CRIMINAL JUSTICE DYNAMICS: A PLANNING MODEL

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ABSTRACT

The use of quantitative methods in criminal justice planning is growing rapidly. This study employs the modeling technique of "system dynamics" to simulate a local criminal justice system and demonstrates the usefulness of that technique in assessing the merits of alternative criminal justice policies and procedures. In formulating the model, we discuss the information feedback characteristics of the system as well as the qualitative aspects of crime control in light of popular theory and the supporting data. A set of control variables are identified as well as a set of system performance measures that can be used in the planning process. Preliminary results indicate that the criminal justice system is well insulated from small perturbations or changes in input, and that a continuation of current practices will lead to a gradual decline in both its ability to deliver services and to control crime.

INTRODUCTION

The criminal justice system (CJS) is the apparatus which society uses to enforce the standards of conduct necessary to protect individuals and the community. The system strives to achieve this goal of crime control by three methods: deterrence, incapacitation, and rehabilitation. It works by apprehending, prosecuting, convicting, and sentencing those members of the community who violate the statuatory rules of group existence. Each sector of the CJS, through its constituent agencies and departments, moves toward this goal, and toward the goal of improved efficiency, with honest determination but often in a manner that overlooks the effects that specifically targeted programs have on the other sectors of the system. This lack of perspective, arising from decentralized authority and an overriding concern for efficiency within a particular department, points to the need for a system-wide approach to planning and administration. Beginning with this premise, we have examined the dynamics of the institutions, resources, and operating policies of a municipal CJS. The first phase of this work, the development of a dynamic model, used a narrative description of the CJS to derive a quantitative representation of its major state and flow rate variables. Preliminary work with the model has demonstrated its potential for evaluating the effects of alternative crime control strategies on CJS performance.

In the next section we discuss the historical growth of criminal justice modeling. This is followed by model development and a quantitative description of the CJS. Finally, we give some preliminary results for the base case and then demonstrate how the model might be used by developing five-year projections for a speedy trial policy and contrasting them with the base case results. Future applications of this model will establish the impact of specific operating policies on system behavior.

BACKGROUND

Over the last decade, the use of quantitative methods in criminal justice planning has grown from a variety of isolated activities into an organized body of accepted practices and procedures. The need for deliberate calculation in decision-making has come to be recognized as an equal to the need for sound judgment and intuition. The Space-General Corporation's cost/effectiveness study (1) of the California criminal justice system marked the first attempt to apply the techniques of system engineering to the problem of crime and delinquency. Two major contributions emerged. The first was the introduction of the concept of "criminal career cost"--the total system cost for processing an average offender over his entire lifetime; the second was the development of an analog computer simulation model for conducting the operational analysis.

The President's Commission on Law Enforcement and Administration of Justice (2) continued this application of systems engineering by sponsoring a systems analysis of the national CJS. This effort built directly on the Space-General model and provided a refined method for future analyses by formalizing much of the working vocabulary and structural framework. The model treated the system as a single production process and featured the probability of rearrest as a decreasing function of age as well as a crime-switch matrix containing the crime-type transition probabilities for successive arrests. The results, further developed by Blumstein and Larson (3), included a cost distribution by crime type and estimates of offender flow and cost sensitivities to changes in the control variables. An interactive digital computer version of the original model, based on the Allegheny County CJS, crystallized in the computer program, JUSSIM (4). Soon after its publication, a number of variations appeared to meet the needs of other localities (5, 6, 7).

As the depredations of crime became more intense and as more money became available for crime control, more sophisticated methods were used to analyze the problem. In particular, "system dynamics" (8), previously applied to the modeling of industrial and economic systems, gained popularity with urban planners and, to a lesser extent, criminal justice planners. Because the system dynamics approach does not require empirical data (although added confidence obviously follows when important relationships can be derived from statistical analyses), it offers a valuable alternative to the more traditional approaches to simulation. Riccio (9) demonstrated the potential value of this method for evaluating criminal justice operations and for formulating policy; Fey, Wadsworth, and Young (10) expanded the scope of Riccio's work to include the socioeconomic influence of the community.

A second example which serves to illustrate the divergence of criminal justice system modeling approaches that have evolved can be found in Avi-Itzhak and Shinnar (11). This study abandoned simulation in favor of closed-form solutions of simplified equations describing system and criminal behavior, and focused on incapacitation as the primary method of crime control. The study's impact was significant in that it was the first successful analytic representation of the CJS and in that it identified key system parameters (e.g., probability of conviction given arrest, criminal career length) as well as those intervention points that exhibited the greatest sensitivity to procedural change. Much of the recent basic research in crime control has been directed at obtaining a better understanding of these key parameters.

The above sketch has centered on the principal system-wide models of the CJS. For a comprehensive review of the myriad efforts directed at subsystem and component analysis and optimization, see References 12 and 13.

MODEL DEVELOPMENT

The activities and operations of criminal justice form a closed-loop, information-feedback system. Conditions in one component provide a basis for decisions that control action (implicitly or overtly) which alter the state of other components. Such feedback cycles of cause and effect are continuous, and we cannot properly speak of a beginning or an end. As Forrester points out (14), a model of such a system must preserve its closed-loop structure. Building on earlier work (3, 9, 15, and 16), we develop a comprehensive, continuous-flow model of the District of Columbia CJS. For the reasons cited below, system dynamics is used as the structural medium.

In a linear representation of the CJS such as JUSSIM, a 50-percent increase in the conviction rate produces exactly five times as many additional persons to be sent to prison as a 10-percent increase in convictions. Such a model ignores limited institutional capacities, limited manpower, and other state-dependent phenomena over which little control can be exercised. These restraints cause nonlinearities in the response of the CJS and make its management an elusive and difficult task. They must be included in a useful model. Further, because operational changes are the essence of the manager's job, a useful model must be dynamic and capable of adequately describing the evolution of the CJS through time. Accordingly, the ability to reproduce the transient response to a policy or institutional change must be included. Intervention strategies resulting in large departures from current experience, even for a minimum time, might prove unacceptable despite their long-term promise. System dynamics offers an apt means for incorporating these requirements in the model. Further, a system dynamics model provides a vehicle for testing behavioral sensitivity to variations in assumed relationships, thereby allowing for the inclusion of the system's qualitative aspects.

The actual model is a dynamic simulation embodying a quantitative description of the system's organizational form, policies, and underlying structure. It can be represented mathematically as follows:

$$\dot{x}(t) = f(x(t), u(t), t) \quad (1)$$

$$y(t) = h(x(t), t) \quad (2)$$

where:

x is an n-dimensional vector of state variables,
t is time
u is an m-dimensional vector of exogenous variables,
f is an n-dimensional nonlinear transition function,
y is a k-dimensional output vector, and
h is a k-dimensional function transforming the states into the system measures.

The state vector x represents the level or the condition of the CJS at any instant. These variables have a measurable, finite value. The complete model comprises 16 states, including the number of crimes under investigation, court backlogs, and the corrections populations.

The exogenous variables u are equivalent to the independent inputs to the system, or what is usually called the system's forcing functions. It is assumed that they arise outside the boundaries of the system and cannot be regulated by the states. They are the fixed or time-dependent inputs which we choose to view as beyond the scope of our influence. In this model they include the percentage increase in the average crime rate per criminal and the number of original grand jury indictments.

The transition function f embodies the structure of the system and its dynamic characteristics. It relates the system parameters (i.e., branching ratios, time constants, service capacities, normalization coefficients, and resource levels) to the states, forming the information-feedback loops. Taken together with the rate variables $\dot{x}$, it yields Equation (1), termed the rate equations or decision functions (14). These equations are the statements of policy that determine how the available information about levels leads to decisions. These decisions pertain to impending actions and are expressible as flow rates (of arrestees, indictments, convictions, etc.). As used here, the term decision means not only conscious human decision, but also those that arise from the structure and constraints of the system. Flow out of the trial queue might result from a deliberate decision by the prosecutor to terminate a case, or it might occur naturally as part of the trial process. A decision function may appear as a simple equation that determines, in some elementary way, a flow in response to the condition of one or two levels, or it may be described by an elaborate set of equations that involve the evaluation of a number of intermediate concepts.

The output vector y is an indicator of system performance. It is a function of the state variables and time and is calculated from the transformation h. In some cases the identity transformation suffices, as with the calculation of the average crime rate, itself a state variable; but in other cases, the transformation is more complex requiring data averaging, variable aggregation, and information delay.

The model building technique focuses on each level variable separately. Incoming and outgoing flows are identified, translated into quantitative terms, and then summed to yield the total rate of change for the particular level. For example, if n_i flows are associated with the ith level variable x_i, then the corresponding differential equation would be given as:

$$\dot{x}_i = \sum_{j=1}^{n_i} \dot{x}_{ij}$$

where $\dot{x}_{ij}$ is the jth flow variable associated with level i and may be a function of any of the other system states or the exogenous variables u. Euler integration (see (14)) is used to compute the value of the level x_i.

QUANTITATIVE DESCRIPTION OF THE CJS SYSTEM

This section presents an abridged description of the CJS flows and the working assumptions necessary for translating those flows into quantitative terms. The intent here is only to convey an understanding of the computational scheme and not to itemize each step of model development. The exposition mirrors the three CJS sectors--police, courts, and corrections. For a more complete discussion, see Reference 17. Figure 1 displays the symbols used for diagramming; Figure 2 displays the CJS flow diagram. Sources and sinks are infinite and lie outside the system's boundary. The throughput variables are surrogates for a collection of rates and are used to sum and distribute flows. In Figure 2, some CJS components have been simplified through aggregation for greater readability. For example, the actual model treats crime as a two-component vector, felonies and misdemeanors, while the diagram shows only the totality. Likewise, the District of Columbia Department of Corrections has a variety of inmate facilities that have been considered in the model but are shown in Figure 2 as simply the incarcerated population. As a point of clarification, the working units of flow are respectively, crime reports and persons in the police sector, cases in the court sector, and persons in the corrections sector. The juvenile justice system (JJS) is treated as an exogenous entity. Work on a complementary JJS model is near completion and will be appended to the "adult" CJS model.

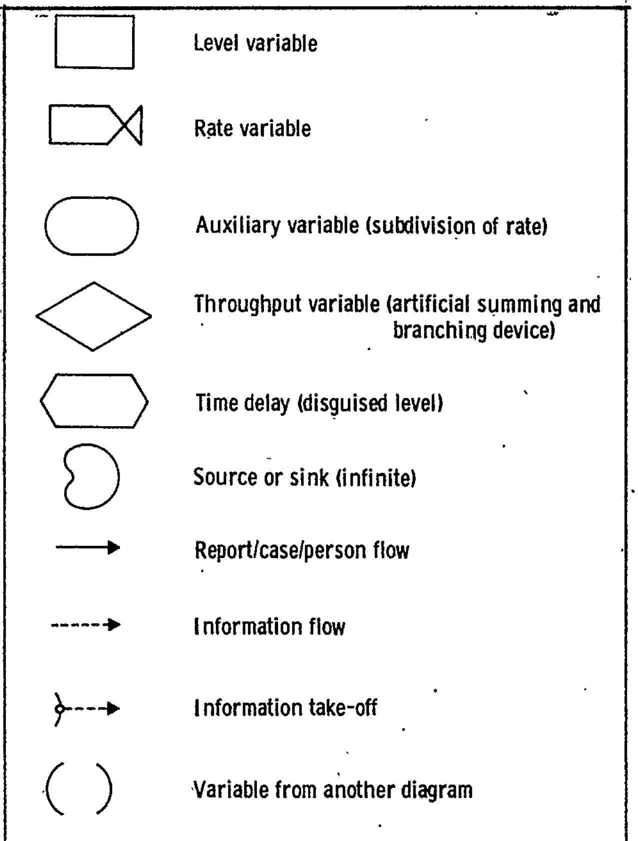

Figure 1. Diagrammatic Elements

Police Sector

The CJS is predominantly a reactive mechanism called into service when a crime is reported. Therefore, the crime rate (CR) can be viewed as the system forcing function. This rate (crimes per unit time per population) is assumed to be the product of the at-large criminal population (CP), a system level, and the average crime rate per criminal (λ), a model parameter. Specification of any two determines the third. Unfortunately, none is known with a high degree of accuracy; further, if we are to treat crime as a vector (e.g., the seven FBI Index crimes), the data problem becomes more vexing because λ and CP would have to be known for each type of crime. For simplicity, the model only divides crime into felonies and misdemeanors and assumes a homogeneous CP committing felonies and misdemeanors at average rates of λ_F and λ_M, respectively.

The at-large criminal population as used here denotes those individuals who are actively engaged in crime. As postulated, CP times λ equals the crime rate: if the crime rate is changing, then either CP or λ or both are changing. Therefore, a number of assumptions must be made regarding the flow in and out of the CP and the variability of λ :

- The total criminal population is constant in the base case.
- Any form of incarceration removes an individual from the CP.
- λ increases linearly with time.
- λ is uniform across the CP.
- The CR has a seasonal and a random component.

At any given time there are a number of crimes actively being investigated by the police. This gives rise to the system level, crimes under investigation (CUI), whose incoming flow is governed by the crime rate. The corresponding equation is

$$\dot{CUI}_{CR} = (\lambda * CP + R + S) * (1 + P * t) \qquad (3)$$

where:

$\dot{CUI}_{CR}$	is the time rate of change of CUI due to the crime rate,
CUI	is the number of crimes under investigation,
λ	is the average crime rate per criminal,
CP	is the at-large criminal population,
R	is the random component,
S	is a seasonal component,
P	is the change in λ, R, and S per unit time, and
t	is time.

As seen in Figure 2, CUI can be decreased by two events. The first occurs when the case is cleared through either arrest or secondary means, and the second occurs when the case is relegated to the inactive file for want of sufficient justification to continue its investigation. The average time for either of these is estimated to be one week. It is assumed that the arrest rate (AR) is a function of the CUI and the strength of the police force (PN). This dependency is taken into account by the intoduction of an arrest multiplier (see Figure 3) which is a piecewise linear function relating the fraction CUI/PN to the "normal" arrest rate. Normal refers to the initial condition value. Note, the introduction of multipliers causes the flows, which would otherwise be linear, to respond in a nonlinear manner to the information feedback of the system. The multipliers are the local transfer functions and are fashioned from a combination of empirical data and theory. The complete equation for characterizing the arrest rate is

$$\dot{CUI}_{AR} = - ARN * CUI * ARCPM/T_{AR} \qquad (4)$$

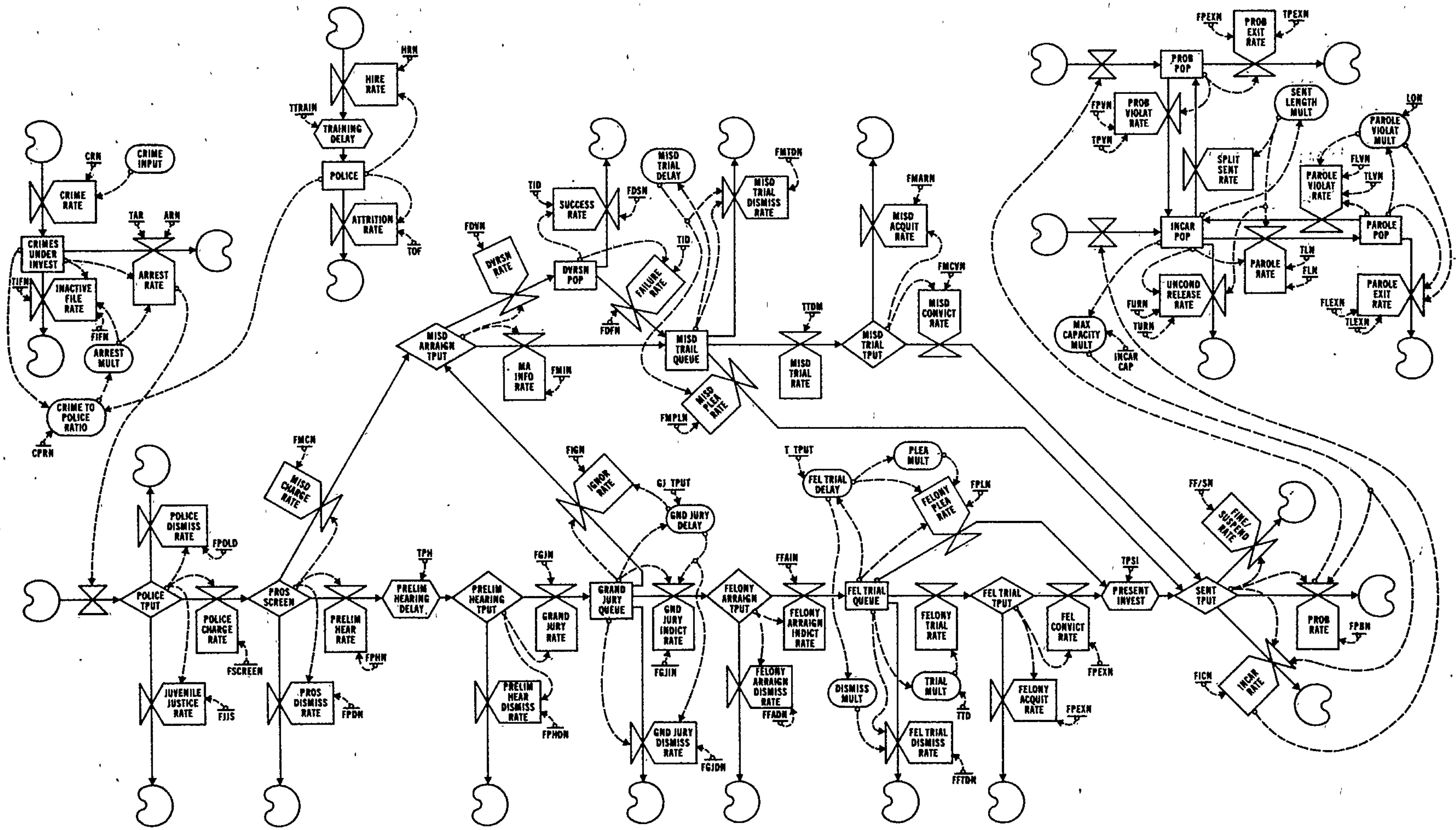

Figure 2. Criminal Justice Model Flow Diagram

where:

$\dot{CUI}_{AR}$ is the time rate of change of CUI due to the arrest rate,
ARN is the normal fraction of CUI which leads to arrest,
ARCPM is the arrest-from-crime-to-police multiplier, and
T_{AR} is the average time from report to arrest.

The rate at which crimes are disposed to the inactive file (IFR) is the complement of the arrest rate, and is given by the following equation.

$$\dot{CUI}_{IFR} = -(1 - ARN * ARCPM) * CUI/T_{IFR} \qquad (5)$$

where:

$\dot{CUI}_{IFR}$ is the time rate of change of CUI due to the inactive file rate, and
T_{IFR} is the average time from report to inactive file disposition.

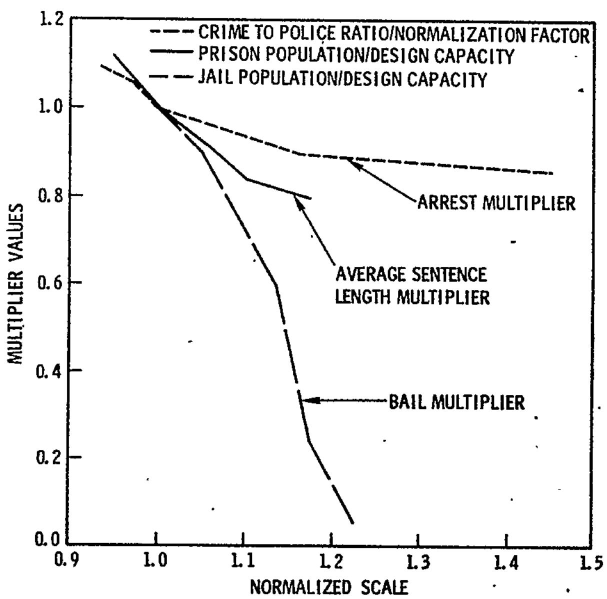

Figure 3. Selected CJS Multipliers

Combining Equations (3), (4), and (5), we get the differential equation for the state variable, CUI:

$$\dot{CUI} = \sum_{j \in J} \dot{CUI}_j ; \quad J = \{CR, AR, IFR\}$$

$$= (\lambda * CP + R + S)*(1 + P * t)$$

$$- ARN * CUI * ARCPM/T_{AR}$$

$$- (1 - ARN*ARCPM) * CUI/T_{IFR}$$

Arrested individuals are processed at the police station where they meet one of a number of fates. Juveniles are channeled to the JJS; those cases lacking merit are dismissed; while the remainder are charged as either felonies or misdemeanors. This juncture represents the intersection of all three criminal justice sectors. Charged cases are simultaneously screened by the prosecutor and reviewed by the bail agency which produces a recommendation for the detain-release decision to be made by the court. The bail multiplier, shown in Figure 3, modulates the percent of arrestees who are detained prior to trial as the jail population exceeds its design capacity. Limited space dictates that an accommodation be made between pretrial detainees and sentenced offenders.

In actuality, the role of the police and the dynamics of crime are much more complex than portrayed above. For instance, police presence in the community is often a principal determinant of the arrest rate and the rate of migration of criminals out of the community (18). Together, arrest, conviction, and outmigration combine to reduce the size of the criminal population. The ratio of arrests and convictions to crimes committed greatly influences the perceived attractiveness of crime. Becker (19) represents this feedback of information by the criminal's offense supply curve (state dependent λ), a stand-in for the concept of deterrence. Insufficient empirical data militated against the inclusion of deterrence in this model, but for a cross section of analytic treatments see References 19 and 20. Finally, law enforcement agencies must have the cooperation of ordinary citizens in order to be effective. Crimes often are not reported in areas where people are apathetic toward crime or have little faith in the criminal justice process.

Although we could have taken many of these intangibles into account (see 9 and 10) by theorizing their functional form and then building the local transfer functions, it was felt that such an approach, in the absence of any supporting data, would have weakened the model's credibility. The alternative would have been to develop the results parametrically by varying transfer function values. Then, if the system proved to be sensitive to these variations, the need for obtaining a clearer understanding of the underlying dynamics could be justified. Insignificant fluctuations in output would lead to a contrary conclusion. The difficulty with this approach however, is that as the number of factors increases, the number of combinations of values of input parameters increases geometrically resulting in an unacceptably large number of cases to be tested. For these reasons and because of the general uncertainty in criminal motivation and psychology, we chose to employ the narrower assumptions presented initially.

Court Sector

The mathematical description of the court sector must distinguish between states of the system and stages in the judicial process. The distinction is purely operational and depends on the selected solution interval (14). The stages can be viewed as nodes in a network, each having an average service time per case. When this service time is less than the solution interval, each case is in effect, handled upon arrival, so no queue can form and no state will exist. As the solution interval is shortened, not all arrivals will be given immediate access to service. Thus, limited processing facilities at certain stages occasion the formation of a queue behind the service mechanism. Branching between nodes is unidirectional and is governed by the rate equations. The branching probabilities, the coefficients of these equations, are Markovian and, as shown above, often state dependent.

The first transaction in the court sector occurs when a case is delivered to the prosecutor for screening. Felonies follow one branch and misdemeanors another. The felony route commences at the presentment stage and continues on to the preliminary hearing which is modeled as a first-order delay. Some cases do not continue in the system beyond this node, but a majority are bound over to the grand jury and placed in its queue, a state variable. The grand jury itself is modeled as a deterministic server, so the average wait in the queue is computed as follows:

$$T_{GJ} = GJQ/\mu_{GJ}$$

where:

T_{GJ} is the waiting time in the grand jury queue,
GJQ is the grand jury queue, and
$1/\mu_{GJ}$ is the service time per case.

Upon indictment by the grand jury, individuals are arraigned and their cases are placed on the court calendar (trial queue) where they remain until one of the following four transactions occurs: abscondance, plea, dismissal, trial. Operationally, it is assumed that each transaction takes place after an average but variable time T_T has transpired. Abscondings are not discovered until the trial date and occur at a fixed rate proportional to the trial queue. On the other hand, both pleas and dismissals occur at a variable rate proportional to the trial queue but increasing as the wait in the queue increases. The rate at which cases go to trial is inversely proportional to a state dependent service time increasing as the queue increases. The rate equations given below describe these transactions

$$\dot{TQ}_{AB} = - FAB * TQ/T_T \qquad (6)$$

where:

$\dot{TQ}_{AB}$ is the time rate of change of the trial queue resulting from abscondings,
TQ is the trial queue,
FAB is the normal fraction of cases absconding, and
T_T is the variable average waiting time in the trial queue.

$$\dot{TQ}_{PL} = - FPL * PLDM * TQ/T_T \qquad (7)$$

where:

$\dot{TQ}_{PL}$ is the time rate of change of the trial queue resulting from guilty pleas,
FPL is the normal fraction of cases pleading, and
PLDM is the plea-from-delay multiplier.

$$\dot{TQ}_{DS} = - FDS * DSDM * TQ/T_T \qquad (8)$$

where:

$\dot{TQ}_{DS}$ is the time rate of change of the trial queue resulting from dismissals or nolle prosequis,
FDS is the normal fraction of indicated cases terminated or at trial, and
DSDM is the dismissal-from-delay multiplier.

$$\dot{TQ}_T = - \mu_T * TRIALM \qquad (9)$$

where:

$\dot{TQ}_T$ is the time rate of change of the trial queue due to cases going to trial,
μ_T is the normal service rate per case, and
TRIALM is the trial-length-from-queue-length multiplier.

Combining Equations (6) through (9) with the indictment rate IR, the complete rate equation for the state variable TQ is

$$\dot{TQ} = IR + \sum_{j \in J} \dot{TQ}_j; \qquad J = \{AB, PL, DS, T\}$$

The trial node, represented as a throughput variable in Figure 2, branches in the direction of either acquittal or conviction. Defendants found guilty join those who have already pleaded guilty (perhaps to a lesser offense than charged) to await sentencing. The presentence investigation is modeled as a first-order delay averaging three weeks. The sentence itself is fashioned from a subset of the following possibilities: fine or suspended sentence, probation, jail, prison, or community corrections. The latter three denote institutional incarceration where each facility is constrained by a maximum capacity which is assumed to lie somewhat beyond its design capacity. The logic employed to account for these constraints is as follows. Under conditions of available institutional space, individuals are sentenced at normal rates to one of the foregoing five possibilities. But if the community corrections population exceeds its limits, those individuals slated to enter a community corrections program are redistributed, in proportion to their normal rates, among the probation, jail, and prison populations. In the event that the jail is full, offenders ordinarily sentenced to jail are placed in prison. If both the jail and prison are full, offenders are placed on probation.

The misdemeanor route short circuits a number of the felony stages, eliminating the need for a show of probable cause and the return of an indictment. Charged misdemeanants are sent directly to arraignment where they enter a plea. A subclass of these defendants enter a pretrial diversion program; however, if they fail to comply with the program's guidelines or restrictions, their cases are placed back in the misdemeanor trial queue. From this point on, misdemeanor adjudication follows the same path and logic as that set down for felonies.

Corrections Sector

Offender flows through this sector are multidirectional and are partially governed by both space and manpower limitations. The first encounter an individual may have with the corrections department occurs at arrest. A court decision to detain an arrestee places him in the pretrial detention population (PTD), a system level and a subdivision of the jail population (JN). As mentioned, the bail multiplier regulates the flow into PTD by monitoring the total jail population. Flow out of PTD is a function of the transactions at each judiciary stage where a fixed percentage of pretrial dismissals and posttrial dispositions leads to a discharge from PTD. Note, detained individuals who are convicted and subsequently sentenced to jail will remain in jail but notationally, will be transferred from PTD to JN.

The other major states included in this sector are the prison population (NN), the parole population (LN), the probation population (BN), and the community corrections population (CCN). With a few exceptions, the flow between these states occurs linearly in proportion to the size of the state. The general form assumed by the rate equations is given below.

$$\dot{x}_i = \sum_{j \in J} (f_{ji}\, x_j/T_{ji} - f_{ij}\, x_i/T_{ij});$$

$$J = \{JN, BN, NN, LN, CCN, CP\}$$

where:

x_i is a corrections sector state variable such that $i \in J-\{CP\}$,

f_{ji} is the normal fraction of persons in state j in transit to state i, and

T_{ji} is the average time spent in state j before transit to state i.

Contrary to the above linear formulation, the average time spent in prison T_{NNi} is a function of the prison population and is controlled by the average-sentence-length multiplier as illustrated in Figure 3. The assumption being that when the population exceeds the design capacity, sentence lengths will be reduced to maintain a minimum net entering flow and to service a greater number of persons per unit time. The effects of this reduction, however, will not be evidenced immediately, but only after the newly sentenced offenders become a significant proportion of the total inmate population. This latter response is modeled as a first-order delay.

The second exception to the constant-coefficient formulation of the rate equations is exhibited by the variable nature of the fraction of persons who violate their release conditions and are subsequently reincarcerated. For parolees, this fraction is governed by the parole-violation-from-case-load multiplier. As the ratio of parolees to parole officers exceeds its normal value, the fraction of the population that violates its conditional release terms increases, slowly at first, then more rapidly, finally leveling off at a maximum value. A switch is positioned in the circuit, however, permitting the flow to continue only as long as the institutional populations remain below their maximum capacities. If no space is available to house violators, neither parole nor probation is revoked.

When incarcerated individuals are granted release, either conditionally or unconditionally, some of them reenter the at-large criminal population, while the others return to the general population, rehabilitated. To offset this outgoing flow across the system's boundary and maintain the total criminal population at a fixed level, an appropriate number is added to the CP. This is effected by the rehabilitation component (17) of the model which addresses both the number of released individuals who return to crime and the average time that elapses before they reenter the CP. Increasing the rehabilitative effort beyond a predetermined threshold will reduce the total criminal population.

PRELIMINARY RESULTS

The system measures are computed from Equation (2) and are the barometers of performance, recording current conditions and trends and foreshadowing future problems. The system control variables are the decision-maker's entry points into the process, and are embedded in the functional form of Equation (1). They may appear as model parameters, or more elaborately, as a series of logic calculations. Table 1 delineates some examples of both these analytic components.

The model was validated with four years of historical data obtained from District of Columbia criminal justice agencies. The base case run of the model serves as a benchmark for further investigation. This run excluded the possibility of any structural changes or external shocks to the current system, and, therefore, implied that the future will reflect the past. Figures 4 and 5 depict the five-year forecasts for this run.

Performance is indicated by the percent change in the CJS variables relative to the beginning of 1976. As can be seen, a number of objectionable trends are prefigured for 1982: an 18-percent increase in the crime rate, a 166-percent increase in the grand jury delay, and an 11-percent decrease in the probability of conviction given a crime ($P_{C:C}$). While the jail population is predicted to remain unchanged, due to space limitations and current oversubscription, all other corrections populations will increase slightly. Curiously, the felony trial delay projections remain at the 1976 level. This can be

Table 1. Components of Operational Analysis

System Measures	Control Variables
Average crime rate	Manpower (police, judicial, etc.)
Operational costs	Legal codes
Resource requirements (manpower, facilities)	Incarceration capacities
Processing delay times	Policies (bail, sentencing, parole, etc.)
Probability of conviction per crime (Arrest)	

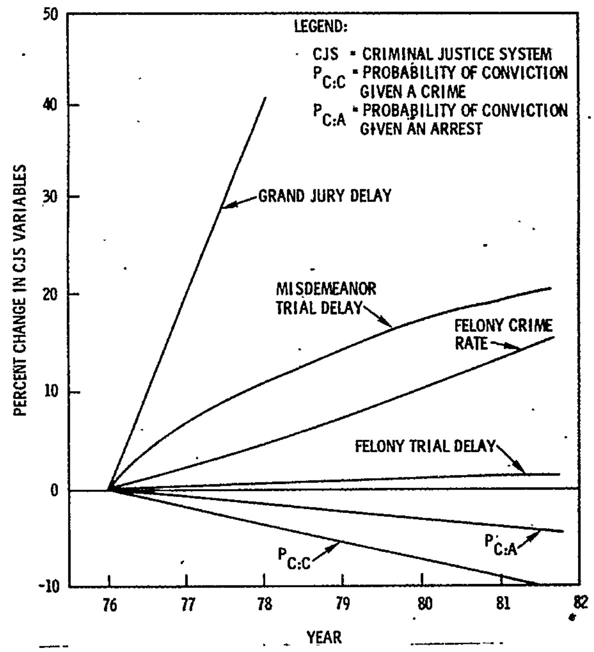

Figure 4. Base Case (crime and courts)

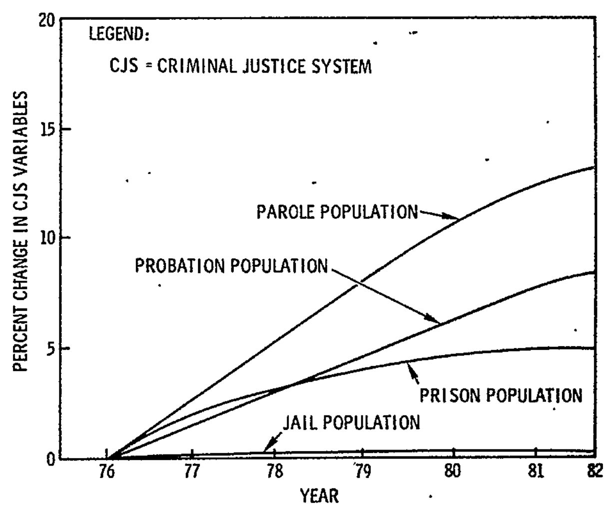

Figure 5. Base Case (corrections)

explained by the existence of an equalized flow rate to and from the felony trial queue. The bulk of the incoming flow originates from the grand jury and is constant; the remainder, willfully bypassing indictment, originates from the presentment or preliminary hearing stages and is variable. Conversely, the outgoing flow, though not necessarily constant, is self-adaptive over a wide range of time delays, increasing as the trial delay increases through additional pleas, dismissals, and trials. Thus, a balance is struck between those entering and those leaving the trial queue. During a second run of the model, a reduction in the grand jury delay that was effected by increasing its throughput and indictment rate, produced a transient imbalance in the felony trial queue flow rates that eventually equalized to produce a constant trial delay fractionally greater than that first observed.

More importantly, crime is seen to be outpacing convictions. The modest decline in the conditional probabilities $P_{C:C}$ and $P_{C:A}$ (conviction given an arrest) is, in part, a direct result of the steady-state conditions established about the trial queue but not about the crime rate or arrest rate. Moreover, the constrained jail capacity has effectively reduced the percentage of persons who are detained prior to trial, while a near equilibrium between offender flows into and out of the correctional institutions has developed to limit, in practice, the number of offenders who are incarcerated. This is underscored by the insignificant drop (approximately 150 persons) in the at-large criminal population over the base period, suggesting that the 18-percent increase in the felony crime rate is attributable to the assumed 4-percent per year increase in average felony crime rate per criminal.

To demonstrate how the model may be used in planning, we developed five-year projections for a speedy trial policy using the District of Columbia Superior Court as the frame of reference. A fixed schedule, reflecting the midterm criteria of the Federal Speedy Trial Act of 1974 (21), has been adopted for the analysis, viz., 7 weeks maximum from arrest to indictment and 16 weeks maximum from indictment to trial. This contrasts with the current, average delay of 8 months between arrest and trial for felony cases.

Two approaches immediately present themselves as mechanisms for implementing these criteria. The first would maintain judicial resources and manpower at their current levels and simply dismiss those cases that linger for more than the accepted period of time. The results of this approach would be clearly negative. Defendants realizing the situation would refuse to plea bargain, or if they did, hold out for absurdly lenient terms. This would quickly dispel any pretense of justice, further aggravate the already overcrowded court calendar, and perhaps bring the judiciary to its knees. Any deterrent effect that the system once had would be lost to the wholesale abandonment of cases.

The second approach would implicitly permit the system to expand its throughput to accommodate any excess demand for service. This could be achieved by a combination of increased productivity and the acquisition or shifting of resources and manpower. Prior judicial reform, highlighted by the 1970 Court Reorginization Act, coupled with the current practice of moving judges between felony and misdemeanor courts to ease the backlogs, argue for the adoption of this approach. Note that because we are working with average delays and aggregate events, some cases will always exceed the tolerable limits of delay and be subject to dismissal for want of a speedy trial.

The implementation of the speedy trial policy for felons, by way of a variable trial throughput, produces some surprising, if not discomfiting, results. Initially, the excess backlog of cases is brought to trial and the system experiences a sharp increase in efficiency; probability of conviction given a crime and probability of conviction given an arrest increase 30 percent, the pretrial dismissal rate decreases 20 percent, while the trial throughput increases 200 percent over the first year but then levels off at 55 percent above its normalized value. Ultimately, probability of conviction given a crime returns to

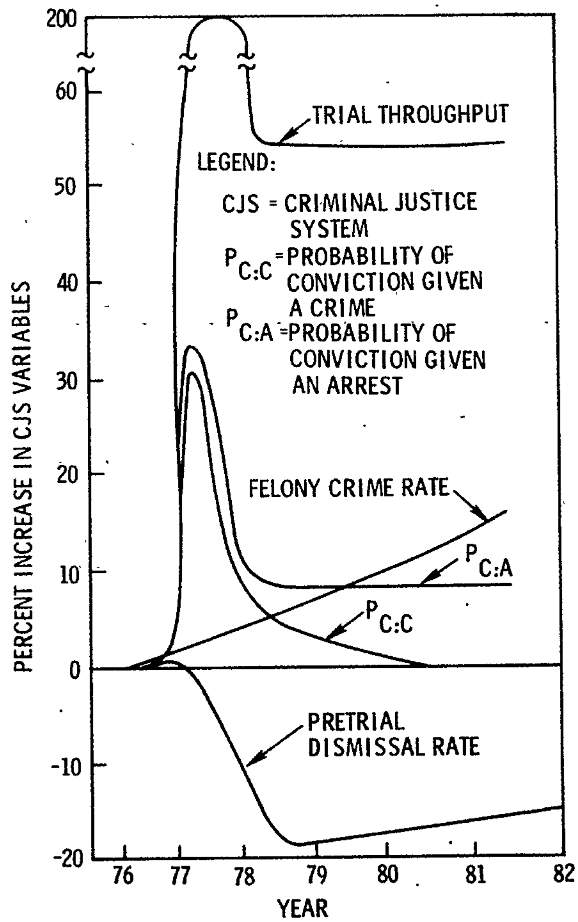

Figure 6. Speedy Trial (normalized to 1976—arrest to indictment: 7 weeks; indictment to trial: 16 weeks)

its 1976 level and probability of conviction given an arrest drops to 8 percent above its 1976 level; however, for both probabilities this still represents a 12-percent improvement relative to the base case. Figure 6 depicts these results.

Unfortunately, the criminal sector does not display the same virtues. By the end of 1981, the crime rate is up 18 percent, the same increase forecasted in the base case. The corrections populations are also at the base case levels. It is reasonable to surmise, therefore, that improved operational efficiency does not necessarily lead to an improved effectiveness in reducing crime. The reason for this disappointing result can be traced first to the conviction rate and then to the dynamics of the criminal population. Increasing the trial throughput increases the number of guilty verdicts; however, this addition is still small in proportion to the total number of convictions, which comprises both pleas and guilty verdicts and is dominated by the former. Therefore, the sentencing rate and subsequent incarceration rate are only marginally greater than those of the base case. Although this leads to a slight increase in the post-conviction jail and prison

Table 2. Speedy Trial: Percent Change in Criminal Justice System Variables

System Measures	5-Year Forecasts Relative to 1976 (percent)	5-Year Forecasts Relative to Base Case (1982) (percent)
Felony crime rate	+18	0
Grand jury delay	-33	-75
Felony trial delay	-28	-28
Pretrial dismissal rate	-15	-17
Trial throughput	+55	+55
*$P_{C:C}$	0	+11
**$P_{C:A}$	+8	+12
Jail population	0	0
Pretrial detention	-13	-5
Sentenced	+14	+4
Prison population	+7	+3
Community corrections population	+15	+5
Probation population	+11	+3
Parole population	+15	+4

*Probability of conviction given a crime

**Probability of conviction given an arrest

inflow rates, this increase is immediately offset by an increase in the pretrial release rates resulting from shorter detention stays. Thus, because defendants spend less time in jail prior to trial, the at-large criminal population remains relatively unchanged.

Table 2 summarizes the major results for the speedy trial scenario. All comparisons are made between 1982 and 1976 values. System measures omitted from the table realize no appreciable change from their base case forecasts.

CONCLUSIONS

The criminal justice system is a fragmented collection of agencies, persons, and institutions without a unified set of goals. This study has attempted to clarify the interactive roles of the system's many components by identifying their information feedback characteristics and quantifying their dynamic relationships. System dynamics proved to be an apt vehicle for pursuing these ends by offering a compromise between a macro-and microlevel representation of the process, while permitting its interesting nonlinearities to be taken into account. As such, we have been able to satisfy our original goal of providing a stronger basis for overall planning than was previously available. Under the given set of assumptions, preliminary results indicate that if current practices and policies are continued, the effectiveness of the CJS in controlling crime will continue to decline. In the absence of any major structural or procedural changes in the system, this decline will be gradual, reaffirming the basic insensitivity of multilevel systems to change.

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