CRISIS MODELING OF THE CRIMINAL JUSTICE SYSTEM

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ABSTRACT

This paper applies a crisis triggered procedure to the analysis of the criminal justice system of the United States; in particular it reports the development of a "crisis triggered" computer simulation model of the criminal justice system. The model is then used to identify potential major crises that have occurred or are expected to occur in the criminal justice system, to simulate them, and to study alternative regimes or patterns of recovery that the system may undergo.

INTRODUCTION

The most evident feature of the criminal justice system (CJS, from hereon), and probably the root of much of its deficiencies, is its disjointedness. The system has clearly suffered from the lack of a master plan. The individual identities and roles of the criminal justice subsystems, and their interfaces, have been allowed to emerge piecemeal over time. It is no surprise then that this system is constantly in crisis. To study crises in corporate systems one virtually has to construct crisis models and trigger these crises to discover both the forces that create them and the consequences that they precipitate. In the CJS one has the "luxury" of being able to learn much about crises even without the benefit of analytical models. Three major crises are constantly visiting the system: the number of crimes far exceed law enforcement capacities, the number of cases far outstrip the availability of judges, and the number of prisoners far exceed nominal jail capacities.

The actual dimensions of such crises are staggering. In the 14-year period from 1965 to 1979 the population of the United States rose approximately 15 percent but the population of Federal and State prisons increased 43 percent (from 210,815 to 301,017) /1/ and incidence of reported crimes increased 105 percent (from 5.9 million to 12.15 million) /2/.

The CJS cannot be accused of total negligence in its fight against crime. There has been an attempt to keep up with its rising trend, albeit a losing battle. In the 8-year period alone from 1970 to 1978 total personnel increased by 52.8% (to 1.15 million); total expenditures (in nominal dollars) rose by 181% (to $24.09 billion) and rising rapidly /3/.

These observations do not, however, negate the usefulness of criminal justice system models particularly in the study of the crises that beset it. In the first place the model is needed to enact the processes that lead to a crisis. In the second place the model is needed to point out those parameters of the system which may be adjusted to enhance the state of some system variable or the system itself. In the third place the model is needed to demonstrate the dynamic behavior of the system in response to parametric adjustments; to show, for instance, how minimizing the probability of one crisis simply increases the probability of another crisis. And, finally, the

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evolutionary patterns of behavior of alternate 'regimes' can only be discovered through experimentation with new versions of the "old" criminal justice model.

Its piecemeal formation notwithstanding, the criminal justice system is a tightly interfaced one. One does not even need a model to appreciate this fact. A rise in arrest rate or conviction rate has an almost immediate impact on jail overcrowding. The model to be presented here vividly depicts this.

METHODOLOGY

The methodology used here and referred to as 'crisis triggered modeling' has been developed and presented in /4/. This methodology requires some reform in management's attitude towards crises: rather than treat crises as events to be avoided or 'designed away' they must be treated both as opportunities for change and, more importantly, as the bases for change. With the aid of a dynamic structural simulation model, the set of potential organizational crises is developed; each is then artificially "triggered" via the model. After numerous test runs alternative paths of recovery are then formulated.

To be more specific, the crisis modeling procedure consists of the following steps: (1) construction of a crisis-triggered simulation model of the organizational system by a modeling expert perhaps with the aid of a panel of other experts, (2) setting by the panel of the threshold levels or critical values of vital organizational variables, e.g., market share, pollution level, and population density, (3) experimental simulation runs to study the behavior of the system under alternative crisis situations to provide pertinent information for the panel, (4) generation of alternative 'regimes' or new evolutionay patterns of the system with the panel's aid, and (5) evaluation or analysis of each 'regime' by the experts. The individuals involved in this procedure are: an executive in-charge of the system, a modeling expert, and a panel of key representatives of interest groups in the criminal justice system.

The Basic Crisis Simulation Model

We have attempted to show in /4/ that even the most prominent dynamic structural simulation methodologies availabe to date, namely system dynamics /5/ and econometrics /6/ are, as such, ill-suited to the task of modeling such discontinuous processes as crises. We propose a change in the way they are used that will make the dynamic structural model suitable for crisis modeling.

The basic mathematical relationship used by dynamic structural models is the differential equation. It is well-known that a critical requirement of differential calculus is that surfaces and graphs be continuous. When the model system experiences a "disruption", i.e., a discontiuity, the only way the modeler can represent this is by abruptly switching to a different set of input parameters or, worse, a different set of variables and relationships.

We have also shown in /4/ that most continuous models do run themselves down into a collapse mode. We now introduce some of the terminology to be used below:

Let us assume that a system is described by its state variables, denoted by f(i,t) where f is some process and i denotes a system variable, e.g., jail population. i ranges from 1 to some number N. t is the time, which in the case of numerical simulations from year to year, is an integer ranging from 1 to some value, e.g., 10 or 100 years, depending on the time scale of the problem being considered.

As this theory assumes the availability of computers we will use difference equations.

In general, therefore, we write

$$f(i,t)=f(i,t-1)+\sum_{j=1,k=1}^{M,N} g(j,f(k,t-1)) \qquad \text{Eq. 1}$$

where $g(j,f(k,t-1))$ are expressions describing the changes applied to $f(i,t-1)$ to find this new value at time t. M is the number of contributions to changes in i.

Obviously, the functional forms of $g(j)$ determine the time evolution of the system. The evolution of the system depends on the initial variables $f(i,0)$, as well as the form of $g(j)$ used. Once the difference equation is formulated, $g(j)$ determines the type of system that evolves. Nearly all numerical simulations published are of this type.

It is our contention here that collapse modes are not surprising at all and may not be all that disastrous given the possibility of intelligent control, if not, superior mutants of the collapsed system. In fact, it would be more surprising to discover, accidental as it may be, steady-state solutions.

Existing dynamic numerical simulations almost always lead to catastrophic results /5,6,7,8,9/. When such situations are reached in modeling, simulations are generally stopped, the crystal-ball nature of numerical simulations take root, and modelers assume the role of Cassandras. It is doubtful that modelers could ever avoid the image of Cassandras, or for that matter, even optimistic futurologists, depending on their philosophical orientation. For, such is the nature of the equations used that the modeler would have to be incredibly lucky to find steady-state solutions. It would mean improbably lucky choices of the initial conditions or an improbably fortunate set of g's.

We have attempted to show that our approach can be readily utilized in modeling discontinuities and, more importantly, in aiding government to exploit the dynamics of crises more effectively.

Even if one accepts the virtual inevitability of crisis one is still faced with the problem of having to determine, not to mention dealing with, which crisis. Dynamic structural simulation models like those of system dynamics can be used to generate the set of crises to which a particular socioeconomic system may be susceptible. These crises can be induced and, consequently, studied as follows:

Three new concepts are used. The first one is: the critical index $I(i)$, which when reached by a system variable, triggers a crisis leading to a radical change of $g(j)$'s.

The second concept is the set of potential regimes or 'recovery modes' of the system: various sets of $g(j,c)$ are generated where c refers to different regimes with c=1 to some small integral value m. For example, c=2 may be used to represent a moderately predictable future-oriented system and c=3, a less predictable highly future-oriented system. This is discussed in greater detail in /4/.

Third, is the tacit admission of the existence of regimes, not as natural cycles as determined by one set of $g(j)$, but of different cycles, whose g's are invented by experts. The regimes are certainly not periodicities, such as the sunspot cycles, or even economic cycles, but regimes arising out of the inability of systems to take themselves out of catastrophic evolution.

To formulate these concepts in mathematical terms, we define:

$$I(i,L) = f(i)/f(i,min) \qquad \text{Eq. 2}$$

$$I(i,H) = f(i)/f(i,max) \qquad \text{Eq. 3}$$

where $f(i,min)$ and $f(i,max)$ are pre-set values. It is tacitly assumed that the variables could easily assume these values if they are allowed to evolve according to the set of g's used. It is required that $I(i,L) > 1$ and $I(i,H) < 1$. When either of these two inequalities are violated, the system, encountering a discontinuity, is terminated and a new set of g's are activated. The model is again allowed to evolve using this new set of equations, until one of the state variables stikes a critical value and a new set of g's takes over.

In reality, governments are helpless in radically changing the equations of motion abruptly. The functional relationships described by g are not that easily changed. But our modeling approach does not stress such a drastic, discontinuous measure. Instead, we emphasize that long before the attainment of critical indices are reached, the modeler will have come up with altered equations of motion representing a new 'life' or evolutionary pattern for the system. It is in this sense that we call our model a crisis triggered simulation – the crisis may or may not in fact take place in the real world, but the possibility of the crisis is established by the model. In addition we are given insight into the possible choices we have concerning the system's future.

Our proposed procedure will be illustrated in the ensuing section beginning with construction of a crisis triggered model of the criminal justice system.

Outline of the Criminal Justice Model

There are four major subsystems of the criminal justice system (CJS, from hereon): the societal subsystem which includes families, schools, peer groups, the economy, the churches, etc.; the law enforcement subsystem which includes police agencies, the FBI, etc.; the judicial subsystem; and the penal-rehabilitative subsystem which includes not only jails, rehabilitation agencies, but also parole officers and parolees. In this initial attempt at modeling the CJS we aim to build a grossly aggregated model, which we expect to grow in detail and features as it matures over a period of time. We focus, for now, on the following variables: (known) crime rate, arrest rate, "charge" rate (the rate at which those arrested are formally charged in court), conviction rate, average sentences, average time served before being paroled or released after sentence completion, and the jail population. The U.S. population (in year t), P(t), is an exogenous variable of the system.

$$P(t)=P(t-1)+G(t)*DELTA \qquad \text{Eq. 4}$$

where G(t) = 1.0105 and DELTA = one year, our summation (integration) unit.

The central variable of our model is 'Jail population', represented as JP.

In difference equation form:

$$JP(t)=JP(t-1)+(NJ(t)-NO(t))*D \qquad \text{Eq. 5}$$

where NJ(t) is the number of persons jailed during the year t, NO(t), the number released after completion of service of sentence and D is DELTA. JP(0) = 200,000.

The crime rate, N(t), from 1965 to 1979 has been found to remain at a relatively stable proportion of the US population level. The recidivism rate, V(t), is added to allow us to test the relative effect of recidivism on the crime rate. (The data used below are extracted from /1/ and /10/.)

$$N(t)=P(t)*M1*C1+V(t) \qquad \text{Eq. 6}$$

$$V(t)=NO(t)*M7*C6 \qquad \text{Eq. 7}$$

where M1 is the per person rate of known crime, is initially equal to 0.0297 (Table 302 in /1/) and grows at an annual rate of .051 (the crime rate is seen to be growing at an exponential rate), C1 is a policy variable allowing the modeler to conduct tests on the effect of varying M1 rates on N(t), M7 is is per released convict rate of recidivism and is guestimated at 0.056 from Table 6.40 on p. 519 of /10/, and C6 is the policy variable allowing for tests on N(t) of varying M7 rates. We have tentatively assumed the ratio of one criminal per incidence of crime. The data in Table 333, p. 196 in /1/ seem to reflect this. It can also be argued that the fact that several suspects may be involved in one incidence of crime is counterbalanced by the fact that the same suspect may be involved in several crimes.

The rate of arrests (excluding false and wrong arrests), NA(t), is defined simply as a ratio of the known crime rate. Our estimate of this ratio, called M2, is a weighted average between violent and major property crimes and is equal to 0.1974 arrests per known crime (Table 319, p. 189 in /2/). This is a fairly constant ratio over the 1965-1979 period at least.

$$NA(t)=N(t)*M2*C2 \qquad \text{Eq. 8}$$

where C2 is a policy variable allowing

tests on varying rates of M2.

The 'charge rate', NC(t), is the rate at which persons arrested are charged and brought to court. This is measured on a per person arrested basis. It is also found to be a relatively fixed ratio, M3, of the rate of persons arrested. M3 is equal, on the average, to 0.9028 (Table 319 in /1/).

$$NC(t)=NA(t)*M3*C7 \quad \text{Eq. 9}$$

where C7 is another policy variable used to vary the per person 'charge rate'.

The 'jail rate', NJ(t), is the number of persons convicted and jailed per year. This is a relatively constant ratio of the 'charge rate'. This ratio is called, M4, and is, on the average, equal to 0.3078. C3 is the policy variable used here.

$$NJ(t)=NC(t)*M4*C3 \quad \text{Eq. 10}$$

The release rate, NO(t), combines persons released on parole and persons released after completion of jail sentence. As we are presently building an aggregate model of the system we take the average sentence of persons paroled, 5.7 years, and the average sentence of persons released after sentence completion, 1.8 years, and combine them into a weighted average of 2.97. (Many more prisoners are released on parole.) The parameter, M6, is used to represent the average sentence imposed by the court subsystem. Of the sentence given only a portion is actually served in prison by the convict. Average service to parole is 0.38 of the imposed sentence while average service to release is 0.68. The weighted average comes out to 0.59. This average service rate is represented by W6. The policy variable is called C5.

$$NO(t)=JP(t-1)/(M6*W6*C5) \quad \text{Eq. 11}$$

The US population, the known crimes per year , and the jail population levels for the standard model run are presented in Appendix A.

RESULTS AND FINDINGS

We have been able to verify that the model replicates the known crime rate. We have been unable to verify model replication of the arrest rate, the charge rate, the conviction rate, the jail rate, and the release rate because of the inadequacy or inaccuracy of data. The published arrest rate, for instance, is largely inflated by false and wrong arrests. The model does not replicate the jail populations from 1966 to 1979. The model in fact shows exponential growth. We suspect the accuracy or relevance of available data. More seriously though, we suspect that the severe constraints imposed by jail capacities have resulted both in release rates being pushed up artificially and detention rates (presently not modeled due to unavailability of useful data) being pushed down artificially. In order that the jail populations can be replicated for the 1966-1979 period the release rates have to be pushed up by at least 70%. It is known in fact that jail populations exceed jail capacities in most prisons. To minimize the probability of exaggerating the critical state of the system we disregard the nominal jail capacities and use the jail populations as estimates of real capacities. We found that the total Federal and State prison capacity has grown by an average of 6,786 convicts per year over the 14-year period in question.

In the standard model run alone we have discovered major inconsistencies in the published crime statistics. We speculate that the CJS has been implicitly utilizing this 'regime' technique that we have proposed as part of our crisis modeling procedure. In order to moderate the impression given of crises at least in the penal subsystem the CJS 'managers' have somehow been switching to one or more alternative regimes: shortening service times and lower 'charge rates'. Both are easily camouflaged. Judges may continue to hand out stiff (or stiffer) sentences and make the courts look good on paper. They can, however, arbitrarily shorten serve times without much notice mainly through the parole option. Likewise, law enforcement agencies can (and have) increase(d) their rates of arrest and look impressive in the Statistical Abstracts. Our crude model suggests that legitimate arrests are running below 25% of the number of reported arrests.

Crisis Triggering

The three crises enumerated above—number of crimes exceeding law enforcement agencies' capacities, number of court cases exceeding judicial capacities, and number of prisoners exceeding jail capacities— all violate the Eq. 3 requirement. We have the gravest situation where all three crises are currently occurring. This fact presently obviates the need to crisis trigger the model. It would be pointless to test the effects of such alternative policies as (1) improving the arrest rate, (2) increasing the case disposition rate of the judicial subsystem, and (3) increasing jail capacities. Queueing Theory, for instance, states that we have no decision problem when the arrival rate of units (criminals or prisoners) exceeds the service rate (arrest rate, disposition rate, and jail rate) of the respective subsystems.

PRELIMINARY CONCLUSIONS

It is difficult at this stage to make more refined remarks and draw more refined conclusions from our highly-aggregated model. In order to develop more sophisticated results we have to move in one or more of the following alternate directions: (1) disaggregation – separating violent from major property crimes, separating juvenile offenders from adult offenders, separating the Federal from the State and Local subsystems, etc.; (2) enlarging the scope – to include the economy, the rehabilitative subsystem, the community (family, school, neighborhood, and peer groups), the government, etc.; and (3) increasing model detail in terms of subsystem interfaces, i.e., increasing the number of interrelationships in the model.

Although we can only obtain more conclusive results from a more developed model we feel that the only promising route for the CJS to take is to expend more of its energy in its rehabilitative effort and to urge, or better, work with, other governmental agencies to mount a major effort towards the lowering of the crime rate itself. We suspect that strategies to 'manage' the crime rate through its economic, psychological, and sociological determinants provide the only hope to put a significant dent on the runaway crime rate of the United States.

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APPENDIX A

YEAR	POPULATION
1967	1.98664E+08
1968	2.0075E+08
1969	2.02858E+08
1970	2.04988E+08
1971	2.07141E+08
1972	2.09315E+08
1973	2.11513E+08
1974	2.13734E+08
1975	2.15978E+08
1976	2.18246E+08
1977	2.20538E+08
1978	2.22853E+08
1979	2.25193E+08
1980	2.27558E+08

YEAR	NO. COMMITTING CRIMES (KNOWN)
1967	5.90033E+06
1968	6.27275E+06
1969	6.66818E+06
1970	7.08456E+06
1971	7.52523E+06
1972	7.99257E+06
1973	8.48862E+06
1974	9.01531E+06
1975	9.57462E+06
1976	1.01686E+07
1977	1.07994E+07
1978	1.14694E+07
1979	1.21809E+07
1980	1.29365E+07

YEAR	JAIL POPULATION
1967	409520
1968	519900
1969	588980
1970	641477
1971	688188
1972	733877
1973	780703
1974	829697
1975	881412
1976	936196
1977	994319
1978	1.05602E+06
1979	1.12154E+06
1980	1.19112E+06

YEAR	ACTUAL JAIL POPULATIONS
1970	196,000
1975	241,000
1976	263,000
1977	285,000
1978	294,000
1979	301,000