist of tasks, sets of activities instrumental to completion of a
particular project. Task results have value as a contribution to the project, but
little value standing alone. (Project results, on the other hand, are valued in
themselves.) But any given set of tasks is merely one of many potential ways
to carry out a given project.

Tasks, in turn, are made up of subsets of activities or steps, sequences of
action that, when executed in the proper form and with appropriate timing,
constitute completion of that task. Steps are identified in terms of what
actions are to be done. Tasks are identified in terms of what their completion
contributes, instrumentally, to the project(s) of which they may be a part.
Projects are identified in terms of their purposes, that is, in terms of what
outcomes or products are sought.

For the most part, researchers in the group area have studied steps and
tasks but not projects. Indeed, group researchers seem not to have thought
very much about groups as performing projects (that is, as achieving goals),
but rather have thought of groups only as carrying out specifiable, repetitive
tasks, often tasks assigned to them by management or by an experimenter.
Notably, the now vast goal setting research literature (see Locke, Shaw, Saari,
& Latham, 1981) deals almost entirely with goals that are a statement of
intended production rate on such repetitive tasks, rather than goals in the
broader usage given here. There is a need to study groups that are doing
projects that extend over more meaningful periods of time, on which the
New technology can affect all three group functions, at all three levels. In regard to the production function, new technological means are likely to change the steps involved in many tasks. Such technological changes also often alter the sets of tasks by which some group projects can best be done. Moreover, new technologies sometimes open up possibilities for entirely new projects, missions that can help the group attain its long-run purposes but that were not possible or even conceivable within the limitations of the prior technology.

Furthermore, although technological changes are usually aimed at modifying the group’s production function, they almost always have profound effects on the group well-being and member support functions as well. The distribution among group members of both access to the hardware portions of the new technology and of the expertise needed to use and understand the new systems may provide brand new dimensions of the distribution of status and power within a group—dimensions that correlate quite poorly with the prior status structure.

Nesting and Coupling

Groups are partially nested and loosely coupled systems. Nesting relations refer to the logical inclusion relations among different units within a system (members in work groups, groups in other organizational units such as departments, and so on). Coupling, on the other hand, refers to the efficient causal relations among the parts of a system. Both nesting and coupling have temporal implications, and both may be affected by the imposition of new technologies.

Individuals are partially nested within the groups of which they are members. When one says that certain persons are members of a certain group, one must keep in mind that they are, simultaneously, components in many other social units as well. Groups may also be partially nested in that a given group may have an overlapping relation within more than one larger unit of the organization within which they are embedded.
nature of the stages within each function, and of their relation to one another, are indicated in Figs. 2.1 and 2.2. I describe the four stages of the production function first, and then the parallel stages for each of the other two functions.

**Stages of the Production Function**

For the production function, Stage I, the project inception stage, poses for the group a production or achievement opportunity (and demand). This is the stage in which the particular project becomes one of the group's

### Group Contribution Functions

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<tr>
<th>Stages</th>
<th>Production</th>
<th>Member Support</th>
<th>Group Well-being</th>
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<tbody>
<tr>
<td>Inception (Goal Choices)</td>
<td>Production</td>
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<td>Interaction</td>
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<td>Technical Problem Solving</td>
<td>Position</td>
<td>Role</td>
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<td>Problem Solving</td>
<td>Status</td>
<td>Net</td>
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<td>Problem Solving</td>
<td>Attainments</td>
<td>Definition</td>
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<tr>
<td>Conflict Resolution (Political Choices)</td>
<td>Policy</td>
<td>Payoff</td>
<td>Power</td>
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<td>Conflict Resolution</td>
<td>Allocation</td>
<td>Distribution</td>
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<td>Execution (Goal Attainment)</td>
<td>Performance</td>
<td>Participation</td>
<td>Interaction</td>
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**FIG. 2.1.** Stages and functions.

**FIG. 2.2.** Paths through the project stages.
goals, priorities, or purposes. In general, groups acquire projects by one of three routes:

1. A member of the group proposes the project, which the group then decides to undertake.
2. An outside agent (such as the group's organizational superior, or an experimenter) assigns the project to the group, and the group then "decides" to accept it.
3. The project may be one that is in some sense indigenous to the group and its reason for existence, and/or a recurrent project of long standing for that group. The group undertakes such projects more or less automatically (unless it "decides" to change its raison d'être or its past habits).

The inception stage involves several substages: acquisition of the goal or idea of the project; acceptance of that goal as one of the group's aims, and therefore acceptance of the project as having a certain priority for group attention, effort, and resources; and planning, at least at a general level, for conduct of the project. In general, Stage I involves a choice of goals and a consequent initial selection of a performance strategy.

There are three main alternative paths from inception to completion of a group project. If the activities required to achieve the project are straightforward, inception may lead directly to Stage IV, which is simply called execution. (See path A of Fig. 2.2). The execution stage refers to carrying out, in real time and space, the behaviors that are necessary and sufficient to attain the project goal(s). Stage IV involves goal attainment. Many projects need no intermediate stages (e.g., those that are recurrent and hence routine), and thus follow the relatively simple path A, which is the "default path" for work in groups.

Sometimes, however, direct attempts at execution of a project do not avail; it is not clear to the group just how the goal is to be attained. In such cases, the group needs to identify or construct a logically correct or best means for solution, or at least come to agreement on the procedures to be used. When the project poses such technical problems, the group's production function enters Stage II, the problem solution stage, which involves choices of means. When these choices of means have been made, the group can then go on to the execution stage (Stage IV) to complete the project by applying those chosen means. This is path B in Fig. 2.2. For path B, sometimes the problem-solving activities of Stage II are the heart of the matter, and Stage IV is pro forma once the correct procedure or appropriate algorithm has been determined.

Sometimes the activities involved in a group project require not so much the resolution of technical problems about means, but rather the resolution of either conflicting viewpoints or interests within the group. In such cases, after the inception of a project the group may attempt either to execute the task directly (i.e., Stage IV), or to deal with the project as if it were a set of technical problems to be solved (i.e., Stage II). However, it may find that a set of conflicting interests needs to be adjudicated before it can execute the project. In this case, the project enters Stage III, the conflict resolution stage. Here, the group must work through the conflicts of viewpoint or of interests and motives, and in so doing resolve conflicts of perspectives, value-orientation, goals, and outcome criteria within the group. If Stage II can be regarded as technical, Stage III can be regarded as political. With those issues settled, the group then moves the project to an execution stage (or, perhaps, back through a technical solution stage). This is Path C. For Path C, on some projects the resolution stage may be the heart of the matter, with the execution stage and even the technical solution stage pro forma or even trivial, once the political conflicts have been resolved.

The course of a project through these stages is not always as clear cut as indicated thus far. At the outset a group may not recognize that a project requires technical choices or resolution of conflicts, or both. Such groups may persist in trying to execute the project directly, without making those technical choices or resolving those conflicts. If so, the project will flounder in execution, eventually getting cycled back to appropriate earlier stages. Moreover, it is not always clear whether the problems or the conflicts have to be resolved first. Finally, actually working through the project may create new technical problems, or new conflicts, that were not there at the outset, and hence may require group action on the project to cycle back from the execution stage to some earlier stage. So projects often exhibit recurrent cycling of the production function among Stages II, III, and IV. For the sake of clarity, not all of those alternative loops are shown in Fig. 2.2.

Stages of the Group Well-Being and Member Support Functions

Stages of the group well-being and member support functions parallel those of the production function. For the well-being function, project stages reflect relations among group members. For the support function, project stages reflect relations between individual members and the group.

Consider Stage I, the inception of a project. This is an achievement opportunity (and demand) from the point of view of the group's production function. It is an interaction opportunity (and demand) from the point of view of group well-being. It is an inclusion/participation opportunity (and demand) from the point of view of the individual group member. It offers inclusion of that member in the group, in return for participation, loyalty,
and commitment by that member to the group. All opportunities come tied to potential costs, risks, and dangers. Member participation in a group project always involves a balancing of interpersonal openness and closedness, of privacy and intimacy.

Consider Stage II, the technical stage of a project: This is a problem solution effort from the point of view of the production function. From the point of view of the group well-being function, it is a role net definition stage, in which the group must decide the technical staffing questions of who will do what, when, and with whom. These involve choices of interpersonal means. From the point of view of the member support function, it is a position or status attainment stage. In this case, attainment refers to both the self-selection and the group assignment aspects of how individuals fit into their positions, statuses, or roles within the group.

Consider Stage III, the political stage of a project: This is a conflict resolution activity from the point of view of the production function. From the point of view of the well-being function, it is a power allocation stage in which the group must resolve political issues of who controls the distribution of work and rewards. This involves the resolution of political issues of interpersonal status, power, and payoff. From the point of view of the member support function, it is a matter of allocation of payoffs and commitments. The individual's expected contributions to and payoff from the group must be negotiated and renegotiated as projects (and members) come and go.

Consider Stage IV, the execution stage of a project: This is an action or goal attainment stage from the point of view of the production function. From the point of view of the well-being function, it is an interaction stage, in which the group must carry out the concrete interpersonal activities that are involved in the group project performance process. From the point of view of the member support function, Stage IV is a matter of participation.

Concluding Comments

For productivity, well-being, and support functions, these four stages are not an inevitable sequence, but rather a set of logical relations that must be reckoned with. Not all group well-being activities have to deal with either role net definition or power allocation. Nor do all member support activities have to deal with new position/status attainments or payoff allocations. In some situations inception of a group project will lead directly to member participation, group interaction, and task execution. In other cases, project inception must be followed by activity involving the establishment or reestablishment of a role net definition and an allocation or reallocation of position/status attainments by individual members before participation, interaction, and task execution can be successful. In still other cases, inception must be followed by activity having to do not with the pattern of role differentiation and position/status attainment, but rather with the pattern of allocation of power, personal commitments, and payoffs, before participation, interaction, and task execution can be done effectively. As noted earlier, sometimes the group has to cycle back, to redirect its activities to some (logically prior) stage it had not adequately reckoned with, in relation to its group well-being function, its member support function, and/or its production function.

It should be expected that many group projects will require a three- or four-stage path, or an even more complicated recycling, for at least one function, even if it only requires a simple two-stage path for one or both of the other functions. Hence, there is often not a smooth, synchronized flow of all activities through a group's multifunction project stages. A researcher who is attending to only one function (e.g., the production function) may mistake such complexities of process for group performance inefficiencies, or in Steiner's (1972) pejorative term, "process losses."

The idea of process losses needs considerable translation to fit within the present multiple function, variable stage perspective. To be sure, there probably are some actions of groups that do not contribute positively to any, and contribute negatively to some, of the group's contribution functions. These would truly be process losses; they would be inefficient or wasteful actions from the point of view of all criteria of group success. But one cannot identify such "true" process losses by simply computing a task performance score and comparing it to some expected value based on a model that takes into account only the simple execution stage of the production function. One needs to examine comparable scores for support and well-being functions, based on appropriate theoretical models of those functions as well. It is not reasonable, from my perspective, to regard all group activity that is devoted to group well-being, to member support, and even to the solution of technical and political problems within the production function, as wasteful or as evidence of inefficiencies of process. Group process is much more complicated than can be reflected in a simple fit of a simple additive productivity model, as becomes evident in the next sections of this chapter.

In any case, these important but complex logical and temporal relations among the stages of each function, and among the three functions as well, are very likely to be modified by the introduction of new technology. By definition, new technology offers new technical choices for a range of tasks that groups might intend to carry out. But at the same time, such new technology might unwittingly introduce new political choices within the production function (e.g., the need to set priorities among projects, tasks, and members for access to the new technology). New technology is also likely to perturb the prior patterns of role definition, power, and payoff.
allocations within the group. Furthermore, some kinds of technology may free group members from the usual tight coupling of participation to spatial and temporal proximity; and at the same time it may modify the social psychological meaning of member inclusion in the group and the rewards and negative consequences that may flow from such inclusion. For example, for membership and participation in an electronic mail group, the idea of member inclusion and member support certainly implies a different set of social psychological conditions than membership, participation, and inclusion in a face-to-face work group, even if the frequency of participation is the same. Such effects of new technology on the structure of work in groups is discussed more systematically in the final section, after a further examination of the temporal patterning of work in groups.

THE TEMPORAL PATTERNING OF BEHAVIOR IN GROUPS

Behavior in work groups shows many forms of complex temporal patterning, including some that are nonlinear and even nonmonotonic in temporal form. This section gives attention first to temporal aspects of the flow of work in groups, such as scheduling, synchronization, and time allocation, and then to the matching of "chunks" of time with "chunks" of work to be done. Much of the section deals with entrainment processes or patterns of synchronization—both the mutual synchronization, witting and unwitting, of group members' behavior with one another, and the synchronization of group behavior with ongoing events in the systems within which the groups are embedded.

The Flow of Work in Groups: Timing, Timeliness, and Time Cost

Three generic temporal problems inherent in any collective action (and that are reflections of three major sources of stress in organizations) are temporal ambiguity, conflicting temporal interests and requirements, and scarcity of temporal resources (McGrath & Kelly, 1986; McGrath & Rotchford, 1983).

Organizational responses to these three inherent temporal problems can be characterized as scheduling, synchronization, and allocation, respectively. The parallel individual responses to those same problems can be identified as making temporal commitments, negotiating norms for behavior sequencing, and regulating the flow of task activity and interpersonal interaction. The "fit" (or misfit) between individual and organizational responses to these problems provides the potential for a set of residual problems for the system. Those residual problems are (a) the need to set and meet deadlines (the residual problem of the fit between organizational scheduling and individual commitment); (b) the need for dynamic teamwork (the residual problem of the fit between the organization's efforts at synchronization and the sequencing norms adopted by the individual); and (c) the need to assure an adequate demand/capability match (the residual problem of the fit between the organization's allocation of temporal resources and the individual's regulation of the flow of task and other activities). These residual problems arise at the interface between individual and organization. Most often, that individual/organization interface occurs within the kinds of functional groups discussed here; hence, those interface problems get played out mainly in a group context (See McGrath & Kelly, 1986).

These three temporal issues also can be expressed in terms of three temporal criteria: timing, timeliness, and time cost. Timing has to do with whether the behaviors that individuals perform in order to carry out their tasks are synchronized (temporally coordinated), both within and between members and with other relevant sets of events or actions. Timing (or synchronization) is much involved with the entrainment processes discussed later in this section. Timeliness has to do with whether a given set of actions, or a given task or project, is completed at a time appropriate to its scheduled deadline. Usually, deadlines are times at or before which something must be done. Sometimes, however, timeliness has to do with whether a set of activities is completed within some temporal interval, neither too late nor too early. Thus, timeliness (or scheduling) is timing (or synchronization) at a more macrotemporal level. It, too, involves potentially complex entrainment processes. Time cost has to do with how much time a given task or project consumes. Time costs of a project can be calculated with reference to both hours of staff time (and other resources) used in the project, and in terms of calendar span elapsed from its launching until its completion. The former, staff time costs are often calculated in relation to some budgeted allocation of staff time and resources. The latter, calendar time costs are often evaluated in terms of completion by some overall deadline. Hence, time cost, too, is timing at an even more macro level.

These three time criteria are key elements in what might be called the "temporal infrastructure" of work in groups. And it is this temporal infrastructure, more than anything else, that is both facilitated and perturbed by new communication technology.

The Time/Activity Match

Scheduling work entails fitting activities to periods of time. Melbin (1987) argued eloquently that time is a container into which we invest activities. In scheduling multiple projects in complex systems, it is vital to have as much flexibility as possible in regard to what bundles of activities can be done in
what time periods. Two of the assumptions of the Newtonian conception of
time, which dominates our culture and organizations within it, are (a) an
atomistic assumption that time is infinitely divisible, and (b) a homogeneity
assumption that all the "atoms" of time are homogeneous, that any one
moment is indistinguishable from and interchangeable with any other. But
these assumptions do not hold in our experience. Time is epochal, not
homogeneous; a given hour of the day, day of the week, or month of the year
is not like every other one. And for most practical purposes, different periods
of time of equal duration are not infinitely divisible and interchangeable with
one another.

Consider some examples in which time periods of equal duration but at
different locations within a day, a week, or a year, cannot be indiscrimi-
nately interchanged with one another without cost. An hour-long meeting
with one's child's teacher, for instance, may "cost" much more (in time and
in opportunity costs) if it must be done midmorning on a workday than if it
could be done that evening. Similarly, for many purposes, ten 1-minute
work periods, scattered throughout the day, are not of equivalent produc-
tivity value to one 10-minute period of work from 9:15 to 9:25 a.m. Nor is
the day before Christmas equivalent to February 17th for most retailers. A
piece of time derives its epochal meaning, and its temporal value, partly in
terms of what activities can (or must) be done in it.

Activities, too, cannot be divided into (or combined into) units of any
arbitrary size without cost. Who would want to do laundry one garment at a
time, or aggregate the dirty dishes over a full year? And what executive would
schedule twelve 5-minute meetings, back to back in the same hour, and
expect to fulfill that schedule? Space, facilities, sanitary considerations, and
other matters of convenience, place substantial constraints on how much we
can partition or aggregate any given activity, hence on how much time and
which chunks of time we can effectively use to undertake and complete that
activity.

Thus, both time and activities are "lumpy" and epochal in these and
related ways, rather than smoothly divisible, aggregatable, and interchang-
able. Work in groups is affected, dramatically, by at least three aspects of this
time/activity match:

1. By the behavior versatility of the periods of time involved; that is, by
the range of activities that can be done in them.
2. By the temporal flexibility of the activities involved; that is, by the
range of times during which they can be done.
3. By the temporal modifiability of the activity bundles; that is, by the
degree to which parts of the activities can be aggregated, or parti-
tioned, into units of activity of different sizes, to fit the units of time that
are available for their completion.

It should be noted that certain technological tools are designed in part to
ease the constraints of the time/activity match in relation to communication
in groups. For example, certain forms of computer conference arrangements
permit so-called asynchronous communication among group members. This,
in turn, loosens the limits of the time/activity fit, by permitting participants to
use more time to insert more content, and to shift the time of their participa-
tion to a more convenient hour. The effects of this looser coupling of the time
structure of communication may be quite complex. They are discussed in
some detail in the final section of this chapter.

Social Entrainment

The term entrainment is borrowed from biological science, where it refers
to the well-documented fact that some endogenous biological and behavioral
processes are captured, and modified in their phase and periodicity, by
powerful (internal or external) cycles or pacer signals. In the biological
sciences entrainment applies to a plethora of physiological and behavioral
processes in plants, animals, and humans. Here, the term entrainment
is applied in a social psychological context, both at the macro level of broad
social schedules (e.g., seasonal effects, rush hours, shift work effects), and at
the more micro level of effects of time pressure on production rate and
quality in work groups.

The idea of entrainment is not yet a familiar one for all social scientists, so a
word of explanation is appropriate. To communicate the idea of entrainment,
an analogy is often made to the somewhat more familiar action of tuning
forks. If a tuning fork of a given pitch is set in motion, then placed near
another stationary fork of about the same frequency (or a submultiple), the
latter fork will begin vibrating more or less in synchrony with the former.

In the biological sciences, the classic cases most often used to exemplify
entrainment processes are the circadian rhythms. All animals and plants have
a number of physiological and biological processes that operate in rhythmic,
periodic, or oscillatory forms. Among these are a set that operate with a
periodicity of about 24 hours. (The two Latin words from which circadian is
composed mean about and day). The processes that make up the set of
circadian rhythms are endogenous oscillating processes. That is, they oscil-
late, on and off or high to low to high, naturally and without any external
triggering.

Under ordinary conditions of life on earth, these processes become mutu-
ally entrained to one another; that is, they shift phase and frequency so that
they oscillate in synchrony. Ordinarily, too, these processes all operate as a
coordinated, mutually entrained bundle of biological processes with a peri-
odicity of 24 hours, in synchrony with the day/night rotation of the planet.
Under extraordinary conditions, however, when the light/dark and
The idea of entrainment contains two kinds of synchrony:

1. The mutual entrainment of endogenous rhythms to one another, as occurs for the separate processes that make up the circadian bundle.

2. The external entrainment of such a rhythm or bundle, by powerful external signals or pacers (sometimes called zeitgebers or "time givers"), as occurs for the entrainment of the circadian bundle by the light and temperature signals contained in the day/night cycle of the planet.

Some researchers (e.g., Kelly & McGrath, 1985; McGrath & Kelly, 1986; Warner, 1979, 1984, 1988) have argued that both of these forms of synchrony operate for social psychological as well as biological processes, and that such social entrainment processes play an important role in the behavior of individuals and groups at each of many levels of social system operation. For example, Warner (1988) found mutual entrainment of speech patterns for interacting partners. Kelly and McGrath (1985) reported external entrainment, by time limit instructions, of group task productivity rate, features of group task product quality, and features of the content of group interaction (amount of evaluation of task contributions, amount of interpersonal content). These and other researchers (e.g., McGrath & Kelly, 1986; McGrath, Kelly, & Machatka, 1984) have argued that some of the effects of shift work on the worker have to do with entrainment of the non-work life to the work schedule and the consequent disenentrainment of workers from the rhythms of daily living of the other people (spouse, family, friends) in their social networks.

Note that both forms of entrainment represent instances of loose coupling. The oscillating tuning fork induces but does not compel (in the sense of a tight mechanical linkage) the vibration of the nearby tuning fork that was initially at rest. The light and temperature changes of the day/night cycle induce but do not compel a shift in phase or periodicity of the bundle of circadian processes. So it is, as well, with instances of social entrainment. The time urgency contained in task instructions induces but does not compel changes in the group's rate and quality of task work, and in the rate and pattern of their interaction.

The research supporting the basic idea of social entrainment, some of which was noted earlier, merits further discussion. Kelly and McGrath (1985) found that the imposition of a task performance deadline (a part of the temporal context of the group) resulted in entrainment of the rate and quality of group task performance and of the pattern of group interaction process—effects not only on the initial trial but on later trials as well, when the deadlines had been changed. Groups who were assigned a tight time deadline early in their limited experimental "lives" continued to work at a fast rate (but with low quality, and with an interaction pattern that was highly task-focused) on later trials when in fact they no longer had the tight time deadline. Conversely, groups who began working against a less stringent time deadline continued to work at a slower rate (but with higher quality, and with an interaction pattern that was more interpersonally focused) on later trials when in fact they had shorter time deadlines.

Tasks of different types yield different patterns of entrainment effects, and those differences can be traced to what Kelly and colleagues (Kelly, 1988; Kelly, Futoran, & McGrath, 1988) called qualitative versus quantitative difficulty of the task. Under task conditions for which early trials yield an experience of qualitative difficulty, groups tend to slow down the rate at which they work on later trials (and may, thereby, increase the quality of that work). Under task conditions for which early trials yield an experience of quantitative difficulty, groups tend to speed up the rate at which they work on later trials (and generally reduce the quality of that work).

Entrainment processes operate within the group's communication pattern as well as in the group's productivity. Those same entrainment studies and others (e.g., Warner, 1984, 1988) show that the participation patterns of interacting group members tend to become mutually entrained to one another as they work together. This seems to hold for patterns of speech and silence, for patterns of nonverbal expression, and for features of the content of the interaction as well. As an example of the latter, Kelly and McGrath (1985) found that groups who begin work with stringent time deadlines (compared to groups that have more ample time in their early work periods) spend relatively less time in evaluations of proposed task ideas (agreements, modifications, disagreements), which might well affect the quality of the product. They also spend virtually no time in communication of interper-
sonal content, which might well affect both the member support and the
group well-being functions. Furthermore, these interaction process effects
carry over (as do the task product effects already discussed) even to later
trials for which the time limits have changed.

Such nondeliberate and nonconscious synchronization of behavior of

group members can occur in several forms. Sometimes synchronization
requires out-of-phase alternation, as in human conversations. Sometimes it
requires in-phase synchrony, as in the execution of many complex motor
behaviors. The idea of mutual social entrainment of behavior between mem-
bers of groups offers a new handle for exploring the interaction process itself.
Furthermore, both mutual entrainment by members and entrainment by
external pacers are central to the ways in which new technology may affect
group process.

Stages, Functions, and Entrainment Processes
in Group Interaction

Consider some implications of those entrainment effects in the flow of work
in groups, if we regard groups as working in the multifunction, multistage
project framework laid out in an earlier section. Suppose we observe a group
that has acquired and accepted a project. Suppose that the group is a “task
force” (McGrath, 1984), created for the purpose of executing that specific
project. Suppose further that the intended primary focus of the project is
on the production function. Nevertheless, because that group was created for
the project and has no past history, it potentially has a lot of work to do in
relation to its well-being and support functions (role net definition, position
and status attainment, and perhaps power and payoff allocation). The project
is presumably new to the members of that group, both collectively and
distributively, so the group also has a lot of work to do in the problem-solving
stage, and perhaps in the conflict resolution stage, of its production function.
Thus, the project may call for a full cycle (that is, four-stage) treatment in the
production function, as well as in the other two functions.

Now suppose, still further, that the group has imposed an artificial and
stringent deadline. Presumably, group members will “work faster”—and,
according to the Kelly and McGrath (1985) evidence, they are likely to
produce a product at a poorer level of quality. Time pressure may induce
such groups to try to go directly to the execution stage, even if the require-
ments of the project would normally have called for investment of some
effort (and time) in technical problem solving. The Kelly and McGrath
evidence also suggests that under such time pressure groups will eliminate
much of the communication activity by which they evaluate one another’s
task ideas, and virtually all of the interpersonal or nontask aspects of their
interaction. If so, then not only might the production function suffer in
quality (because of the short shrift given to the technical solution stage, and
to evaluation of task ideas), but the group is also likely to fare poorly on both
its well-being and its member support functions because no time or commu-
nication activity has been devoted to these functions.

Conversely, the entrainment findings would suggest that a group, given a
more than ample amount of time to carry out the same project, would
indeed use up all the time available for it (as in Parkinson’s notorious first
law). But such groups might well spend some of that time “profitably,” from
a production function viewpoint, by moving the project through a technical
problem-solving phase (and perhaps a conflict resolution phase as well). In
any case, groups with ample time might deliver a product of higher quality
in the end, if only because they pay more attention to evaluation of task
contributions. Furthermore, the entrainment studies suggest that a group
with such an “over supply” of time would put more attention and effort on
the stages involved in the group well-being and member support functions
(role definition, position/status attainment, power and payoff allocation,
etc.). Hence, such a group might not only deliver a high-quality product on
its initial assigned task, but in so doing might also position itself better to
undertake other missions, of the same or even of different type.

The Gersick findings, discussed earlier, raise other interesting questions
in the context of the entrainment findings. If groups with a fixed and known
time deadline “take stock” and “redirect” half way through, what do groups
with no time deadline (or with an indefinite one) do about these important
matters? Many groups undertake projects without a specific deadline, but
with the understanding that time is important, even crucial. For example, it
may be clear that delay costs money—or even that the enemy may attack at
any minute. Such groups are likely to work at the most rapid pace they can
but to follow whatever strategy they happened to use at the outset. That is,
they are likely to try to go directly to the execution stage, and to devote all
their effort to the production function. Such “groups in crisis” might never
make use of a midlife change in direction to improve strategy (that is, to
carry out the technical solution stage), because time is always running out.
This could lead to a consequent drop in quality on the production function
(no communication about evaluation of the quality of ideas), and little or no
attention to the well-being and support functions (no communication in the
group about interpersonal matters). When groups work under such crisis
conditions for extended periods of time, they are likely to produce low-
quality work, and to be self-destructive social systems as well.

If the previous description is what happens when a group implicitly has
an infinitely short time deadline, what happens when it implicitly has an
infinitely long time to complete its project? That is, what if no time limit is
given and the context makes it clear that the project does not have any time
urgency (e.g., long-range planning activities)? Such a group might work at
top quality on the project—if it worked on the project at all within any particular segment of time. Such a group might also spend considerable time and attention on the group well-being and member support functions. Assuming that such a time investment usually yields a net positive outcome on those well-being and support functions, such groups might become more attractive to their members (because of the strong member support function) and more effective and viable as a group—even if (or perhaps because) they did little or nothing during those early time segments to enhance the production function.

I do not mean to imply that if groups are given plenty of time they will always and inevitably turn out to be good groups, even in terms of their member support or group well-being functions, much less in terms of their production functions. The purpose, here, is to point out some new ways to look at these issues that are opened up by a temporal perspective, including the entrainment findings, along with a multifunction, multistage conception of groups at work.

In terms of the focus of this chapter, it is important to note that temporal patterning of interaction processes, in general, and entrainment processes in particular, play a dual role in relation to technological aids. On the one hand, they are key temporal features of group work that may get altered (for better or worse) by the introduction of technological tools. On the other hand, these same temporal processes are endogenous features of group communication that themselves either magnify or undo the intended effects of introduction of such technological tools. In the final section of this chapter, I examine these complex interactions of entrainment with endogenous communication processes when technological aids are introduced.

TECHNOLOGY AND TIME IN GROUP COMMUNICATION

Much of what needs to be synchronized in groups is verbal and nonverbal communication. Any group's communication system is replete with key temporal features. Most technological tools are designed to alter the group's communication system one way or another. Consequently, most of those technological aids affect the temporal components of communication drastically.

We need to keep in mind that any particular communication system—whether or not it includes new technological aids—offers both possibilities for and potential constraints on communication in that group. We currently have at hand a spectrum of electronic devices—telephone, television, and computer—each usable in a variety of possible ways. We thus have a stunning array of potential new patterns of such constraints and possibilities for group communication, many of them never before contemplated much less realized in interpersonal communication. Many of these potential constraints and possibilities are temporal in character or have temporal consequences. Moreover, it is likely that any given use of a technological aid will alter the temporal features of that group's communication in both desired and undesired ways.

Stated in overly simplistic terms, then, this rich array of possibilities tempts us to ask: How can we manipulate channel and network links (telephone, television, computers, and so on) to help most, or to hinder least, the temporal flow of communication and work in groups? That question is infinitely easier to ask than to answer. It can be addressed in a limited fashion, though, by considering the advantages and limitations of communication in natural face-to-face situations compared to various kinds of electronically modified arrangements.

Communication in Groups

In any consideration of the effects of electronic interventions on group work it seems sensible to start with a discussion of the nature of direct, open, full-channel, so-called face-to-face communication, and view that kind of communication as the baseline case against which comparisons are to be made. Face-to-face communication may or may not be the best possible pattern, or the worst, for any given purpose. Rather, face-to-face communication is an appropriate baseline for comparison simply because we are used to having it available in almost all our human interactions—for better or worse.

Such face-to-face communication has a number of important features, many of them temporal in character, that affect the process and outcomes that are likely to result. It is important to keep in mind that those features—for example, time lags in response, differential participation of potential sources, certainty/uncertainty as to audience, and so on—are in themselves neutral, neither good nor bad. Rather, any one of those features will be advantageous in some communication circumstances and disadvantageous in others.

Features of Communication in Face-to-Face Groups

There is a relatively vast literature on communication in face-to-face groups under more or less normal conditions. Unlike many other aspects of the group research literature, it shows a clear and robust pattern of results. Groups engaged in face-to-face communication exhibit a remarkably orderly pattern of communication, as if there were a rigorous set of norms or rules regulating that behavior.
First, across a wide range of sizes, types, and compositions of groups, there is a very orderly distribution of participation over time. There are few interruptions or times when more than one person is speaking. There are relatively few silences and those tend to be short.

Furthermore, there is a very orderly distribution of participation over group members. There is a positively skewed distribution of frequency (and duration) of acts across group members over any given block of time. That skew reflects a hierarchy—a status ordering—among group members. The skew increases with increases in the strength of the status ordering, as well as with increases in group size. Furthermore, the presence and strength of a status hierarchy, and the size of the group, have what might be called a "chilling effect" on contributions by low status members. That is, the larger the group, the lower the probability of contribution by the modal member; or, conversely, the larger the group, the larger the modal group of members that make few or no contributions.

**Face-to-Face versus Written Communication Systems**

This pattern can be contrasted with communication in groups that have various kinds of restrictions on their communication networks, modalities, or strategies. The literature is less abundant here, though still considerable (see Hesse, Werner, & Altman, 1987; Williams, 1977), at least for some communication systems. Results are also less robust, or at least less straightforward and simple. It is clear, however, that there is a relatively complex pattern of shifts in features of the communication process that accompanies certain shifts in features of the communication structure.

The strongest contrast for which there is a solid body of evidence is between the face-to-face case and communications systems in which members of groups communicate with one another only in written form—as would be the case in what I later call on-line or synchronous computer conferencing (Hesse, Werner, & Altman, 1987; see later discussion). Some of the regularities found for face-to-face communication change when groups communicate only in written form. First, there is likely to be a more equal (less hierarchical) distribution of participation over members. That is, members are likely to participate without regard to status—, or, at least, low status members are more likely to participate. There is, you might say, a lessening of the "chilling effect" that status hierarchy and group size can have on contributions by low status members. But equal participation by all group members is not an unmixed blessing, especially because it is often the case that group members are far from equal in their potential for communicating worthwhile contributions on a given issue. Nor is the anonymity of a message source that can be a part of such communication systems an unmixed blessing, and for the same reasons: It is often strategically valuable for group members to know the source of a contribution before reacting to it (Galegher, 1987, makes similar arguments).

Communication only by written means produces some other effects as well. There is a far less orderly flow of inputs over time. There are more anomalies in the transitions of floor turns, the smooth succession of "speakers." Depending on how the communication system is instrumented, these anomalies amount to delays or even denials of participation for some members. There are also longer, and far less predictable, lags between input and feedback.

These gross comparisons between face-to-face and one other rather constrained form of communication system hint at the complexity of the problem addressed here. There are many forms of technological aid that change the group communication pattern far less than the one examined here (synchronous computer conferencing), and some that change it far more. To consider as full a range of alternative forms as possible, and yet keep the complexity of matters manageable, the rest of this section is structured in the following way: First, I state as systematically but succinctly as possible the main features of communication in face-to-face groups that are relevant to the present issues. Second, I present a list of possible modifications of the face-to-face case by various technological means, ordered in terms of how drastically they alter the "normal" face-to-face communication process. That list is intended to be representative, not exhaustive; it is an ordered series of ideal types. I indicate which features of the face-to-face case are modified in each such ideal type. Those presentations imply a variety of effects on the communication process—some positive, some negative—that are associated with each of the modified communication systems. I close the section by trying to summarize some of the most important of those implications, both the good news and the bad.

Throughout this section, my emphasis is on the temporal features and consequences of communication systems. In furthering that emphasis, unfortunately, I may unintentionally overlook some other nontemporal features and consequences that are equally or more important.

**Some Defacto Rules of Face-to-Face Communication**

Communication in face-to-face groups implies a set of at least two individual humans who are members of the communicating group. Each member is a potentially independent source of input. All members are, by definition, the targets of every input. All members are in the same place at the same time, all are known to one another, and the member who is the source of each message is known to all (i.e., neither members nor messages are anonymous).

Face-to-face groups are embedded within a full and open communication
network. That is, each member is connected bidirectionally to every other member, via all modalities by which humans are capable of communicating with one another (sight, sound, olfaction, etc.). There is assumed to be zero time lag in message transmission and feedback response times.

Such face-to-face communication flows as if it were regulated by a strongly held set of cultural norms. These norms vary in detail from one culture (and subculture) to another. Within the dominant culture/subculture of our social system (the one that work organizations draw on), those norms about human communication include the following implicit rules:

Rule 1. Only one person can have the floor at any one time.

Rule 2. Someone must have the floor at all times, at least implicitly. There is, in effect, a "default speaker" at all times. Sometimes the default speaker is a continuing group leader; sometimes it is a host for the particular meeting; sometimes it is an issue protagonist (e.g., the person who asked for the meeting).

Rule 3. In the course of a discussion, the immediate prior speaker functions as default floor holder for a brief time after completion of his or her own contribution. Members act as if they need to have that person's permission, or at least his or her acquiescence, in order to take the floor. A speaker, therefore, can exercise some control over who the next speaker will be, as well as when the next speaker will take the floor.

Rule 4. Floor time is to be shared among group members, though not necessarily in an egalitarian way. Often, the floor sharing allocation is a hierarchically skewed distribution (e.g., a leader and followers; a presenter and audience).

Rule 5. Pause times between contributions are critical to smooth transitions. Because of rules 1 and 2 (that there be one and only one floor holder), pauses must not be either too short (risking interruptions) or too long (inserting silences).

Rule 6. Transitions between speakers are signalled by multiple cues, some verbal, some nonverbal (e.g., shifts of eye contact), and some paraverbal (e.g., lowering pitch and amplitude of voice). These signals are crucial for adjusting pause times, hence for upholding the norms about interruptions and silences and smooth transition between floor holders. These multiple signals use different modalities or communication channels; hence restrictions in communication systems reduce the redundancy normally available in these cases.

Rule 7. Participants assume that the audience for each contribution to the group's face-to-face communication is the set of all participants present, but only them. That is, they act on the assumption that all members are awake and attentive, and no one is surreptitiously eavesdropping.

Rule 8. Participants assume that the set of potential next speakers is the set of all participants present, but only them. That is, they act on the assumption that any one in the group can have the floor, and no outsiders will intrude.

Rule 9. The source of each communication input is known to all participants—there is no anonymity in face-to-face groups.

Rule 10. Participants assume that each input is logically and/or psychologically connected, either to the immediately preceding input or to other prior inputs, or else that it foreshadows future inputs. If there is not a connection to immediate or recent past inputs, it is assumed that the speaker will so inform the audience explicitly in the message.

A Classification of Alternative Group Communication Technologies

There are a variety of forms in which technological aids can be used to modify normal face-to-face communication in groups (Galegher, 1987; Hesse, Werner, & Altman, 1987). Some of these involve video or audio communication systems; some involve computer communication systems.

Those modified communication systems can be arranged in a rough order of increasingly drastic change from the face-to-face case. They fall into three sets. The first set are distance-spanning but time-synchronous systems. These allow groups whose members are not all in the same place to "meet" or at least to communicate. They buy that space-spanning advantage by restriction of modalities; but they retain the requirement that members are all acting in the same time. The second set are time-bridging or asynchronous systems. These retain the distance-spanning feature of the preceding set, but in addition relax the requirement that all members be sending and receiving in the same period of time. This time-bridging advantage is bought at a further cost in restriction of modalities. There is a third cluster of possibilities that are less pertinent in the present context but that are included for the sake of completeness of the comparison set. These are systems designed explicitly to be one-way communications. Some of them are on-line (e.g., a radio broadcast), whereas some are explicitly archival (e.g., a book). Neither expects feedback from recipients of the communication (See Fig. 2.3).

Synchronous Distance-Spanning Systems

The first main type of technologically altered group communication system alters the requirement that all group members must be in the same place, although they still retain the requirement that all be communicating in the same period of time:
Closed Circuit Television Conferencing with Audio. These represent a major restriction of modalities, though we often fail to recognize that fact. They eliminate communication in all sensory modalities (e.g., olfaction, touch, taste) except the visual and auditory channels. Sometimes such systems also lose some nonverbal cues because of limitation of cameras and positions. Such systems may or may not impose any substantial transmission or response lags, although hookups over long distances could do so at least on the audio channel.

Telephone Conferencing. In addition to the constraints imposed in the closed-circuit video case, telephone conferencing loses all nonverbal cues and is likely to lose some paraverbal information as well. Telephone conferencing also can have substantial transmission and response lags if long distances are involved.

On-Line Computer Conferencing (perhaps including a simultaneous chat mode). This refers to communications systems in which the participants operate in so-called synchronous communication mode via computer. In addition to the restrictions already listed for the video and audio cases, such computer conferencing may be limited to two or a very few members, especially if they are using a truly simultaneous or chat mode rather than a form involving synchronous communication limited to one “speaker” at a time. In either case, such systems can involve substantial transmission and response lags. These systems also give up all nonverbal and paraverbal information, as well as the other sensory modalities.

Furthermore, such systems extract a high time cost per word for messages, because typing is much slower than talking even for the best of typists. Users often attenuate this cost by sending messages in cryptic and abbreviated forms. Using such condensed transmissions runs the risk of loss of information that is carried in the syntactical forms of the written or spoken language when used in standard form. There is also a potential loss of connotative information that is carried in the style of full-form written communication. This is less of a problem in this level than it is likely to be for the asynchronous computer conferencing mode to be discussed later.

An even more serious problem involves procedures for changing speakers that are not fully developed for such systems, either in a formal structural sense or in the sense of strong regulatory norms. Hence, turn taking often becomes highly chaotic, with many interruptions and silences. Of course, simultaneous input in a true chat mode bypasses the turn taking idea—but it does so by drastically restricting the number of participants and by violating the natural communication pattern of one and only one speaker at a time.

Asynchronous, Time-Bridgeing Systems

The second main class of technologically altered group communication system relaxes the time-synchrony requirement as well as that for place-sharing.

Asynchronous Communication Conferencing. In addition to all of the restrictions of modalities indicated for the preceding systems, these systems also relax the “same time” constraint as well as the “same place” requirement. These systems involve communication in written form, via computer, but with various participants choosing to receive and send at times of convenience to them (as in electronic mail, see below). Consequently, this kind of communication system inserts extensive and highly unpredictable lags in feedback, and it totally eliminates all of the nonverbal and paraverbal channels as well as the other sensory modalities. Furthermore, as in the synchronous version of computer conferences, asynchronous
computer conferencing systems increase time cost per word, thereby encouraging cryptic and abbreviated messages and the potential loss of syntactical and connotative information as discussed in the case of on-line computer conferencing. The problem is even more serious here than in the preceding, synchronous case. From several studies discussed in the literature reviews cited here (see Galegher, 1987; Hesse et al., 1987), users of this form of communication system apparently also complain about losing information regarding the temporal order of messages when the messages arise from more than one source; but that does not seem to me an inevitable or insurmountable problem.

Such communication systems can accommodate a virtually unlimited number and variety of participants, although they also can be used with restricted and predetermined networks. Message sources are anonymous unless some form of signature system is imposed—and that anonymity can be either an advantage or a disadvantage in communication depending on the nature of the task and what participants assume about the expertise of various participants. The potential audience is also unknown unless a restricted net is used. In any case, the actual audience for any given message is totally unknown until and unless feedback is received. Furthermore, who the next speaker will be, when the next input will occur, and whether or not it will be connected to the current input, is known to and totally out of the control of the current speaker. The more "open" the system is made, regarding time, place, source, and recipient, the more "chaos" there can be in the flow of information.

Electronic Mail. This communication system contains all of the restrictions and features of asynchronous computer conferencing as previously described. In addition, there is a reduction in the normative force on the recipient of a message to provide feedback, a reduction in the normative constraints on length and number of messages that one source sends, a reduction in normative constraint on the range of permissible topics of messages, and no normative requirement for connectedness between messages. All of these add up to an increase in volume of information received, and a reduction in control of when, how much, and what kind of information is received. That is to say, from the point of view of the receiver there is an increase in the level of chaos, or a reduction in the degree of structure, of the communication process.

One-Way Communication Systems

This class of technologically altered group communication systems is really not group communication at all; rather it is a one-way communication of one to many. It is included for completeness.

Broadcasts: One-Way, Concurrent Communication Systems. These systems are, in order of increasing restriction of channels: telecasts, radio broadcasts, computer bulletin boards, and memos. They share all of the restrictions of the preceding systems. In addition, they virtually preclude feedback or insure a long delay; they can make the source quasi-anonymous and the audience totally unknown. There is no communication process flow (that is, there is no turn taking, no next speaker, no connectedness of messages, and so on). Those features are totally constrained.

Archival Forms of Communication. These also are not group communication, and are not intended to draw response. They include, in order of increasing restriction of channels: video tape, audio tape, computer files or tapes, and printed products such as books, magazines, journals, and newspapers. These share all of the restrictions affecting the preceding communication forms, and have the additional feature of being intended to be "timeless"—that is, to continue to be both available and useful on into the indefinite future.

Summing Up: The Good, the Bad, and the Hopeful

All of the preceding material adds up to some good news and some bad news for people interested in using technological aids to improve group communication. It also implies some questions amenable to research, that can help us reap some of the potentially good effects and avoid some of the potentially bad ones.

We can begin a summing up by asking: Do technological aids alter the temporal aspects of communication in groups? The answer, it would seem, is a loud and definite "yes." The effects appear to be both powerful and pervasive, and they contain both positive and pernicious consequences for group behavior.

We can continue that summing up by posing three further questions, which serve as the basis of the following discussion:

1. What are the effects of technologically produced changes in network, modality, and channel configurations on information transmission in groups?
2. What are the effects of such technological changes on the timing of communication activity, hence on synchronization/entrainment processes in those groups?
3. What are the effects of such technological changes on the sequence of stages by which groups do their work—not only the stages of the production function, but also those of the member support and group well-being functions?
Technology and the Flow of Information

As group communication systems are altered by technological means, and thereby moved along the continuum implied by the classification system of the preceding section, there are two concommitant changes in the channel/modality configuration of that system. On the one hand, there is a progressively more constrained use of channels and modalities. At the same time there is a progressively less constrained definition of who, where, when, and what will enter into that communication network. So, use of electronic means opens up the who/what/when/where of it and simultaneously closes down the how (modality) of it.

This is both good and bad news. On the negative side, virtually any restriction of communication modality or channel affects the breadth and redundancy of cues available for smoothing the flow of communication (e.g., for signaling change of speaker). Such reductions make it harder to follow the normative rules about communication on which we all depend. In information theory terms, they thereby both reduce the redundancy of cues needed to regulate flow, and increase the potential chaos or noise in the communication system.

Furthermore, such technological aids to communication have asymmetrical effects on sender and receiver. For example, asynchronous communication systems are more loosely coupled systems than face-to-face groups. This loose coupling provides a liberating effect for the sender—it relaxes the constraint on the who/where/when of participation in the network as a sender. At the same time, from the point of view of each receiver in the net, that loose coupling largely removes the constraints on amount and sequenc- ing of incoming information; hence it provides a less orderly, more chaotic, less predictable flow of information for the receiver. So, although such technological changes free the sender with respect to time and place, for the receiver they reduce redundancy and increase noise—that is, they increase uncertainty.

On the other hand, the so-called asynchronous communication systems permit meetings or at least discussions to be held among groups of people who are not all in the same place and not even all “in” the group at the same time. Indeed, the gains from being able to communicate across different time periods sometimes seem to the participants to be more important than the gains from communication over spatial distances (Eveland & Bikson, 1986; Galegher, 1987).

The gains to be had from such asynchronous communication systems (asynchronous computer conferences in the earlier discussion) seem to be offset by losses arising from several other features of the communication process in such systems: The resulting overload of information for the receiver; uncertainty about audience; frustration from lack of response to one’s contributions; and confusion about source and sequence of other’s communications (see Galegher, 1987; Hesse et al., 1987).

This is a more favorable balance sheet than it might seem at first glance. The time bridging gains cannot be gainsayed, so to speak; they inhere in the nature of the system. On the other hand, the losses just enumerated seem capable of elimination or reduction by rather straightforward means. Asynchronous computer conferences can be run using signature systems to identify contributors. They can select and delimit participants, and make the audience nonanonymous. They can generate an agreement among participants to read and react to all contributions by some predetermined deadline. They can include an agreement on upper and lower limits of input by each participant, and thereby generate any distribution of “floor time” among members that they wish.

Note that none of these efforts to make asynchronous computer conferences more effective involve any hardware development at all, and they require relatively little in development of software in conventional senses. Rather, they require social contracts among the participants. That is, they require the deliberate creation of the very kinds of social norms that apparently arise spontaneously in natural face-to-face groups, and that are very powerful and effective devices for regulating face-to-face communication in those groups.

We certainly need research in this area to explore these matters. For example, it seems likely that there are substantial differences in the cue value of various channels or modalities. We need to know which ones are most valuable. We also need to develop techniques for inserting effective turn-taking information into some of the reduced-modality communication systems. As already noted, such techniques are more likely to involve social rules agreed on by participants, than to involve costly hardware or complex software.

Thus we need major research efforts to invent and test means for more effective use of currently available technological tools, new electronic devices as putative aids to communication in groups. Those inquiries should seek ways of offsetting the inherently adverse effects that such technological aids apparently have on the group communication process when they are used in their natural states. As already noted, effective means for making current technology more “group friendly,” so to speak, are more likely to involve rules regulating procedures of use—operational algorithms if you will. I prefer to call those rules social system norms.

Synchrony and Timing

Between Communication Partners

The timing of contributions to a flow of communication is sort of the other side of the coin from the time/activity match. It is the match of bursts of sending and bursts of receiving across partners. Those two can match up well or poorly across the two (or more) partners in a communication system. Making communication asynchronous is again a two-edged sword: It elimi-
nates cues and makes the mesh harder to achieve; it also stretches the time scale so that required coordinations are not so fine-grained, and hence are easier to accomplish.

In earlier parts of this chapter I have argued that normal face-to-face communication in groups involves strong entrainment (or other temporal patterning) across communication partners—and that multiple, redundant channels, back channels, and other features of the communication system operate to produce the patterned synchrony. Some technological tools reduce the redundancy of cues, because they eliminate some of the channels or modalities (e.g., nonverbal and paraverbal channels) through which the cues that structure these entrainment processes can flow. Those technological tools thereby disrupt the attainment of synchrony or entrainment between communication partners.

There is further bad news about timing. Many kinds of electronic interventions introduce time lags both in message transmission and in feedback response. We have little empirical evidence about the effects of such lags on the communication process in groups. But we do know that some researchers in human engineering areas have deliberately introduced such transmission and response lags as a means for inducing stress. Hence, it seems like a good bet that the introduction of such time lags will not turn out to have extremely positive effects on communication in groups. The question of transmission and response lags is directly related to entrainment issues as well. It seems likely that transmission and response lags can be major factors leading to desynchronization among otherwise mutually entrained features of the communication process.

Certainly this area calls for empirical research. Moreover, this is one clear example of how we can use electronically modified communication systems to do more effective basic research on some features of communication in normal or unaided systems. The experimental study of such lags offers a means for learning, at one and the same time, both about fundamental temporal processes in groups and about the impact of technological aids on those processes.

There is a need, for example, for a systematic set of studies (probably laboratory experiments) that are designed to explore the consequences of changes in various temporal features of communication, and to identify the limits of those changes beyond which the communication process is seriously altered or breaks down altogether. It is easy to visualize a series of parametric experiments to study such communication lags in relation to entrainment processes. Such studies would insert transmission lags of different temporal durations and patterning into the communication system for members of groups engaged in tasks requiring collaboration, presumably using electronic equipment to carry out the interventions. Such a series of experiments could identify the "range of entrainment" (Moore-Edc et al., 1982) of such transmission and response lags beyond which mutual entrainment processes (i.e., cross member synchronization) break down—and, one would presume, beyond which effective group performance deteriorates, as well.

### Stages and Functions of Group Work

Communication by technological means may also strip away affect and interpersonal content in the group's communication activity. This is likely to affect the group's work in two ways. First, it is likely to reduce the amount of attention given to Stage II and Stage III of the group's production function—for better or worse, depending on the circumstances. That is, groups placed in the more constrained communication environments of the systems that are heavily mediated by technological aids are likely to attempt direct execution of projects with whatever strategy gets implemented at the outset. That conjecture poses at least two direct implications for group work in such communication systems. First, if groups working in such technologically aided systems tend to attempt direct execution and avoid technical problem-solving and conflict resolution activities, then those systems are likely to work much better for tasks in which Stages II and III (technical problem-solving and conflict resolution) are relatively unimportant and/or already resolved. This in turn implies that such systems will work best for already-established groups doing relatively routine and well-practiced tasks, for which they already have a well-established division of labor and allocation of payoffs. Such an implication would hardly make technological aids for group work the high road to increased creativity in groups! But these implications must be regarded now as merely hypotheses—though testable ones, inviting future research.

There is a second implication of the conjecture that groups in which communication is mediated via highly technological systems will deemphasize Stages II and III of the production function: If so, then very early inputs by group members will have a disproportionate influence on the group's problem-solving strategy. In fact, there already is evidence of such a disproportionate influence of early contributions to the group in normal face-to-face groups that are not blessed (or cursed) with technological aids. The line of argument developed here would suggest that such disproportionate influence of early actions would be increased for groups with technologically aided communication systems. That suggestion, too, is a hypothesis both worthy of and amenable to test.

Along with these potential effects of added technology on how groups do the stages of their production function, there is a parallel set of potential effects on the group's attention to its other functions. Specifically, the depersonalization effects of technological devices may reduce the amount of
attention that the group pays to all stages of the group well-being and member support functions. This could have major deleterious effects on the accomplishment of truly collaborative work in groups.

Collaborative work—in anything but the most trivial sense of two people who just happen to be doing some task together—implies that there is more or less long-term cooperative work on a broad band of activities (i.e., projects) among the same collaborators. This would be exemplified by joint authors of a book, by co-investigators of a substantial research project, or by partners in a joint business. But if success requires the broad and deep cooperation of the same collaborators over a long time period, by definition they need to put forth some effort, early on, to address successfully those tough and tenacious interpersonal questions implied in the stages of the member support and group well-being functions: What will I get out of it; what will it cost me; whose ox is to be gored and whose ax is to be ground; how much stroking will I have to do to get appropriate responsiveness from my partners; and the like? If the presence of technological tools increases the chances that these questions cannot (or at least do not) get addressed, it may at the same time increase the chances that the collaborative effort will not flourish over a long period of time.

A number of tactics might help reduce the problems created by a neglect of member support and group well-being functions, and of the middle stages of the production function as well. For example, we might create work groups initially on a face-to-face basis, and then when they are established (in the sense of the functions and stages discussed here) add the technological tools to their armamentarium. Alternatively, we might try to create large working groups of communicators, using technologically mediated communication systems (such as electronic mail networks) at the outset but dealing only with routine communication matters. Then, let interest-based subgroups emerge from that large network to become continuing collaborative groups, using multiple communication systems—including the face-to-face option—as their collaboration becomes more lasting and less topic specific.

Concluding Comments

The conjunctures put forth on these latter issues imply considerably more complicated questions for research, and intervention possibilities that pose considerably more difficult operational problems. Nonetheless, these suggestions for future study, along with the hypotheses and suggested research approaches offered in earlier parts of this chapter, provide a partial agenda for research that can help us make best use of the technological possibilities we currently face, as well as those we may acquire in the near future. This review should also make it clear that the proper questions to ask do not involve discovering the perfect mix of electronic and human means that will deliver a communication system that is all things to all communicators. Rather, our hope lies in the formulation and pursuit of the kinds of research questions noted throughout this summary, most of them having to do with social psychological processes rather than electronic innovations. Research along those lines of inquiry can (and I believe should) be designed so that it helps us learn about effective uses of technological tools in groups at the same time as it will contribute to our basic knowledge about group process and performance—especially about those time matters in groups on which this chapter has focused.

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