11

Individuals and Groups: Stress, Coping, and Social Support

In the previous chapter we have examined models in which "chains" are coupled together in increasingly "smart" ways. The structure of the arms-race model is, in systems terms, only slightly more complex than those of the models considered in previous chapters. As a theory of social action, however, it is different in important ways. Rather than having a single system or actor, the arms race model has two actors; rather than representing social "action," the model represents a social "interaction." In the arms-race model, the kind of social action that is captured is somewhat more complex. In the escalation game, each actor is aware of the other and formulates strategy based on its own goals and its perceptions of its opponent's actions. In this model, the behavior of each actor depends on the behavior of the other—that is, rather than simple "action," the model captures a process of "interaction."

Models that capture the dynamics of "interaction" are of central importance in social science theory. Many of the key issues in international relations and international political economy are centered on the processes of interaction (be the interaction economic, cultural, political, or military) among nations. The behavior of economic (and other) organizations over time is often examined as patterns of interaction between the focal organization and other organizations in its environment. Much theory of general social psychology, small group processes, and the family and intimate relations is explicitly concerned with the dynamics of interaction between individual persons. In a more abstract vein, most "game theory," whether pure theory or applied to political, social, or economic action is explicitly concerned with

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Author's Note: The work reported in this chapter is the joint product of David L. Morgan and Robert A. Hanneman.

processes of interaction in the sense that we have used the term here.[1]

The essentials of models of "interaction" are quite straightforward. Interaction requires more than one actor, that actors be aware of each others' actions, and that they dynamically adjust their own behavior (and possibly their own goals) over time, taking the behavior of the other into account. The dynamics of such systems are inherently more complex than those of "closed" or "open" systems because the stimuli that each actor is responding to is continuously shifting as a consequence of the actions of the other—and hence, indirectly, its own past actions.

The processes of interaction that social scientists describe in their work are often quite complicated. Actors' perceptions of their environments (including particularly the behavior of other actors), are frequently regarded as highly problematic. Unlike simplistic models of "rational action," most theories of interaction suppose that actors may have great difficulty in obtaining information about relevant aspects of their environments. The amount and quality of information they obtain varies over time and as a consequence of their positions in networks of interaction. Most interaction models suppose that information about the environment and other actors is variably understood and interpreted by actors, depending on processes of socially conditioned cognition. The behavior of actors in response to stimuli, as perceived, may also be quite variable, depending on the goals actors hold, their expectations about the behavior of others in response to their acts, and the resources they have available. In short, the processes underlying "games" or "interactions" among actors are often regarded as being quite complex and worthy of study in themselves.

In this chapter we will begin to explore some of the possibilities for modeling these more complicated dynamics. We use as our example a particular theory of "stress buffering" drawn from the literature on social networks, social support, and mental health. The structure of the system that we will use to construct this model, however, is potentially of much wider applicability. In principle the model could be extended to include any number of actors. It can be elaborated to embody still more complex hypotheses about perception, cognition, and action, and the actors could as easily be organizations (governments, firms, etc.) as individuals and groups. The "smarter" interaction that is characteristic of the system describing "stress buffering" may be of interest in itself for the application to other similar interaction processes. The model also suggests the richness and flexibility of the theories that can be systematically developed using the approaches advocated in this volume.

The Problem: Stress Buffering and Social Support

In the course of everyday life individuals are subjected to "stressful life events." Most of these events are quite minor and are easily dealt with without seeming to cause any permanent damage or disability. You are aggravated by having to wait in a line to purchase groceries, your boss yells at you, you find that you have too much work to do and too little time to do it in, the children are difficult, and on and on. By the next morning when you wake up the events are largely forgotten and you feel no worse or better than you did before they happened.

In addition to these everyday happenings, we are all subject to less frequent but more severe stresses arising from "major" events: deaths of loved ones, loss of jobs, dissolution of marriages, etc. Most of the time most people are able to cope effectively with the stress from these "big" events as well, but often they leave emotional scars, and often we are temporarily partially disabled by them.[2]

Considerable theoretical and empirical effort has been focused on the question of the processes by which individuals are able to cope with "stressful life events," and why some individuals appear to suffer less short-term and long-term disability as a consequence of these events. Among the many contributions to the theoretical and research literature on this subject are a number of works that emphasize the role played by "support networks" in aiding individuals to cope with stressful events. The fundamental hypotheses of these works are highly plausible and, at a general level at least, supported by statistical analyses of cross-sectional and panel data. At many points in our development of the model in this chapter we will make quite arbitrary assumptions about the time forms of relationships. Researchers in the field of social support have only recently begun to specify over-time models, and hence provide only limited guidance about this part of the theory.[3]

All of the major theories have a number of common features. They suggest that the effect of stressful life events on the ability of individuals to maintain normal functioning is mediated both by the individual's coping resources and by characteristics of the individual's "support networks"—that is, other individuals and institutions that can provide resources to assist the individual in coping with the distress arising from stressful life events. The more resources that the individual has available personally or in its networks, the more likely it is that the impact of stressful events on individual functioning will be kept within manageable limits.[4]

Feed-Forward Effects

As researchers have sought to account for the effects of social support and individual coping, they have advanced increasingly complex theoretical models of the processes of interaction that occur in stressful situations. Various authors have suggested three quite different mechanisms by which the relationship between an individual and its support network can produce more effective coping with stress and less loss of functioning.[5]

First, it is suggested, certain characteristics of support networks reduce the probability that stressful events will occur for the focal individual and thus prevent the occurrence of stressful life events. To choose but one example, individuals who are part of a family-run business (a "network" of a sort), may be less likely to endure the stress accompanying being laid off or fired from a job. Second, if stressful events occur, the degree to which they produce actual "distress" in the focal individual also depends upon the nature of the support network. Again, to choose a simple example, a frequent churchgoer may experience less distress from the death of a spouse than an individual who is not connected to a network of coreligionists. This, it is argued, is because the close network buffers the focal individual by interpreting the event and defining the reality in such a way as to make coping easier. The assertion by one's reference group that the death of a spouse is "God's will" and that the focal individual is expected to "be strong" may go a long way toward reducing the degree of distress perceived by the affected individual.

Third, in addition to these mechanisms of "prevention" and "buffering," support networks are seen as providing compensating resources and support to help restore functioning once a stressful event has occurred. Again, to choose an obvious example, an injury that produces physical disability is probably somewhat more easily endured if the disabled person has helpful neighbors and friends who provide assistance so the disabled person may remain home, rather than being placed into some direct-care residential facility. Persons with resource-rich support networks can more easily "compensate" for some of the economic and other costs of stressful events and hence have their levels of functioning more fully and quickly restored.

In addition to "prevention," "buffering," and "compensation" through network support, individuals also deal with stressful life events by mobilizing their own personal resources to cope. Most theorists hypothesize that the focal individual is also able to "prevent," "buffer," and "compensate" for stress by a set of mechanisms parallel to those provided by the social network.

Individuals who possess high levels of personal resources are more likely to "prevent" the occurrence of stressful life events than those with fewer resources. Individuals who have certain cognitive sets of skills may be better able to "buffer" the stress induced by events when they do occur. And, individuals who possess more personal resources (material and psychic) are more able to mobilize them to compensate for losses of functioning due to stressful events.

We can take all of the ways in which individuals and their social networks are connected to stress and functioning discussed thus far and represent them diagramatically, as in Figure 11.1. The theory, to the degree that we have developed it thus far, suggests that both individual "coping" and social network "support" affect individual functioning in several ways. The resources of individuals and individual's networks may act to "prevent" environment hazards from affecting the focal individual. When such events do occur, both individual and group resources can be called upon to "buffer" the intensity of the resulting distress. And once distress has resulted in the loss of functioning, both individuals and the social networks may act to "compensate" and restore the individual to normal functioning.

Feedback Effects

There are a number of ways in which the theory is still quite incomplete. In particular, we've not paid much attention yet to the nature of the control structures that connect individual functioning to "prevention," "buffering," and "compensation," or to the connections between individual's resources and coping or between network resources and support.

We might hypothesize that the "prevention" effects are more or less automatic, that is, they are governed by "dumb" control mechanisms. Prevention of untoward events by both the network and the focal individual operate without monitoring, goals, or conscious decisions. But "buffering" and "compensation" effects are probably somewhat more complicated.

Buffering by the focal individual may be usefully thought of as occurring more or less automatically.[6] The meanings that we attach to events, and how "stressful" we find them are mediated by personality and cognitive structures that operate automatically and instantaneously. On the other hand, the buffering of stressful events by the support

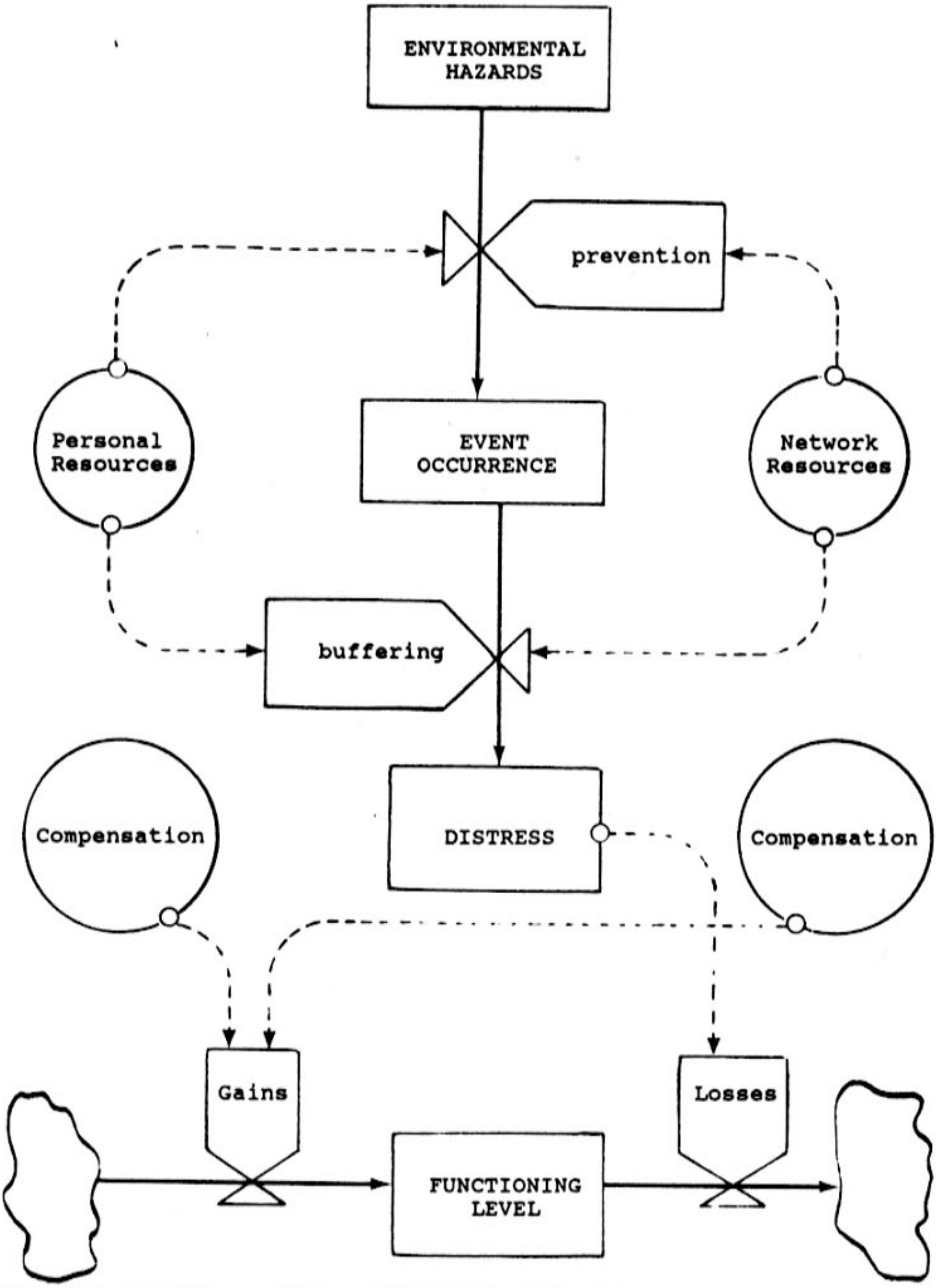

Figure 11.1: Stress, coping, and social support: feed forward connections.

network is not so automatic. In order to engage in buffering activities, the support network must be aware that a stressful event has occurred, decide that buffering is an appropriate response, and act. That is, the support network must monitor event occurrence, make decisions about action based on this information, and then act. The degree of awareness of event occurrence, the decisions that the support network makes about taking buffering actions, and the speed and intensity of the implementation of buffering acts may all vary considerably, depending on the nature of the network.

Efforts by both the affected individual and his or her support network to "compensate" for distress and restore functioning are also far from automatic. We might hypothesize that these processes are based on "smart" control. Affected individuals can be thought of as monitoring their own level of functioning and mobilizing personal resources to restore functioning to a "goal state"—normality. The support network's compensatory actions are governed by a similar process: The network monitors the functioning of the affected individual, compares this functioning to a "goal," and mobilizes resources ("support") to restore the individual's functioning. Of course, the speeds with which the intrapersonal and interpersonal compensation processes operate might be expected to be quite different, and to operate with different goal levels. The capacity of both the focal individual and the network to respond to perceived functioning problems may be thought of as limited by the resources available to each. We have added the implied feedback and control mechanisms discussed here to Figure 11.2 (along with a couple of others, to be discussed below).

As we have specified it so far, the system is rather a "smart" one, consisting of two negative feedback loops (the use of individual coping and network support) to overcome the effects of exogenous stressful events. But there is one last complication that we must consider that makes the dynamics of this particular model more interesting and realistic: Not only do stressful life events induce distress, but they may also simultaneously reduce the capacity of the individual and his or her social network to respond. A disabling physical injury, for example, not only causes "distress" for the focal individual but also reduces the individual's capacity to cope by limiting mobility, taking away discretionary income (due to loss of work and medical bills), and so on. Analogously, the death of a spouse may be both a highly distress-inducing event and an event that substantially reduces the resources of the focal individual's support network, because the spouse is usually a central figure in individual's support systems.

There are two additional connections in Figure 11.2 that we have not yet discussed. These connections are relatively straightforward. For both the individual and for the network, there is a connection between the level of compensatory effort and the resources available. Not surprisingly, both individual and group efforts at restoring functioning

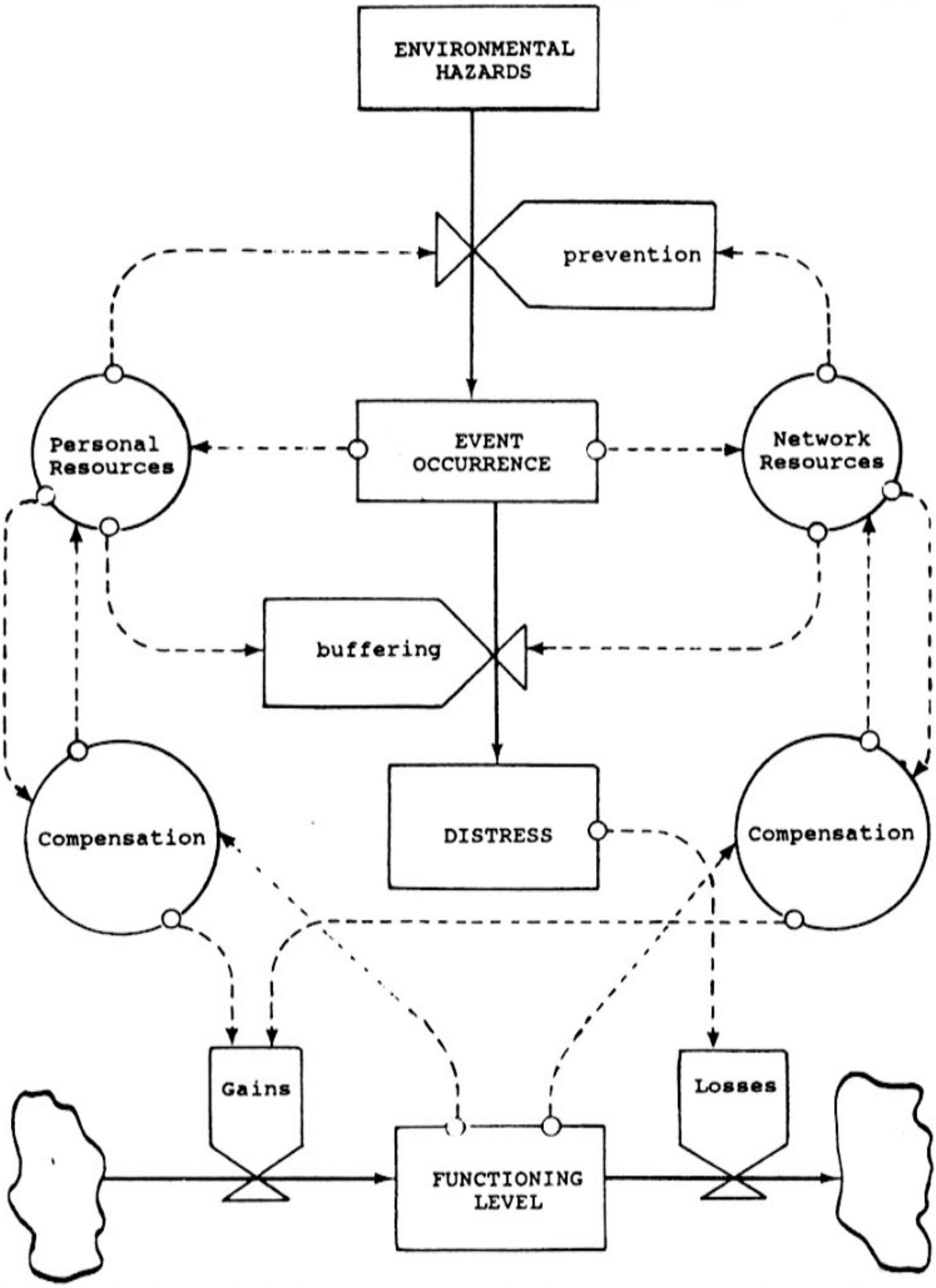

Figure 11.2: Stress, coping, and social support: feed forward and feedback connections.

are limited by available resources and the speed with which they can be mobilized. When resources are used for the purpose of coping or supporting, they are removed from the stockpile of those available to respond to future events. In our model we do not deal in any detail with the source of either personal or network resources which are regarded, for simplicity's sake, as self-renewing.

The dynamic processes represented in Figure 11.2 are, in the terms we have been using, rather complex (though, as we will discuss a bit later, the current formulation is really just a starting point). The system consists of two "smart" actors: the focal individual and the social network. Each of these actors is aware of the actions of the other (though they are not necessarily timely or accurate in their perceptions), and each formulates strategies and behaviors on the basis of the continuously changing interaction between them. This particular dynamic system is one that is "equilibrium seeking," but is composed of a substantial number of effects that may or may not allow the realization of the goal of maintaining individual functioning in the face of stressful life events. Indeed, now that we have formulated the various hypothesized processes into a dynamic system, our theoretical work has just begun. We must now translate the system into a model, and then use the model to explore the limitation and implications of our ideas.

Developing the Baseline Model

Functioning

As we have discussed it above, the whole stress, coping, and social support system revolves around the level of functioning of the focal individual. This is the quantity that is decremented by stressful life events and restored by the compensatory action on the part of the focal individual and of the network. So that we can model continuous rates of change in functioning, we will treat it as a level variable, and indicate it by the letter F.

```
L    F.K = MAX(F.J+(DT)(FIR.JK–FLR.JK),0)
N    F = FI
C    FI = 100
```

In these three statements we first state that the level of functioning at a later point in time is equal to the level at the previous point in time plus integrated effects of factors acting to increase functioning (the functioning increase rate, FIR), less factors acting to decrement the functioning rate (functioning loss rate, FLR). Since we would suppose that functioning does have a fixed lower limit (i.e. "dead" or complete loss of function), we use the MAX function to limit the values that the level can take to positive ones.[7] The second statement sets the initial level of functioning equal to a constant called FI, so that we can easily modify this value for reruns of DYNAMO simulations. The third statement sets the initial value to 100 units of functioning. This simple statement, of course, completely begs the issues of the meaning of "functioning" at a conceptual level and how it might be indicated in empirical research—both difficult issues, but neither of which are critical to the development of the abstract theoretical model.

In the theory that we have been developing, losses of functioning are the direct consequence of "distress" (DIS) resulting from (buffered) stressful events. We can specify the functioning loss rate (FLR) as:

```
R    FLR.KL = MAX((PARM1*DIS.K),0)
C    PARM1 = 1.0
```

In the first statement we set the rate of functioning loss equal to the larger of either some proportion (PARM1) of the level of distress, or zero. That is, functioning loss is some function of the level of distress, but cannot be less than zero. In the absence of strong theory, we will assume that functioning losses are directly proportional to distress (i.e. PARM1 = 1.0). Future modeling efforts might make different assumptions at this point, particularly about the time shape of this effect. For example, it might be that distress results in loss of functioning only with delay. And it might be supposed that the degree and form of the delay might vary depending on the level of the distress, the kind of event that is inducing the distress, or other independent variables. Such alternative assumptions about the size and time shape of PARM1 could be expected to be highly consequential for the behavior of the system because of their closeness to the level of functioning—the quantity that is central to the whole system.

The rate at which functioning is increased is slightly more complicated, because such increases are the result of both individual compensatory "coping" and compensatory "social support" from the network. If we call the level of individual compensatory coping effort "C" and the level of compensatory social support "SS," the functioning increase rate can be specified as:

```
R    FIR.KL = MAX((PARM2*C.K)+(PARM3*SS.K),0)
C    PARM2 = 1.0
C    PARM3 = 1.0
```

The first statement specifies that the rate of functioning increase must be nonnegative and that it is the sum of coping and social support, each modified by a parameter. Again, for simplicity, we will assume that these parameters are unity; that is, that the effects of changes in coping and social support on functioning are immediate and proportional to the changes in coping and support. Again, we see a place at which the theory could use some future development. The magnitude and time shapes of the effects of coping and social support on levels of functioning might very well be thought of as differing in intensity, being nonlinear in form, and being nonlinear in time. For example, one might suppose that individual coping is more efficacious than group support in restoring functioning (that is, that PARM2 is greater than PARM1); one might suppose that both effects are realized only with delay; and, possibly, that the time shapes of the two effects are different and have different average delays. Different assumptions about these factors would be highly consequential for the overall behavior of the system because of their immediate effect on the level of functioning.

Life Hazards, Stressful Events, and Distress

One of the important theoretical advances in the stress and coping literature is the recognition that individual's characteristics and social positions can prevent and buffer the negative consequences of stressful events on individual's functioning. In order to build a model that takes these "preventive" and "buffering" effects into account, we must distinguish between life hazards, the occurrence of stressful events, and the distress induced by the occurrence of events. It is useful to think of these quantities as a "chain" of states, as shown in Figures 11.1 and 11.2.

Let us first suppose that the actual occurrence of life events is generated by some process exogenous to the model. One such process that will be used later on is the following:

```
A    S1.K = EXOG.K
A    EXOG.K = 10.0+PULSE(MAG,5,30)
C    MAG = 100
```

Let "S1" stand for the intensity or seriousness of events occurring at a given time. The first statement (which is not strictly necessary) sets this quantity equal to the output of some EXOGenous process. For the current run, we suppose that stressful events are decomposed into a constant or chronic level of "background" stress (equal to 10 units) and a single powerful event of peak intensity of "MAG" units that occurs at time point 5 (here, MAG is set to 100 units), and is repeated 30 time points later. As with the other parts of the model, there are alternative ways that this exogeneous "hazard" might be specified. In addition to examining "transient response" by use of a PULSE, we might very well also want to specify constant exogenous stress (to examine the equilibrium tendencies of the model), or random shocks drawn from various distributions (e.g. equiprobability, normal, Weibull).

The degree to which environmental hazards are translated into stresses affecting our focal individual are theorized to be limited by "preventive" factors. The intensity of the prevention depends upon the resources of the focal individual and the resources of the social network of which the individual is a part. Let us call the intensity or stressfulness of events that actually occur for our focal individual "S2." We can represent this part of the process as:

```
A    S2.K = MAX(S1.K-PARM4*NR.K-PARM5*PR.K,0)
C    PARM4 = .025
C    PARM5 = .035
```

The intensity of the stressful events reaching our focal individual (S2) is equal to the level of hazard (S1) less a prevention effect of the social network (PARM4) that is proportional to the resources of the network (NR), less a prevention effect of individual characteristics (PARM5) that is proportional to the level of individual resources (PR). The MAX function is again used to assure that the level of stress received is not a negative quantity. The two parameters here, PARM4 and PARM5, reflect the efficacy of individual and network characteristics in preventing untoward events. For our baseline, we have assumed that individual resources are slightly more efficacious than network resources.

These assumptions, like many others in our baseline, are clearly too simple (though they go well beyond existing theory). More sophisticated thinking about this part of the problem might suggest that prevention effects act with delays that are different in both form and length between the individual and the network. The intensity of the prevention effect might be thought of as nonlinear with respect to individual and network resource levels; perhaps there are decreasing marginal returns in prevention to increased resources. Or perhaps the magnitude of the prevention effect depends on the magnitude of the stressor or on other independent variables. While we will not explore these possibilities here, the formalization of the model has helped to identify new issues in the theory that require further thinking.

We have now reached the point in the process where unfortunate events are occurring for our focal individual. The degree of "distress" induced by these events, however, is also regarded as variable—

depending on how effective the individual and the social networks are in "buffering" their impacts. We can represent this buffering in a fashion similar to that of prevention:

```
A    DIS.K = MAX(S2.K−PARM6*NR.K−PARM7*PR.K,0)
C    PARM6 = .025
C    PARM7 = .035
```

As with prevention, we use the MAX function to assure that buffering cannot reduce distress (DIS) to a negative quantity. The degree of buffering is modeled as the sum of individual and group effects, each directly proportional to the resource level of the source.

For simplicity, we have assumed that individual buffering and social network buffering are both "automatic" or "dumb" systems. More complicated formulations are again quite easy to suggest. We might suppose that individual buffering is automatic, but that network buffering requires monitoring, decision, and feedback. And, as with prevention effects, we might suppose that the buffering effects of individual resources and group resources operate at different speeds, have differing time shapes, and have different and nonlinear relationships with the resource levels of the individuals and the network. These assumptions are consequential for the behavior of the system, but are necessarily left for future theoretical research.

This completes the picture of how environmental hazards are converted, by means of prevention and buffering by individuals and their networks, into the personal distress that reduces individual's levels of functioning. We now turn our attention to the processes that seek to restore well-being.

Individual Compensatory Coping

Individual's responses to stressful events are highly variable. While we will not seek to specify exactly what individual resources and skills are relevant to coping, we can build a general model of the process of individual coping efforts. At the general level, individual coping is a smart feedback system in which the individual becomes aware of changes in their own level of functioning, evaluates these changes as a problem, and mobilizes personal resources (both material and psychic) to restore functioning. Individual coping responses to stress are limited by the level of resources available to the individual and by the capacity of the individual to mobilize these resources.

The first step in the process is self-monitoring of the level of functioning. For our baseline model, let's use the simplest possible specification of this part of the process:

```
A    FAI.K = FUNCT*F.K
C    FUNCT = 1.0
```

The first of these statements says that the level of functioning apparent to the focal individual (FAI) is equal to the actual level of functioning (F), times a parameter (FUNCT).

In this case, we treat the process of self-perception as completely unproblematic, involving no delay, bias, or noise. Of course self-perception is not really so simple, and one might wish to elaborate on this portion of the model. For example, individuals probably do suffer delay in perceiving change in their own functioning, and there may very well be "noise" and unreliability in their perceptions. The extent and form of the delay, the signal-to-noise ratio, and systematic upward or downward biases in self-perceived functioning may differ across individuals, and may depend on the level of individual resources and/or current levels of functioning. It may be, for example, that individuals who possess high levels of coping resources are likely to perceive functioning problems more quickly and correctly than individuals with lower levels of resources.

The response to perceived functioning problems by the individual depends on the comparison of these perceptions to goals or desired levels of functioning. We must then specify where these "goals" come from, and identify how the discrepancy between these goals and the perceived functioning level are defined. There are many interesting possibilities here, but we will, at least for baseline purposes, use one of the simplest:

```
A    FGI.K = CLIP(100,FAI.K,100-FAI.K,0)
A    FDISCI.K = MAX(FGI.K-FAI.K,0)
```

The first of these statements says that the functioning goal that the individual holds for their self (FGI) is equal to 100 or to the current perceived level of functioning (FAI), whichever is larger. That is, individuals seek to maintain a level of functioning that is no lower than their current level or the baseline level of 100. The second statement says that the functioning discrepancy apparent to the individual (FDISCI) is the simple difference between the functioning goal (FGI) and the perceived current level (FAI), but may not be a negative quantity. That is, individuals do not view functioning at levels higher than their goal levels as problematic.

Again, we make no claim that this particular specification of the process is the proper specification. The processes by which individuals set goals for their own functioning is a separate and interesting problem that we will not pursue here. Individual's goals might change over time as a function of group support, past functioning performances, individual resources, or perhaps even adjust for stressful events by temporarily discounting the level of demands that individuals make on themselves. We have regarded the functioning discrepancy as a simple linear difference between goal and perceived functioning. Again, more complex views are possible. For example, small discrepancies may receive little weight, medium-sized discrepancies may be regarded as very serious, but very large discrepancies might be viewed as hopeless. This kind of view could lead to nonlinearities in individual response to stress that show increasing marginal responsiveness up to a threshold, but then resignation and complete absence of coping in the presence of severe stress.

Once the individual has perceived a functioning problem and identified its seriousness by comparison to goals, resources are mobilized to reduce the discrepancy. Individual's responses, however, are limited by available coping resources. For our baseline model, let's represent this part of the process as follows:

```
A    C.K = PARM8*CLIP(CRL.K,DC.K,DC.K-CRL.K,0)
C    PARM8 = .25
A    DC.K = FDISCI.K
A    CRL.K = MAX(PARM9*PR.K,0)
C    PARM9 = .03
```

The first of these statements says that the level of coping effort (C) is equal to a coping response limit (CRL) if the desired coping response (DC) is greater than the coping resources limit; if not, then the response is equal to the desired coping response. Whichever quantity is selected, it is delayed by a response time parameter (PARM8). More simply, the level of coping effort is equal to the desired coping effort, but cannot exceed the resources available. In either case, there is a delay in mobilizing resources. The third statement is actually redundant in this model, simply relabeling the desired coping effort as equal to the full magnitude of the functioning discrepancy. The fourth and fifth statements define the coping response limit (CRL) as equal to 3% of the available personal resources (PR). The extent to which an individual is able to respond to stress is limited by the individual's available coping resources. Individuals with generally low levels of personal resources, or individuals who have suffered acute loss of resources due to a stressful event are less able to restore their own functioning by "coping."

As with the other parts of the model, when we make our theory completely explicit by embodying it in a set of formal statements, its limitations become very clear. Without doubt, far more complex, realistic, and interesting specifications of how individuals respond to perceived functioning discrepancies could be attempted. One must, however, start somewhere, and simple initial models are to be preferred because we can comprehend their behavior.

For the purposes of our baseline, we will conceptualize the reproduction of personal coping resources and the limits that these resources place on coping in a rather simple fashion. First, we define the level of personal resources and initialize the quantity:

```
L    PR.K = PR.J+(DT)(PRIR.JK-PRLR.JK)
N    PR = PRI
C    PRI = 100
```

Here, the level of personal resources (PR) is increased by a personal resources increase rate (PRIR), and decreased by a personal resources loss rate (PRLR).

Losses of personal resources occur as a consequence of stressful life events occurring for the focal individual:

```
R    PRLR.KL = MAX(PARM10*S2.K,0)
C    PARM10 = 1.0
```

That is, the resource loss in a period of time (PRLR) is equal to some proportion (PARM10) of the life stress that has occurred (S2.K) or zero, whichever is greater. While the parameter in question could be made a function of other variables, we will treat it as a constant in our baseline model.

The definition of the process that restores personal resources is slightly more complex:

```
R    PRIR.KL = PARM11*MIN(IRD.K,10)
A    IRD.K = MAX(PRI-PR.K,0)
C    PARM11 = 1.0
```

The second statement here calculates an individual resources discrepancy (IRD) that is equal to the difference between the initial level of resources and the current level, but restricted to be a positive number. The first statement then specifies that the personal resource increase rate (PRIR) is some percentage (PARM11) of the discrepancy, but cannot exceed 10 units per unit of time. This is a very simple model of the process of the renewal of personal resources, and further work could contribute to a far more realistic and subtle model. Since the renewal of personal resources is not our central concern here, we will live with the oversimplification.

We have now specified how individuals respond to perceived loss of functioning by mobilizing coping resources. The model that we have put forward is a familiar smart feedback system, but one in which response is limited by available resources—which, in turn, depend on the occurrence of stressful life events.

Social Network Compensatory Support

In addition to "preventing" untoward events and "buffering" the negative consequences for functioning that follow from them, individual's social networks are a source of resources that can be mobilized to restore a stressed person to normal levels of functioning. Our model supposes that the processes of compensatory social support operate very much like those of individual responses to stress. That is, actors in the network of which the individual is a part monitor the functioning of the focal individual, compare this performance to expectations, and mobilize resources in support of the focal individual when there is a perceived discrepancy between the expected and perceived functioning level of the individual. As in the case of individual coping responses, network support response is limited by available resources, and network resources may themselves be damaged by the occurrence of stressful events.

We can quickly develop this portion of the model as analogous to the individual coping process. First, the level of functioning (F) is monitored and filtered by some function (FUNCT2) into a level of functioning as perceived by the network (FAN):

```
A    FAN.K = FUNCT2*F.K
C    FUNCT2 = 1.0
```

We will, at least initially, assume that there is no delay, bias, or noise in network perceptions of individual functioning, and that these perceptions are independent of the levels of functioning and network resources. In practice, of course, we would presume that the speed and accuracy of the network's monitoring of the focal individual might very well depend upon the strength of the network and operate more slowly than individual's monitoring of their own functioning.

Once the network has perceived the functioning of the focal individual, the level is compared to the functioning goal held by the network for the focal individual (FGN), and discrepancies between the observed and goal state noted (FDISCN):

```
A    FGN.K = CLIP(100,FAN.K,100-FAN.K,0)
A    FDISCN.K = MAX(FGN.K-FAN.K,0)
```

As with individual's goals and perceived discrepancies, we have presumed that the network seeks to restore the individual to the baseline level of 100, or to the level in the previous period—whichever is higher. We also presume that discrepancies of functioning are perceived by the network as a simple linear difference between goals and perceived functioning.

The network's responses to functioning discrepancies are set equal to either a fixed proportion (PARM13) of the existing discrepancy (DSS) or to the same proportion of the maximum available network resources (SSRL). The latter, in turn, is a constant proportion (PARM13) of total network resources (NR):

```
A    DSS.K = FDISCN.K
A    SSRL.K = PARM12*NR.K
C    PARM12 = .02
A    SS.K = PARM13*CLIP(SSRL.K,DSS.K,DSS.K-SSRL.K,0)
C    PARM13 = .25
```

As in the individual's coping response process, we have supposed that response is delayed somewhat (PARM13), and that it is limited by available resources. In this case, we have limited the maximum possible response to be equal to 2% of network resources in any period of time (PARM12).

The network resources available at any point in time (NR) are a function of a self-renewal process (NRIR) that restores losses in network resources (NRLR) after the occurrence of stressful events:

```
L    NR.K = NR.J+(DT)(NRIR.JK-NRLR.JK)
N    NR = NRI
C    NRI = 100
```

Losses of network resources occur as a direct function of stressful events (S2):

```
R    NRLR.KL = PARM14*MAX(S2.K,0)
C    PARM14 = 1.0
```

Network resources are replenished in direct proportion to their discrepancy from their initial levels, but limited to a maximum renewal of 10 units per unit of time:

```
A    NRD.K = MAX(100-NR.K,0)
R    NRIR.KL = PARM15*MIN(NRD.K,10)
C    PARM15 = 1.0
```

Initially, at least, we will presume that the parameters, as well as the structure of the network social support system are identical to those of individual coping. The only difference between individual and network responsiveness in the baseline model then, is that the network is limited to 2% of its resources as an upper limit on response, while the individual may allocate up to 3%. Again, this is an unrealistic set of assumptions and suggests a place where further work is called for to clarify how the dynamics of social network support differ from those of individual coping.

With the connection of the group to the individual, we have now completed the translation of the theory into a baseline model. The complete DYNAMO program for this model is provided in the Appendix. As we have pointed out at a number of places in this process, we have made among the simplest possible assumptions about many of connections, and much more elaborate and realistic assumptions could be made. Before we begin to explore these possibilities, however, we need to understand the performance characteristics of our baseline.

Behavior of the Baseline Model

With a theory as complex as the one embodied in our baseline model, the dynamic properties of the system are not entirely obvious. It is quite important, therefore, to explore the behavior of the baseline model carefully before proceeding to experiments and elaborations. As we discussed in an earlier chapter, it is most important to grasp the equilibrium tendencies and bounds of the system, and to explore it's transient response to shocks as ways of getting a feel for its range of possible behaviors.

For our first experiment we will put the system in what we believe to be its equilibrium condition and see if (1) our notions about the equilibrium condition are correct and (2) whether the system remains at the initial levels in the absence of shocks. For our second experiment we will subject the system in equilibrium to a mild exogenous shock and see whether it returns to equilibrium, finds a new equilibrium, or becomes unstable. Both of these experiments are performed by simulation using the program as shown in the Appendix.

In this simulation, the system is set initially to a functioning level of 100, personal and network resource levels are set at 100, and personal and individual resource renewal rates (.035 and .025) are set at levels sufficient to cope with the level of chronic stress (which is set at 10 units per unit of time). These levels are likely to produce equilibrium behavior because all discrepancies between functioning and goals, and between resource levels and goals are zero. The level of chronic hazard in the environment (10) should be within the "carrying capacity" of the system at full resources, such that such hazards do not result in distress because of the operation of prevention and buffering. At the tenth time point, the system is subjected to a stressful life event of peak magnitude 100, so that the transient response characteristics of the system can be explored. An event of this magnitude, while noticeable, is not likely to exceed the equilibriating capacity of the system (if indeed it does equilibriate), and hence provides a test of the "normal" coping and social support response to acute distress.

The results of these baseline experiments are shown in three panels of Figure 11.3.

All of the trace lines remain stable for the first 10 time points, demonstrating (a) that when there are no discrepancies between functioning and resource levels and their goal states, no change occurs, (b) that the system in equilibrium tends to remain in equilibrium, and (c) that the "prevention" and "buffering" processes are filtering out environmental hazards so that no distress is occurring (see the last panel of the figure).

The transient response to stressful events is also what we might have anticipated. After the event, discrepancies are created between the perceived level of functioning and the goal state held for functioning by both the focal individual and the network (see the functioning curve in (11.3). These discrepancies are reduced exponentially (at 25% of the remaining discrepancy in each time period) by both individual compensatory coping responses and compensatory social support responses (second panel). Individual coping has a greater effect than social support because we had specified that individual coping was limited to 3% of the personal resource base while social support was limited to 2% of the

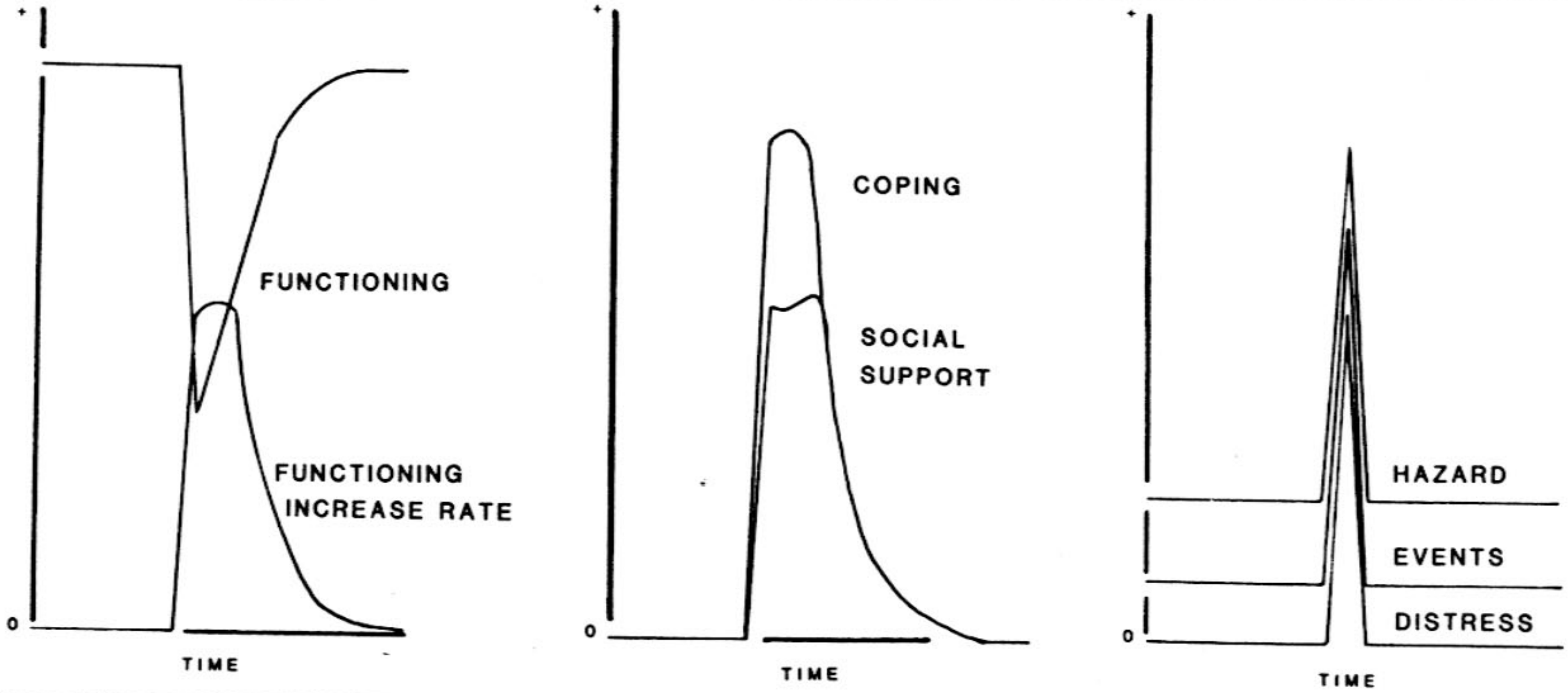

Figure 11.3: Stress, coping, and social support: baseline model.

network resource base. This results in a "ceiling" on network support response to the stressful event.

In a second set of experiments (not shown in detail here), the reaction of the system to differing initial conditions of personal resources, network resources, and functioning were explored. As we had specified in building the system, when resource or functioning levels are initially below the goal state, positive action occurs to restore them to the goal level. When the levels of any of the resource or functioning levels exceeds the goal state, no action one way or the other occurs. That is, functioning below the goal level results in return to the goal level; functioning above the goal level remains stable at its initial level. In the current model, however, chronic stress will gradually down resources or functioning that exceeds the goal levels of 100 units, since no coping occurs when functioning is already above the goal level.

An Experiment: Finding the Equilibrium Bounds

The baseline system succeeds in restoring functioning to its goal level in the face of minor and transient stressful events. But is the system capable of dealing with all levels and kinds of stress? That is, does it always attain equilibrium at "full functioning?" To explore this question, we conducted two additional experiments. In the first we progressively increased the magnitude of the acute stressful event until a level was found at which the system could no longer "cope" (obviously an experiment that one can perform with a simulation, but not with people). In the second experiment we subjected the system to a chronic new stress of substantial magnitude (10 units); that is, we changed the level of stress occurring in each time period from the background level of 10 to a new level of 20.

Acute Stress

As it turns out, it takes a quite severe acute event to drive the system beyond its equilibrium bounds (that is, to drive functioning to the level zero, where coping and social support cease, resulting in a "low level equilibrium trap"). In Table 11.1, we show the minimum resource levels and minimum functioning levels resulting from shocks of various peak magnitudes occurring at t = 10.

An acute event must have a peak magnitude of between 225 and 250 in intensity to reduce the functioning of the focal individual to zero and bring the restorative coping and social support processes to an end.[8]

TABLE 11.1
Baseline Model Responses to Acute Stress

Peak Magnitude of Shock	*Minimum Level of Functioning Reached*	*Minimum Level of Resources Reached*
10	98.6	94.6
20	96.2	93.5
40	91.2	89.7
60	86.0	84.4
80	80.5	79.2
100	75.0	74.0
150	57.4	68.4
200	31.9	47.8
225	14.9	41.3
250	0.0	34.8
300	0.0	21.7

Note that it is not necessary for personal resources or network resources to be reduced to zero for complete loss of functioning to occur in this scenario.

Increasingly serious events create increasingly longer recovery times as coping and network resources are destroyed by the events. In Figure 11.4, for example, some results are shown for a stressful life event of peak magnitude 225.

In the first panel the level of functioning is shown. Note that functioning continues to decline for a period of time after the stressful event. This is because so many personal and network resources have been destroyed by the event that coping and social support are not even sufficient to deal with the "chronic" stress of everyday events. Because, in our specification, both personal and network resources are self-generating at relatively high rates; however, resources sufficient for coping and support are eventually accumulated and functioning begins a long but exponential climb back toward the goal state.

Severe acute stress, then, not only can drive a system to a point where it is no longer able to restore equilibrium, but severe stresses also substantially reduce the rates at which recovery occurs.

Chronic Stress

While the system is quite capable of dealing with even very high levels of acute stress, it is far less able to recover functioning in the face of chronic or continuing stress. Indeed, if the level of chronic stress exceeds the "carrying capacity" of the system (which is a function of the rates at

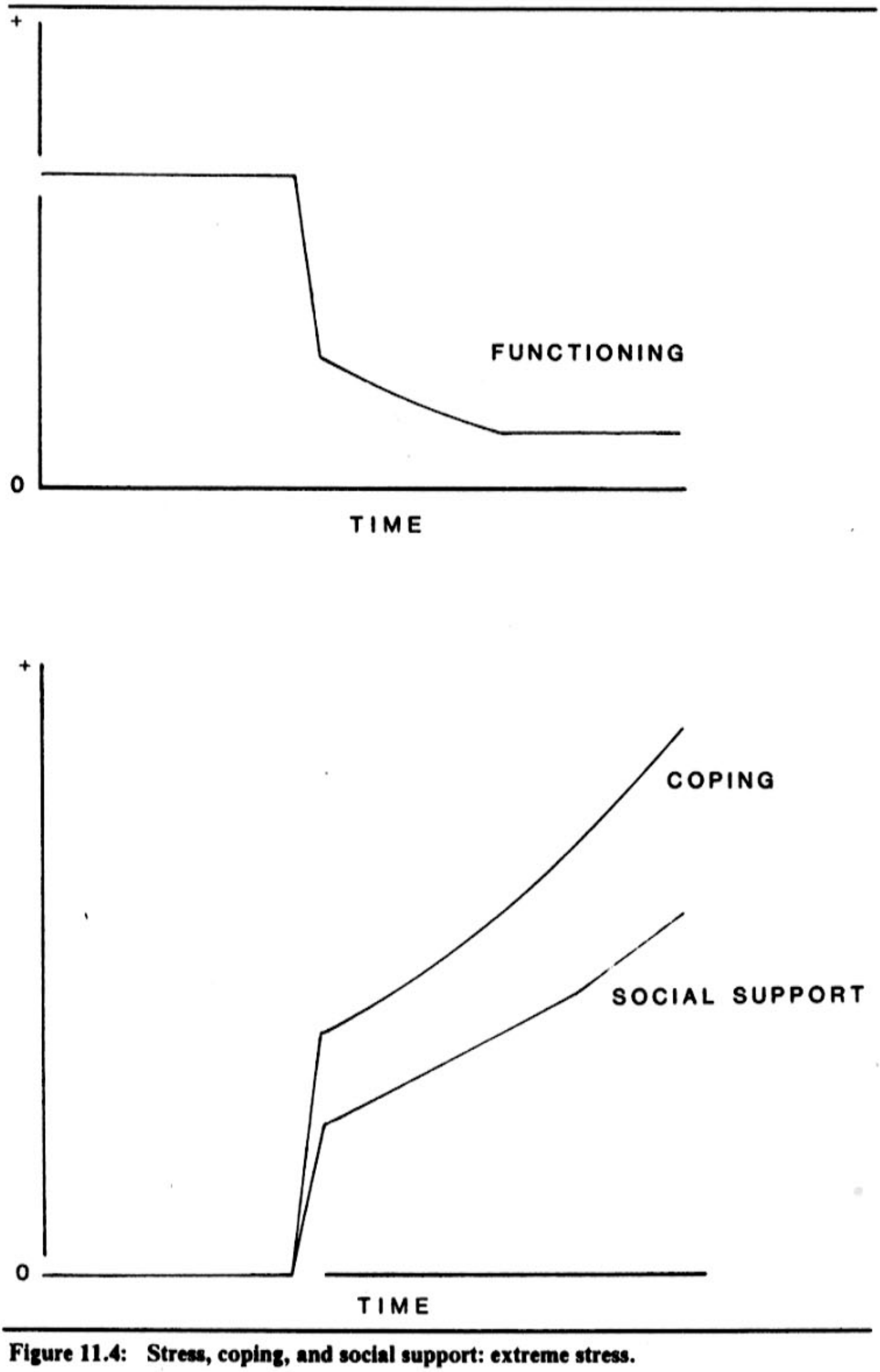

Figure 11.4: Stress, coping, and social support: extreme stress.

which personal and network resources are regenerated), a linear downward trend in functioning results until the individual ceases to function.

In one simple experiment, when the level of chronic stress was raised from 10 to 20 units per unit of time at time point 10, the level of functioning was driven to zero by time 20. Given the parameters of the baseline model, personal and network resources are capable of "refreshing" themselves at a rate sufficient to cope with chronic stress levels of between 10 and 15 units, but cannot recover when subjected to continuing shocks of greater magnitudes; network and personal resources continue to be destroyed at rates faster than they can be created, the capacity to cope or render social support is thereby reduced, and functioning declines until death occurs.

The baseline model with its highly simplified assumptions is capable of producing some interesting behavioral patterns. It appears to be an adequate representation of the general theory in that it produces equilibrium-seeking coping and social-support responses to stressful events. More than this, however, we have found (by intuitively guided "sensitivity" testing) that the system does have equilibrium bounds, and that the time shapes of its behavior are sensitive to resource levels, functioning levels, and the magnitude and time shape of shocks. Perhaps most important, the model produces behavior that is interesting in its complexity and appears to mimic some of our intuitions and observations about stress and coping.

Two Experiments: Resource Strength and Perception Delay

The baseline model is a useful starting point for theoretical analysis, but is clearly too simple in a number of important ways. While it is not our purpose in this chapter to explore these possibilities in any great detail, let's look into two of them with simple experiments.

In the stress and coping model the individual is protected by two sets of processes, one based on their own efforts at coping, the other on support from their social network. Thus far we have assumed that these two processes operate in very much the same ways, and hence act as alternative mechanisms for maintaining functioning. This assumed equivalence is probably quite unrealistic. In particular, the strengths of individual's personal and network resources are highly variable, and personal coping may be much more efficacious than social support because of more accurate and rapid perception and faster mobilization of resources. Let's briefly explore some of the implications of these differences between individual coping and network social support for the speed of individual's recovery from acute stress events.

Resource Strength

For a first experiment, we subject our focal individual to a stressful event of peak magnitude 100 at time point 5 and measure the level of functioning attained some time later (time point 20). In this experiment, as in our baseline model, individual coping is regarded as more efficacious than network support by allowing a higher proportion of available personal resources to be used for coping (3.5%) than network resources (2.5%). The question that we ask here is how well individuals recover if they are themselves weak or strong (implemented by varying personal resources from 50 to 100 to 150 units as starting values), and if they are members of resource-poor or resource-rich social networks (implemented by varying network resource starting values from 50 to 100 to 150 units). The results of these experiments are shown in Figure 11.5.

The results of this experiment are rather easy to anticipate with a bit of thought, but nonetheless rather important. Because the mobilization of personal resources can occur with greater intensity than that of network resources, the "main effect" of varying personal resources is greater than of varying network resources. Much more important to note, however, is the strong "interaction" effect of personal and network resources. Individuals who are both weak themselves and have poor network resources have a far more difficult time recovering from acute stresses than would be predicted simply on the basis of the sum of the effects of poor personal resources and poor network resources; that is, being simultaneously weak in both sets of resources increases risk of poor coping multiplicatively, not additively.

The implications of this experiment are twofold. First, and again quite obviously, since personal coping is more effective than network support in this model, better returns in functioning are achieved if personal rather than network resources are strengthened. Second, and less obviously, because of the interaction of personal and network resources, the returns in functioning to increased resources depend upon the existing distribution of resources. If, for example, personal and network resources are about equal, then the greatest returns in increased functioning come from increasing individual resources. If, however, either personal or individual resources are at extremely low levels, greater returns in overall functioning are attained by assuring at least

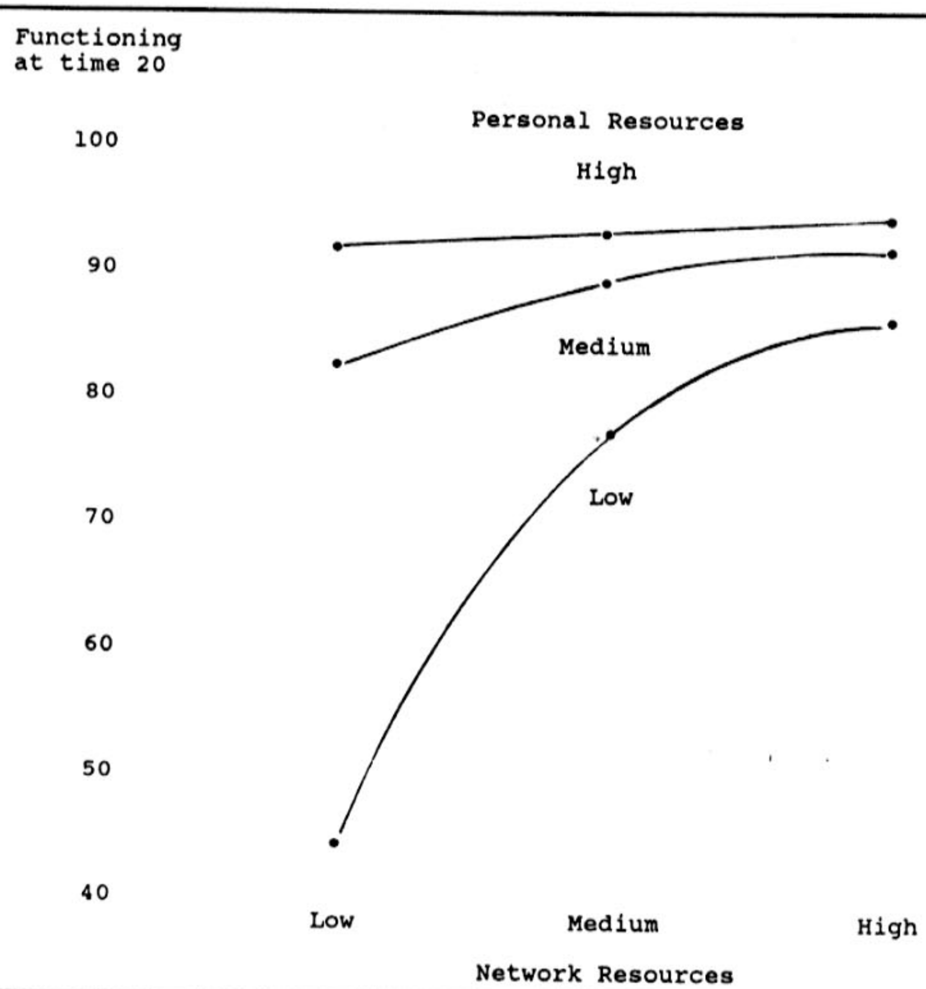

Figure 11.5: Personal and network resources effects on functioning recovery.

minimal levels of both personal and network resources. These unequal "marginal returns" to investment in personal or network resources are the natural consequence of the interaction of the two types of resources in maintaining functioning, and are similar (indeed, they are mathematically equivalent to) "production frontier" analysis in economic theory.

Perception Delay

Personal and social-network resources may also differ in their effects on individual functioning because of the speed with which these resources can be mobilized. While individual coping might be presumed to occur quite rapidly, network responses usually take longer. Networks may not monitor the functioning of an individual member very closely (perhaps varying by the centrality of the individual in the network), may take some time to "decide" that support is necessary, and may be slower in mobilizing and delivering resources.

To get some sense of the importance of these kinds of delays, we performed another experiment with our baseline model responding to a stress event of peak magnitude 100 at the fifth time point. In this experiment a third-order exponential delay was introduced in the network's perception of change in individual functioning, and the average length of the delay was varied from one to seven time periods.

As anticipated, network delay in perceiving that individual functioning had declined (and also delays in perceiving that it is improving as a result of individual coping) does slow network social support response and reduce the speed of the recovery from the stressful event. Somewhat surprisingly, however, functioning is quite insensitive to changes in network perception delays. With an average delay of one time period, functioning had returned to a level of 89.63 by the twentieth time period. With a much longer delay of average length of seven, functioning recovery was only very slightly reduced, attaining a value of 89.23 by the twentieth time period. Thus, while the effect is in the expected direction, and while network social support responses are fairly strongly affected, overall functioning is rather insensitive to network perception delay in this particular scenario. Of course, additional delays in processing information and responding would have further effects, but these are also unlikely to have much impact. And changes in other parameters of the baseline model could interact with network response times in such a way that greater sensitivity to delay might be apparent in alternative models. In the current model, however, we must conclude that the intensity, rather than the speed, of personal and network responses to crisis is far more important.

Directions for Further Elaboration

The simple experiments that we have conducted here give some sense of the variety of behavior that the baseline model can produce and also aid us in identifying areas where further elaboration of the theory might be productive. While the baseline specification is capable of producing a wide range of behaviors, many of which seem intuitively reasonable, it is obviously oversimplified. More realistic models could be suggested that are capable of an even wider range of responses. Among these possibilities are a number that call for some additional conceptualization and some that call for making the current model more complex and dynamic.

Our experiments suggest that the duration and time shape of stress events are critical to system performance, even more so than the simple "seriousness" or maximum stress intensity induced by the events. In particular, events with substantial duration appear to be far more detrimental than short episodes, even when the short episodes are extremely stressful. While this conclusion is dependent upon the particular specification of the personal and social network resource renewal processes specified in the baseline model, it does suggest a fruitful direction for further research. Most current work in this area has focused simply on event intensity—consistent with the cross-sectional and static biases of existing theory. If we are to be concerned with dynamics, however, the current results suggest that duration and time-shape may be far more consequential. This in turn suggests that stressful events need to be classified in terms of duration and time-shape, as well as intensity.

Our analysis suggests a second aspect of "stressful life events" that is quite consequential and hence is worthy of further research. In our experiments we have made very simple assumptions about the ways that events impact on personal and social network resources. We have assumed that events have equal impacts on personal and on social network resources, and that all stressful life events have substantial impacts on resource levels. These assumptions are quite consequential because they result in limitation of the resources available to an individual to cope or to a network to provide support during stressful events. Obviously, not all events have equal impacts on individual and on network resources. Some events are highly consequential because they reduce individual's resources and hence call for greater network support; other events may be highly consequential because they weaken the connection between individuals and their social networks. In understanding whether individual coping or social-network support is the more useful response to depressed functioning we must more carefully specify the nature of the precipitating event in terms of its consequences for personal or social network resources. Widowhood, for example, is usually a major blow to the personal support network, but may not necessarily reduce personal coping resources. Unemployment, in contrast, reduces income substantially, but may not have great effects on the strength of network ties.

We might also consider some changes at the level of modification in the basic structure of the model. In the baseline model we have assumed that individual and personal resources are "self-generating" and that stressful events destroy accumulated resources but not the capacity to produce resources. This assumption is questionable in terms of what we believe we know about responses to stress, and is extremely consequential for the behavior of the model. If stress events not only reduced the levels of personal/network resources, but also the capacity to produce new resources, the tendency of the system to seek equilibrium at its initial level could well be lost. In fact, we believe intuitively that some stressful events not only are costly in terms of personal and network support resources, but also reduce the capacity of the individual and the network to generate resources—as in permanent physical disability or the death of a spouse. Again, events differ qualitatively as well as quantitatively in these effects, and these differences deserve more research because of the fundamentally different dynamic behavior of systems that have self-regenerating resources and those that do not. In many regards, we suspect that the baseline model is far too "optimistic" in its specification, and more realistic models would suggest poorer coping and more enduring disability as more realistic outcomes of many types of events.

At a number of points in the baseline model we have made simplifying assumptions that certain parameters are constants. Most notably we assumed that the capacity of personal and network resources to renew themselves were constant; the speed and accuracy of monitoring of functioning was regarded as constant; the goals of individuals and their networks for levels of functioning were regarded as constants; and the speed and intensity of responses to perceived functioning discrepancies were fixed. None of these specifications is necessary, and all are somewhat suspect. One major direction for further elaboration of the baseline would be to make each of these constants a dynamic rather than a fixed quantity. Changes of these types are also highly consequential in that they create new "loops" that are not present in the baseline model; because they have this fundamental character, their consequences for the behavioral tendencies of the model are not directly deducible—and might differ substantially from the baseline.

Suppose, for example, that the capacity of personal and social networks to generate resources changed with the level of resources accumulated. If richer individuals or networks were able to renew a larger proportion of their resources in a period of time than resource-poor persons or networks, then the discrepancies between "rich" and "poor" present in the baseline would be exacerbated. At the lower end, it would take far longer for badly stressed individuals to recover from extreme events than the current model suggests.

One might also suppose that the accuracy and speed of functioning monitoring was dynamic rather than static. It might reasonably be hypothesized, for example, that members of resource-poor networks must devote more effort to maintaining their own functioning and thus are slower to perceive functioning changes than individuals in rich networks. The delay time in network perception of individual functioning, then, might increase as the resource level of the network decreases. In a parallel fashion one might suppose that the proportion of resources that an individual could mobilize for coping or that a social network could spare for rendering support varied positively with the level of personal or network resources. Both of these more dynamic possibilities would seem to suggest further discrepancies in the recovery times of "rich" and "poor" individuals.

One last possibility for greater dynamic flexibility is to allow "goals" to vary as a function of other variables—causing the system to be always "chasing" a changing equilibrium point. For example, we have supposed that individuals seek to rise no higher in functioning than their initial condition. We might suppose that individuals seek growth rather than stability; that richer individuals have higher goals than poorer people; or, perhaps, that individuals "adjust" their goals to accept, at least temporarily, lower levels of functioning in the face of stress. This last possibility represents yet another form of coping, in that goals are softened (and hence discrepancies between goals and functioning lessened) in response to stressful events.

There are two rather different directions suggested here, and let's pause for just a moment to be sure that the distinction is clear. On one hand, the baseline model can be much more fully explored by varying the kinds of stimuli to which it is subjected, and by varying the parameters governing its response to these stimuli. We have only scratched the surface of the possible areas of "sensitivity" analysis that could be conducted with the baseline. On the other hand, we have also proposed the possibility of some more fundamental changes in the structure of the model itself—that is, in the nature of the connectivities among quantities. In particular, the model could be made far more "dynamic" than it currently is by changing constant parameters into effects that vary as a consequence of system levels. Changes of this latter type make the system more "complex" in that the connectivity of the system is increased and the number of "constants" reduced and "variables" increased. While the system that we have designed here is quite "smart" relative to existing theories of stress and coping, it could—and probably should—be made still more self-referencing and smarter.

Conclusions

In this chapter we have developed and partially explored a model of a relatively complex and "smart" social system. The model is similar to the earlier "arms race" model in that it involves the dynamic interaction between a focal actor and an environment. In the current case, however, the connections between the actor and the environment are much more complicated and contingent than in the earlier model, reflecting higher degrees of awareness and interaction, rather than reaction, on the part of the actors.

The model that we have developed in this chapter is intended to mimic the behavior of individuals coping with the distress induced by exogeneous life events, and the role played by individual's social networks in this process. This particular substantive problem, of course, is of limited interest—though we all suffer stress and attempt to cope. The stress-coping-support model, however, is far more general when considered as an abstract "system." In this model we have two actors, each facing internal constraints (resource limitations), interacting on the basis of their own goals (desired levels of functioning), in ways that cause each to continuously monitor the interaction and adjust their behavior as a result of the actions of the other and their own past actions. While the details would differ very greatly, one can readily imagine using the current model as a template for developing theoretical analyses of such smart interaction between government officials and the mass public; between profit seeking firms interacting across markets; or between kin or ethnic groups. Social action and interaction, considered as dynamic systems, have a great deal in common across substantive areas. And the basic models that we develop to analyze dynamics in one area can often be usefully applied as starting points in other areas.

As we have developed it in the current chapter, the model of stress-coping-support dynamics has been kept deliberately "simple." That is, while it is much more complex than existing statistical or mathematical models of such dynamics, it is still far from representing the full richness of qualitative accounts of such interactions. There is no technical barrier to extending the model to attempt to capture more of the texture of real events. We have proposed only two actors in the system, but there is no reason why we could not have many separate actors. Indeed, rather than an abstract "network," we could model the specific sectors of the network (e.g., family, coworkers, social service personnel, etc.) or even the individual actors in the network. We have not distinguished among types of events or types of resources, coping, and support. Again, there is no technical reason why one should not separately model the dynamics of, for example, chronic versus acute stress events or distinguish between the dynamics of material and emotional resources. As we discussed in the previous section, there is no necessary technical reason that so many parts of the system be governed by "constants," and the behavior of the model could be made far more complex and dynamic than we have.

The reasons that we have not pursued these possibilities further are quite straight forward. First, of course, there is a limit to how much our reader can tolerate. While the current model is very general and interesting in the abstract, more detailed applications to stress and coping are better left to a specialized work. Second, and more important, the current model is complex enough to suggest the wide range of applicability and the quite striking behavioral possibilities of even quite simple "smart" models. And third, with increased complexity comes decreasing analyzability. The current model, for all its simplifying assumptions and caveats, is still complicated enough to generate some unexpected results and new insights. While we have continuously urged that theorists construct more complicated (as well as more systematic) models, there are very real limits of how much complexity of theory is useful. If one cannot even approximately understand the implications of one's own theory, it is too complicated. The current model has that possibility if pushed too much further.

Notes

1. For a survey of recent advances and applications in game theory applications in the social sciences, see Shubik, (1984a) and (1984b).

2. There is a large literature on assessing the magnitudes of stressful life events. A good introduction to the literature on the measurement of event magnitude and the consequences of events for physical and mental health can be found in Brown and Philliber (1981), Holmes and Masuda (1974), Holmes and Rahe (1967), and Rabkin and Struening (1976).

3. The leading examples of efforts to apply statistical models to over-time data in the study of change in functioning are Thoits (1982) and Cronkite and Moos (1984).

4. Some exemplary empirical studies connecting the strength of networks with stress buffering include Dean and Lin (1977), Gore (1985), LaRocco et al. (1980), and Pearlin and Schooler (1978).

5. For reviews of the numerous competing and partially overlapping models of the relationships among stress, coping, and social support, see House (1981), Thoits (1982), and Wheaton (1985). In this chapter we follow the terminology and development of House (1981).

6. Individuals, of course, may display considerable variability in their ability to buffer stress by cognitive mechanisms. One major thrust of programs for the treatment of stress disorders involves the application of cognitive therapy. See, for example, Taylor (1983).

7. Though we have not done so in the current model, a CLIP or SWITCH could be added in the current model to stop all further change in either functioning increase or loss when the current level of functioning was driven to zero.

8. This result depends on the fineness of the integration. For the results in this chapter, each time unit was divided into four parts for the purpose of integrating rates of change (i.e., DT = .25).

APPENDIX 11.1. Stress, Coping, and Social Support Model

```
*            STRESS, COPING, AND SOCIAL SUPPORT MODEL
NOTE
NOTE                        FUNCTIONING
NOTE
L            F.K = MAX(F.J+(DT)(FIR.JK-FLR.JK),0)
N            F = FI
C            FI = 100
NOTE
R            FLR.KL = MAX((PARM1*DIS.K),0)
C            PARM1 = 1.0
NOTE
R            FIR.KL = MAX((PARM2*C.K)+(PARM3*SS.K),0)
C            PARM2 = 1.0
C            PARM3 = 1.0
NOTE
NOTE                        STRESS AND DISTRESS
NOTE
A            S1.K = EXOG.K
A            EXOG.K = 10.0+PULSE(MAG,5,30)
C            MAG = 100
NOTE
A            S2.K = MAX(S1.K-PARM4*NR.K-PARM5*PR.K,0)
C            PARM4 = .025
C            PARM5 = .035
NOTE
A            DIS.K = MAX(S2.K-PARM6*NR.K-PARM7*PR.K,0)
C            PARM6 = .025
C            PARM7 = .035
NOTE
NOTE                        COPING
NOTE
A            FAI.K = FUNCT*F.K
C            FUNCT = 1.0
NOTE
A            FGI.K = CLIP(100,FAI.K,100-FAI.K,0)
A            FDISCI.K = MAX(FGI.K-FAI.K,0)
NOTE
A            C.K = PARM8*CLIP(CRL.K,DC.K,DC.K-CRL.K,0)
C            PARM8 = .25
A            DC.K = FDISCI.K
A            CRL.K = MAX(PARM9*PR.K,0)
C            PARM9 = .03
NOTE
L            PR.K = PR.J+(DT)(PRIR.JK-PRLR.JK)
N            PR = PRI
C            PRI = 100
NOTE
```

```
R        PRLR.KL = MAX(PARM10*S2.K,0)
C        PARM10 = 1.0
NOTE
R        PRIR.KL = PARM11*MIN(IRD.K,10)
A        IRD.K = MAX(100-PR.K,0)
C        PARM11 = 1.0
NOTE
NOTE                 NETWORK SUPPORT
NOTE
A        FAN.K = FUNCT2*F.K
C        FUNCT2 = 1.0
NOTE
A        FGN.K = CLIP(100,FAN.K,100-FAN.K,0)
A        FDISCN.K = MAX(FGN.K-FAN.K,0)
NOTE
A        DSS.K = FDISCN.K
A        SSRL.K = PARM12*NR.K
C        PARM12 = .02
A        SS.K = PARM13*CLIP(SSRL.K,DSS.K,DSS.K-SSRL.K,0)
C        PARM13 = .25
NOTE
L        NR.K = NR.J+(DT)(NRIR.J-NRLR.JK)
N        NR = NRI
C        NRI = 100
NOTE
R        NRLR.KL = PARM14*MAX(S2.K,0)
C        PARM14 = 1.0
NOTE
A        NRD.K = MAX(100-NR.K,0)
R        NRIR.KL = PARM15*MIN(NRD.K,10)
C        PARM15 = 1.0
NOTE
NOTE                 OUTPUT SPECIFICATION
NOTE
SPEC       DT = .25/ LENGTH = 25/PRTPER = 1/PLTPER = 1
PRINT      F,PR,NR
PLOT       F = */FIR = +/FLR =.
PLOT       C = */SS = +
RUN
```