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AN OVERVIEW OF RULE CONFIGURATIONS

In an earlier paper entitled "The Elements of An Action Situation," I identified the generic elements of actions situations used by analysts to construct a wide variety of important types of analytical models including market, hierarchical, and bargaining models and formal games of all types. The elements are participants, positions, action sets, outcomes, information, control, and costs/benefits. They are related together in the following manner:

Participants are assigned to positions.

Action sets are assigned to positions.

Actions are linked to outcomes.

Information is available about action/outcome linkages.

Control is exercised over action/outcome linkages.

Costs/benefits are assigned to action sets and outcome sets.

Participants (who can be represented by alternative models) assigned to positions choose among actions in light of the information and control they have over action/outcome linkages and the rewards and/or costs assigned to actions and outcomes.

The relationships among the various parts of the action situation are represented within the circle on Figure 1. When an analyst takes each of these working parts as givens, no further inquiry is made as to the cause or source of a particular element. Using a particular model of the individual participant, the analyst predicts the likely outcomes and potentially evaluates the pattern of outcomes using such criteria as efficiency, equity, and error proneness. The analyst can construct two or more action situations in order to compare the predicted outcomes and evaluate which situation leads to the more preferred set of results. At this level of analysis, the analyst is limited in what can be said about how to create situations leading to a more preferred set of results or how to alter situations leading to adverse results so as to improve their performance.

[Figure 1 About Here]

To answer questions about how to change the structure of a situation, the analyst must dig deeper into how sets of rules -- institutional arrangements -- combine with the attributes of goods and of the community of individuals participating to generate particular types of situations. Just focusing on rules for the present, one is immediately struck with the extraordinarily rich set of rules which can affect the structure of action situations. Without a meta language about rules that enables the analyst to talk about how rules are related to one another and how they are related to elements of an action situation, the analyst can simply be overwhelmed by the rich variety of working rules used in practice.

The purpose of this paper is to develop the rudiments of such a language drawing heavily on the work of many other scholars who have addressed various aspects of this task. To simplify the study of rules, I will cluster specific types of rules according to which aspects of an action situation they affect. Six broad classes of rules will be discussed: position, authority, scope, information, payoff, and aggregation rules. Position rules are that set of rules which affect the creation of positions and of assigning individuals to

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positions. Authority rules affect the assignment of particular action sets to positions. Scope rules affect which outcomes will be affected and the range of effect. Information rules affect the level of information available in a situation about action/outcome linkages. Payoff rules affect the benefits and costs assigned to particular actions and outcomes. Aggregation rules affect the level of control that individual participants exercise at a linkage. The relationships among rules and elements of an action situation is shown in Figure 1 as the set of arrows connecting rules to parts of an action situation.

In this paper I will try to define each type of rule and array some of the major variants of each rule type. Some of the sections of this paper are relatively fully worked out. Others are only a brief sketch. Read this version as an initial draft of a paper rather than as a completed paper.

Most rules are stated herein in one of two forms. The first form is as a generative statement (Let there be a ________________) which creates one of the elements of an action situation. The second form is as relational statements using the deontic operators P (permitted), O (obligatory), and F (forbidden) and the conditions under which they apply.

The three deontic operators are interdefinable (von Wright, 1968: 143). If one of them is taken as a primitive, the other two can be defined in terms of this primitive. For example, let us use permission (P) as a primitive. If we are referring to a possible action (a_i), then "Pa_i" would be read: It is permitted to do a_i. Then the statement that an act is forbidden (Fa_i) can be defined as: $Fa_i = \sim Pa_i$. In other words, it is not permitted to do a_i. The statement that an act must be done (Oa_i) can be defined as: Oa_i = ~P~ai. It is not permitted not to do a_i. We could take F as the primative. Then, P can be defined as ~F and O can be defined as ~F~.

The deontic operators can be related to each of the elements of an action situation. In the above paragraph, the deontic operators are related to actions. In scope rules, the operators refer to state variables. In information rules, the operators refer to communication channels.

The deontic operators refer to statements about what is presumed to be PHYSICALLY possible. A person cannot logically be required to undertake an action which is physically impossible for anyone to do. As expressed by von Wright in regard to actions:

> The notion of ability or <u>can do</u> . . . signifies ability so to say in its "naked form," subject only to the restrictions imposed by the laws of nature (including the limits of man's innate capabilities of growth and learning). Within this broad concept of ability (<u>can do</u>) one can distinguish a narrower concept. When, in this narrower sense, we say of an agent that he <u>can do</u> or that <u>it is possible</u> for him to do a certain thing, we mean that his doing of this thing will not violate a set of rules (norms) or conditions such as, for example, the rules of a certain legal order or moral code (von Wright, 1966: 133).

We can think of each of the elements of an action situation as resulting from several underlying layers that are rarely explicitly worked out but are part of the "deep structure" of an action situation. For each element we can first think of a set of all physically possible elements related to this type of situation. Let us call that SET A. Then let us define SET B as the deontic operators of P, O, and F. A rule is then a function which states the conditions that must be met for each element of B to be associated with each element of A. In other words, rules map SET A into SET B. For actions, we could represent this mapping in the following manner:

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          Set A                                         Set B

   Physically Possible Actions               Deontic Status of An Action

   a1 )

   a2 )                RULE                  ( Permitted

    . )    ---------------------------------}  ( Forbidden

    . )                                      ( Obligated

    . )

   an )
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Set A is enumerable in simple situations that are well structured. Set A may be unknown to participants in an on-going situation and learned over time as trial and error proceeds. The resultant action set of a participant in a position at a decision node is a subset of A X B (those ai's which are permitted). A similar concept can be used for each of the elements of an actin situation.

Rules frequently state the conditions (readings on state variables or attributes of participants) under which P, F, or O will be assigned. As discussed below, an entry rule will define a person to be permitted to participate in a position who meets certain conditions (e.g., has a high school education, is a resident of a particular jurisdictions, has registered with an official agency, etc.)

In the following, I have not tried to formulate all of the possible rules that might be used to structure each element of an action situation. I have, however, attempted for formulate the most basic rules. These rules are "basic" in the sense that if these rules were not present, the element in the action situation would not be present or operable. Once these basic rules are formulated, it is possible to elaborate on each and every one of them in greater and greater detail. The formal language being developed is, therefore, a hierarchical structure. Finer rules are elaborations and special cases of the rules I have laid out here.

Position Rules

A key building block of an action situation is the set of positions (S) or anonymous slots which are filled by particular participants and to which specific action sets are assigned at junctures in a decision process. A minimal position rule names a single position -- such as "member" -- as the most inclusive position to be held by all participants in a situation. An example of an inclusive rule establishing one position for all members (M) in a situation is:

(1) Let S = (S) and all i INC M, OS.

This would be read: A position is generated and all participants in the situation are obliged to hold this position. (TEMPORARY NOTE: I am using INC for set inclusion because our High Speed printer does not have a symbol for set inclusion. For the same reason, I will later use GTE greater than or equal and LTE for less than or equal).

Article 1, Section 2 of the U.S. Constitution is a simple example of the establishment of positions:

> The House of Representatives shall be composed of Members chosen every second Year by the People of the several States, and the Electors in each State shall have the Qualifications requisite for Electors of the most numerous Branch of the State Legislature.

A situation with one and only one position held by all participants is an extremely egalitarian situation. Most situations contain more than a single position. Differentiation of authority to act and to communicate is dependent upon the establishment of multiple positions within a situation.

Number of Participants in a Position

A position rule must state whether there is a defined number, no limit, a lower limit, or an upper limit on the number of participants who hold a position. A rule defining the specific number of participants in a position can be stated as:

(2) Let $s_i = U$

If all positions in a situation have a defined number of participants, the total number of participants is thus also defined (as the sum of all n_i). A defined number of participants in positions is used in most recreational games or competitive sports. It is not legal to play with more or less than the defined number of participants in each position on the field. The position of a member of a jury must be filled by a defined number of participants (defined by law and varying from jurisdiction to jurisdiction and according to the type of case involved).

A more general formulation of a rule defining the number of participants is:

(3) Let L LTE s_i LTE U

The lowerbound on the number of participants is L and the upperbound is U. When L = U, rule (2) is the same as (1). Either bound may be left undefined. When the lowerbound is defined and the upperbound is left unspecified, a minimum number of participants must be present but not a maximum. Most quorum rules define a minimum number of participants who must occupy a particular position before particular actions must be taken. When a lower bound is not defined, action can occur without any participants in a particular position. When the upperbound is defined and the lowerbound is left unspecified, a "lid" is placed on the total number of participants that can hold a particular position. A operational example of this type of rule is found in the authorizations given to many public agencies that they can hire up to U participants in a particular position (State Trooper, for example). Such rules may or may not specify whether there is a lower bound. When both bounds are specified, action may not take place until at least L participants are in a position and no more than U are present.

Entry into Positions

Besides establishing positions and the rules setting lower and upperbounds on participants in positions, position rules must also state how potential participants enter positions. We will first focus on the rules related to entry into the most general position of a situation. We will use the term "member" to refer to this position. We will limit our attention to those situations in which all participants in a situation hold the position of member (M) whether or not they also hold other position. The determination of who is eligible to enter this general position are first order entry rules since they affect who can enter the situation itself.

First order entry rules define the eligibility of individuals to hold the position of member. These rules include a set of transformations which partition a defined set of individuals (I), usually bounded in space and time, into subsets of individuals who are eligible (E) and ineligible (~E) to hold the position of member (I = E + ~E). A simple rule to partition I would be:

(4) Let E = (E) and all i INC I with attributes x_1, x_2, . . . x_n, OE.

This would be read that that a classification of "being eligible" has been established and that all individuals within a defined set who have particular attributes are obliged to be eligible. An alternative formulation of the SAME rule is:

(4') Let E = E and all i INC I with attributes x_1, x_2, . . . x_n, F~E.

The second formulation states that it is forbidden to keep a person who has certain defining characteristics from being eligible to be a member. Since P, F, and O are interdefinable, the same rule can be stated with any of the deontic operators. A third way to formulate the same rule is:

(4'') Let E = E and no I INC I without attributes x_1, x_2, . . . x_N, PE.

An example of a rule stated in this manner is the constitutional rule regarding the eligibility of citizens to be a Member of Congress:

> No Person shall be a Representative who shall not have attained to the age of twenty five Years, and been seven Years a Citizen of the United States, and who shall not, when elected, be an Inhabitant of that State in which he shall be chosen.

Second order entry rules define how the set of eligibles (E) are further partitioned into subsets of members (M) and non-members (~M). Non-members are narrowly defined to include those individuals who are eligible to hold the position of a member in a particular situation, but do not hold that position (~M = E - M). Second order entry rules must define how specific members are selected from (E). Four basic types of second order entry rules are in frequent use in operational settings: open, invitational, competitive, and compulsory.

Entry rules are "open" when they allow eligibles full control over the decision whether or not they wish to become members. Any e_i wishing to become a member may do so. Such a rule can be stated as:

(6) Any e_i, PM.

Most election laws, for example, are open and allow eligible voters to decide whether or not to come to the polls to vote. All eligible voters who appear at designated places and times are authorized to participate in an election.

Entry rules are "invitational" when they authorize current members to select future members from (E). Members of the situation issues an "invitation" (V) to be an eligible member. Thus, eligible members are divided into two sets -- those who have been invited and those who have not be invited. The invitation is a condition of entry. This type of rule can be stated:

(6) Any e_i with V, PM.

Many private clubs use a rule of this type. Most businesses and public bureaus also use rules of this type.

A subtype of an "invitational" entry rule is a "competitive" rule where members are selected as an outcome of another action situation in which potential members compete against each other to gain the condition of V whatever it may be. In a competitive election, V is defined as receiving the most votes (or some other definition depending upon the aggregation rule used in the election situation). The selection of legislators is normally the outcome of a separate election in which members are selected by voters from among candidates who are running in this election.

Entry rules which are open, invitational, or competitive may assign a fee or inducement to any i INC I who wishes to become an E or to any e INC E who wishes to become a M. An example of the first is an application fee or reward. An example of the second is a membership fee or reward. Poll taxes are fees that eligible voters have to pay in order to vote.

Entry rules are "compulsory" when eligibles have no control over whether they become members or not. Compulsory rules are stated in the following form:

(8) Any e_i with V, OM.

Being drafted into the army or subpoenaed to serve on a jury involves the selection of a member by a formal process outside the control of any e_i. A person selected as a defendant in a criminal trial has entered this position through a compulsory process. Under a set of compulsory entry rules, participation is "universal" when all e_i MUST participate. All e_i are assigned the condition V. All eligible tax payers, for example, must complete tax forms and pay any taxes they owe. A compulsory entry rule is "particular" when only a subset of E must become members at any one time period. Only some e_i are assigned the condition V. Both the draft and jury duty are particular entry rules.

<u>Multiple Position Rules</u>

When situations involve more than a single position, at least three types of position rules are possible:

(8) Let S = $\{S_1, S_2, . . . , Ss\}$ in which each i INC M, Os_j and Fs_K, $S_j \neq$ sk.

This rule creates multiple positions, requires each participant to hold one of them, and forbids the holding of more than one position. Such a rule is used in many recreational sports. Positions such as guard and forward are defined. Each position is filled by at least one member. All members hold one and only one position. Such a rule covers and partitions the set M.

(9) Let S = {S_1, S_2} where i INC M, OS_1 and {1, 2, . . . i-1, i+1, . . . m}, OS_2.

Such a rule is used in many committee settings which give one and only one member a unique position such as the Chair of the committee and all other members hold the other position. This rule also covers and partitions the set M.

(10) Let S = {S_1, . . .Ss} where ever i INC M, O S_j for some S_j (every member assigned to at least one position) and i P S_j & S_k (members are permitted to hold multiple positions).

Such a rule is used in many organizations when members may hold several different positions simultaneously. A member of a firm may hold a position as a particular worker (secretary, foreman, president) as well as a position related to tenure in office (a probationary versus permanent staff member). This rule covers but does not partition the set M.[1]

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1 The four sets of position rules are similar to a set of rules used by Shepsle (1979) to define a committee system in a legislature. However, the form of the statements differ. Shepsle's formulations (Footnote continued)

Succession Rules

Position rules also define who is eligible to move from one position to another and what criteria must be met. Civil service, seniority, and patronage institutional rules differ primarily in the procedures used and criteria applied in regard to succession of individuals into higher level positions. In a civil service or "merit" system, those who are already employees must serve specified periods of time at lower level positions and pass examinations in order to be placed on an eligible list for promotion to higher level positions. When a seniority rule is used, individuals who have been in a particular position for the longest period of time are selected to move into "higher" level positions when vacancies occur. Decisions about upward mobility in a patronage system are made by individuals who hold the position of "patrons."

Exit Rules

While entry rules define who is eligible to enter a position and who has control over entry, exit rules define eligibility to continue in a position and the conditions under which a participant must not, must, or may leave a position. Defendants in a criminal trial or a prisoner may not leave such a position at their own initiative. The

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[1](continued)
state the result of the operation of the rule in a situation. Statements 9, 10, and 11 state the rules that would produce the types of situations identified by Shepsle. Shepsle shows that equilibria can be structurally induced by a particular combination of rules when the distribution of preferences and a simple majority rule institution could not lead to an equilibrium.

results of a trial may be to release the defendant (allowing the participant in this position to get out of this position). After a defined period of time has passed a prisoner may be released from this position by a probation board or may have simply served a set term and be automatically released. A citizen of a nation may not have full control over leaving this position. Many countries have placed severe constraints on the capabilities of citizens to exit voluntarily.

Position rules sometimes set fixed terms of office with stringent rules concerning the eligibility of a past position holder to be eligible to hold the same position again. Governors of some states and mayors in some cities may hold these positions for one term only or may not be eligible to succeed themselves (even though they may later be eligible after someone else has served in the office). Under such circumstances, the person in the position has no control over retaining the position after the fixed term has expired. The participant must exit from the position when the term of office expires if the participant is ineligible to serve again. For most elected positions, voters have full control over a participant's continuation in office. Positions like those of judges, however, may be for life subject only to removal for illegal or immoral behavior. Participants in such positions are assigned very high levels of control over when and under what conditions they leave office.

The rules related to many positions, however, give both the occupant and others partial control over whether the occupant continues. Except under slavery or imprisonment, occupants of most positions are allowed to exit or resign from positions at their own initiative.[2]

(Particular rules may set a limit on the amount of time that must elapse from announcing a decision to leave and actually leaving or may set a charge associated with leaving a position prior to fulfilling some aspects of a contract.) The capability of a participant to leave a position is a fundamental limit on the power that other participants can exert over a participant.

While the holder of a position in most situations may be able to exit voluntarily, others may also have greater or lessor control over whether the person continues in or leaves the position. Prior to the establishment of civil service legislation in many states, appointed local public employees could be easily removed from office by elected officials. Changes in the party of locally elected officials frequently meant that public employees hired by the other party were fired and new workers loyal to the incoming party were hired. Civil service legislation changed the relative "property rights" of public employees to their positions. No longer could they be fired at will or for lack of political loyalty and activity. After an initial probationary period had expired, a public employee could not be fired except for "cause."

Collective bargaining agreements also affect the relative control that various participants have over exit from positions. Under such contracts, the terms and conditions of employment and firing for an entire set of positions is negotiated at the same time. Grievance procedures may be

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[2] But see the interesting article by Martin (1973) describing the legal structure of contract dissolution in the Netherlands since 1945 in which both employers and employees are prohibited from terminating an employment contract unilaterally without the permission of a district director of labor affairs. Under this system, participants in three different positions all have partial control over the exit of an employee from a position.

instituted to provide a forum and procedure for a participant who wishes to appear a nonvoluntary termination. A participant holding the position of a boss may be forced to re-employ an employee (or provide compensation) if a termination is not considered by the grievance panel to have been within the power of the boss. Contracts often specify rights to positions according to seniority which limits the power of a boss to select which employees will be terminated during times of financial restrictions. Under seniority rules, the last person hired into a position is the first to be laid off regardless of work performance.

Authority Rules

Authority rules specify what a participant occupying a position must (O), must not (F), or may (P) do at a particular point in a decision process in light of conditions that have or have not been met at that point in the process. The actions that a participant must, must not, or may do are dependent both on the position they hold, prior actions (and properties of actions) taken by others and/or themselves, the completion of particular procedural steps, and attributes of relevant state variables. Authority rules partition actions into required, permitted, and forbidden acts dependant upon the path of past actions taken by participants and others and readings on relevant state variables. (In complex situations structured by complex systems of rules, however, a system of authority rules may not completely partition all possible actions into required, permitted, or forbidden actions. Such a set of rules may also be inconsistent in its ordering of actions -- see discussion below of the completeness, consistency, and independence of authority rule systems.)

Authority rules most frequently assign contingent authority -- the set of available actions assigned at any one point in a process is contingent on prior actions that have been taken and on the current status of relevant state variables. A general statement of an authority rule is:

$$(11)\ (P,\ F,\ \text{or}\ O)a_{1i},\ .\ .\ .\ a_{ni}/a_{1j},\ .\ .\ .\ a_{nj},\ c_1,\ .\ .\ .\ c_n$$

In other words, a set of actions for participant i is permitted, oligated or forbidden depending upon the actions of other participants and stated conditions.

For example, in most legislative action situations, a presiding officer is not given the authority to vote on most decisions. Thus, the act of voting is not among the presiding officer's set of permitted actions at many points in a decision process while the same act is included in the set of permitted actions for regular members of a legislature or committee. However, if a tie occurs in a vote by regular members, the presiding officer is then authorized to vote in order to break the tie.

In many bureaucratic action situations, no one participant is authorized to take particular positive actions unless specific state variables are above some minimum or below some maximum. A power plant employee, for example, may not be authorized to open a turbine unless water levels are above a minimum. A social worker cannot authorize food stamps or welfare payments unless an applicants income is below some defined level given the size of the family and other conditions. Further, specific procedures must be completed prior to any determination of the eligibility of a family for welfare payments of any kind.

Rules limiting or expanding the authority of participants in particular positions to propose particular actions can be called agenda control rules (See Shepsle, 1979; Kormendi and Plott, 1983; Mackay and Weaver, 1978). A closed agenda control rule limits the number of alternative actions that can be decided upon. An open rule, on the other hand, allows any feasible action to be considered. A boundary rule can set upper and lower limits on the action variables which can be considered. A "germaneness rule" restricts alternatives to those which affect the same set of state variables (See Shepsle, 1979 for further discussion of these rules).

The action sets of the participants in an action situation are not independant of one another. John R. Commons (1957), drawing on the earlier work of Hohfeld, argued that juridical relationships among participants in a transaction had to be correlative. When we speak of someone having a "right," Commons argued that this refers to a set of permitted actions in the action set of a participant in one position AND to a set of forbidden or required actions in the action set of another participant. For the concept of a "right" to be fully defined, the rule stating the right must affect the action set of at least two participants. Someone must have a duty to forebear from an action that someone else has a right to perform. Or, if someone has a right to obtain a particular state variable, someone else must have a duty (be obliged) to see that this happens.

Further, Commons argues that when we talk about someone have a liberty to act, this type of rule must impose limits on the duties that an individual has to observe because of others' rights. Thus, an enhancement of liberty is one of two changes: (1) a change of the deontic status of an action from F (forbidden because someone else has a right to that action) to P and/or (2) a change of the deontic status of an act from O (obligated to perform because someone else has a right) to P or F. The change in deontic status affects the rights of someone else. They are still permitted to do the action, but no longer have the exclusive right to do this action. They are thus exposed to the consequences of their own and others' actions of a particular type.

Hohfeld's and Commons' work on correlatives and limits is extremely difficult to understand. Hopefully, once the current effort to develop an adequate language to express authority and other rules in a rule configuration is further developed, I will be able to reformulate the Commons arguement in a more coherent fashion. It will also be important to re-examine authoritative situations where the outcomes of the situation are the rules affecting the rights, duties, liberties, and exposures of participants in another action situation. Authoritative relationships involve the establishment of rules for authorized relationships.

Authority rules determine whether a decision of a single participant or of multiple participants is needed prior to an action at a node in a decision process. In many social games, particularly board games, each participant is authorized to make a move when it is his turn. The player's action set at that juncture includes the specific physical moves to be made. While no single player fully controls the final outcome, individual players do control the decisions to be made at individual nodes. However, in legislative and other group action situations, multiple participants jointly control which actions will be taken at nodes in the decision tree. The decision whether to amend or not amend a bill is subject to the joint control of the members of a legislature presented with the options to amend or not amend. Individual participants affect that decision by casting votes that are then aggregated by an aggregation rule to be discussed in a later section. No single participant has full control over the move to amend or not amend the bill.

By widening or narrowing the range of actions assigned to participants, authority rules affect the basic rights, duties, liberties, and exposures of members and the relative distribution of these to all. Authority rules may allocate to positions high levels of control over many different state variables; in other words, authorize powerful positions. Authority rules empower, but the power so created can be distributed in a relatively equal manner or a grossly unequal manner. Authority rules thus affect the total power created in action situations and the distribution of this power.

Completeness, Consistency, and Independence of Authority Rules

For any given type of situation, the authority rules related to that situation may be complete or incomplete, consistent or inconsistent, and independent or redundant. A complete set of authority rules specifies the required, permitted, or forbidden status of any possible action which might be taken in a decision process (thought of as a decision tree) involving all relevant actions for all parties. Such a rule completely specifies the deontic status (permitted, forbidden, required) for each and every node of the tree. A consistent set of authority rules assigns the same legal status to each action at each node of the tree. Under a consistent set of rules no alternative action is simultaneously considered to be permitted under one rule and forbidden under another rule. An independent set of authority rules assigns legal status to all possible combinations of actions without any overlap in the implications flowing from a rule.

When formal analysis is conducted at the level of an action situation, theorists frequently assume that an underlying set of authority rules has completely and consistently assigned legal status to all possible actions being considered. (The possibility of a redundant set of authority rules is not relevant given the way most formal games, markets, and bargaining situations are modeled). If the analyst presumes that participants are strictly law abiding, no forbidden actions are included within action sets. Required actions are not overtly modeled as no alternative actions are available at a node where a participant must take one and only one action. The actions represented as alternative actions are the set of permitted actions at each and every choice point. It is usually presumed that the underlying rules fully specify the legal status of all possible actions and do not lead to potential contradictions in interpretation about the legal status of particular actions.

Let us think for a moment about how a rule system could fully specify the deontic status of each and every action potentially involved in an action situation. One method to insure that the set of rules fully cover all sets of actions, is to have a specific rule which relates to each node in a decision tree. That is a relatively simple requirement for a one-time, two participant, one position, action situation such as many formal games. One only need state a single rule which generates the set of permitted actions.

However, for more complex situations involving complex trees, the necessary set of node specific rules would quickly become excessively large. An average game of chess, for example, has a length of forty moves. Simon estimated that an astronomical number of possible actions -- ten raised to the 120th power -- is involved in a game of chess (cited in Williamson, 1975: 24). The decision tree is practically impossible to enumerate. Consequently, the rules assigning permitted, forbidden, and obligated status to possible moves could not be node specific. A relatively small number of rules is used to specify which general types of actions can be made with what types of pieces and under what conditions. The deontic status of moves late in the game is inferred from this limited set of rules and information about previous moves and conditions on the board.

Given that rules are rarely formulated in a node specific manner, it is certainly possible that logically possible actions exist at nodes that are not covered by a rule or that rules assign contradictory deontic status to actions at a particular node. Two Argentinian scholars, Carlos E. Alchourrón and Eugenio Bulygin (1971) have relied upon deontic logic to explore questions of completeness, consistency, and independence of rule systems in what seems to be a very useful and creative fashion. They use a particular example of a legal question which arises in all societies -- whether a "third party holder" of property must restore that property to an original owner if a second party transferred that property without legal ownership. The "type of situation" involves three participants, three positions, and one piece of real estate. One participant, in the position of a transferor, had possession of another participant's property (who holds the position of original owner). The first participant transfers the property to a third participant -- the transferee. The transferee, frequently called the third holder, faces the question of whether or not the action of restoring the property to the original owner is required or not. This question could itself arise in several ways. The original owner could simply ask the third holder to return the property. The third holder would then be required to reason through the problem of whether he or she was required or not to return the property. Alternatively, the question could be the subject of a court case in which a judge was asked to make a determination of whether the third holder was required to return the property.

In most legal systems, the question of the legal status of an action by a third holder to restore property to an original owner depends upon attributes of the actions taken by participants prior to this particular choice of action. Thus, whether the third holder is required to return the property or is permitted to keep it depends on attributes of the path of prior actions taken. Three attributes or conditions are normally considered relevant and we will limit our analysis to these attributes. These are:

(1) The "good faith" of the transferor -- (A).

(2) The "good faith" of the transferee -- (B).

(3) The existence of a "consideration" -- (C).

Alchourrón and Bulygin simplify the concept of "good faith" by assuming that bad faith is knowledge of the fact that the real estate is owned by someone else and that "good faith is simply the absence of bad faith" (1971: 11). A "consideration" is some form of exchange given by the transferee to the transferor at the time of the transfer of the real estate.

Each attribute can be represented as present (A, B, C) or absent

(~A, ~B, ~C) where absent is interpreted to mean the "complement" of the attribute. ~A is interpreted as the absence of good faith or the presence of bad faith. Given three properties, each of which can take on two values, eight combinations are logically possible. Each of these combinations can be thought of as one possible path of a prior decision process as shown in Figure 2. A more compact matrix of possible prior actions and attributes of prior actions is shown in Table 1.

[Figure 2 & Table 1 About Here]

Table 1 and Figure 2 list the full set of possible cases which could occur using these three properties of prior actions. The participant in the position of transferee could logically be in any of these eight cases. The action being contemplated is the restitution (r) or not (~r) of the property to the original owner. As discussed above, r could be permitted (Pr), obligatory (Or) or forbidden (Fr). An expression in the form of Pr would be read: it is permitted that the action r be done.

Authority rules rarely list a full universe of cases and specify for each case whether a future act is permitted, obligatory, or forbidden. Rather, rules are apt to be formulated listing attributes singly or in pairs without a full elaboration of the universe of relevant cases. One such rule that could exist in a set of authority rules is: "If the present holder (the transferee) is in bad faith, then he has the obligation to restore the estate to its owner" (A & B, 1971: 15). This rule could be represented as: Or/~B. This would be read as "Obligatory r, if attribute ~B. Four of the cases have this attribute: Cases 3, 4, 7 and 8. From this single rule, can we infer a solution for half of the logically possible cases.

Any one rule is likely to be embedded in a system of rules and we are really interested in evaluating the completeness, consistency, and independence of that full system. Let us examine one system of authority rules (ARS-1) related to this type of situation:

Rule 1: Or/~A

Rule 2: Or/~B

Rule 3: Or/~C

Rule 4: Pr/A & B & C

ARS-1 is a reconstruction of several sections of a Civil Code elaborated by the Brazilian jurist Frietas. His proposed code was used as the basis for the Argentinian Civil Code of 1869 with some important differences to be discussed below.

Now we can ask what solutions can be inferred from Rules 1 - 4 in ARS-1. Rule 1 says that restitution is obligatory when the transferor lacks good faith. It leads to a conclusion of Or in Cases 5, 6, 7, and 8. We examined rule 2 above and concluded that it led to a inference of Or in Cases 3, 4, 7, and 8. Rule 3 leads to a conclusion of Or in cases 2, 4, 6 and 8. Rule 4 leads to a conclusion of Pr in Case 1. By listing all the cases and all of the rules in the system we can array this same information in a more useful format as shown in Table 2.

[Table 2 About Here]

Now we can more easily address the questions of completeness, consistency, and independence. The criterion of "completeness" has to do with the capacity of a set of rules to generate an inference concerning the deontic status of possible actions in each and every logical case (or, at each node in a tree). In the tabular form, we can physically examine the rows to see whether there is an entry in each and every row. A row without an entry would produce a "gap" in the application of the rule system. ARS-1 does generate a complete ordering for this set of conditions.

The criterion of "consistency" has to do with the capacity of a set of rule to generate the same inference concerning the deontic status of possible actions. In the tabular form, we would expect to find the same deontic operator in any row with multiple entries. Cases 4, 6, 7, and 8 have multiple entries but the same deontic operator is present in each of these rows. Thus, ARS-1 generates a consistent ordering for this set of conditions.

The criterion of "independence" has to do with the presence or absence of multiple entries in a row. A rule system is "independent" if and only if there are no cases with multiple entries. We have already identified that there are multiple entries resulting from the application of this system to this set of conditions. Thus, ARS-1 is not an independent rule system. Redundancy exists in this rule system. ARS-1 is thus complete, consistent, but not independent.

However, while the rule system is not independent, it is impossible to remove any one of the four rules generating it without producing a gap. Eliminating Rule 1 would leave Case # 5 without a solution. Eliminating Rule 2 would produce a gap in Case #3; eliminating Rule 3 would produce a gap in Case #2; and eliminating Rule 4 would produce a gap in Case #1.

One could reformulate the rules to produce a complete, consistent, and independent system. Let us formulate two additional rules:

Rule 5: Or/~B & C

Rule 6: Or/~A & B & C.

By substituting Rules 5 and 6 for Rules 1 and 2, we create a new rule system (ARS-2) which is complete, consistent, and independent (See Table 3). ARS-1 and ARS-2 have different rules internal to the system but they produce the same solution for the relevant set of cases. Thus, in this sense they are equivalent rule systems or two different formulations of the same rule system. One of the formulations is redundant and the other is independent, but the two rules systems have the same deontic consequences.

To illustrate problems of incompleteness and inconsistency, we will generate two more rules systems and then compare the four systems in terms of the criteria we have been discussing. ARS-3 will consist of Rule 3 and Rule 6. This is a rule system that Alchourrón and Bulygin have derived from Paragraph's 2777 and 2778 of the Argentian Civil Code.

> These prescribe that the restitution of real estate is obligatory where the transferee is in good faith, the transfer is made with consideration and the transferor is in bad faith (#2777), and if the transfer is made with consideration (even if the transferee were in good faith) (#2778) (Alchourrón and Bulygin, 1971: 19).

ARS-3 is a rule system with only two rules, but it produces three gaps (Cases 1, 3, and 7. One of the gaps is the very interesting case of two persons exchanging property in good faith for a consideration (Case #1).

We can create an inconsistent rule system by adding one more rule:

Rule 7: Pr/A & B

ARS-4, consisting of Rule 2, Rule 3, and Rule 7 is incomplete and inconsistent. A gap exists for Case #5. In Case #1, restitution is both required (you must do r) and permitted (you may do r but you do not have do). The four rule systems are arrayed in Table 3 for comparative purposes.

Obviously, the completeness, consistency, and independence of a rule system depends crucially on both the set of rules identified as applying and the set of circumstances used to construct a set of cases. The rules that are appropriate for analysis may include formal legal systems and informal rules adopted by individuals in particular types of situations. When formally constructed rules systems and consistent with informally evolved rule systems, we can expect relatively stable relationships within the constraints of these two sources of rules. The informal rules may serve primarily to fill in the gaps of a formal system that are exposed as individuals work through complex chains of interrelated actions. In the analysis of real-world rule systems, we can expect to find situations, however, where the informal rules are inconsistent with the formal rules. There are many interesting questions to be pursued when this type of inconsistency is present. The development of a language capable of helping analysts identify gaps and inconsistencies is a rather crucial step in enabling us to ask such questions in a systematic and cumulative fashion.

The identification of an appropriate set of circumstances also is crucial for the analysis of completeness and consistency. One set of rules may be complete and consistent in regard to one decision tree and not in regard to another. Thus, it is essential when evaluating any rule system to be clear that it is being evaluated with respect to the types of conditions and likely actions of a particular type of situation.

Scope Rules

The above section has focused on the rules that affect the deontic status of the set of actions available to an individual in a situation. A third element of the structure of action situations is the set of state variables that must, must not, or may be affected as a result of actions taken within the situation. Scope rules define this set, affect the width of the outcome space (number of state variables affected), and the range on each outcome variable included in that space. Thus, scope rules affect the level of opportunity in a situation.

Scope rules are thus the set of transformations that partition the set of state variables which could physically be affected into those which must not be affected (forbidden), must be affected (obligated), and may be affected (permitted). A scope rule may be very broad and give permission to an actor to affect any state variable which could be physically affected given the authorized actions assigned to that participant in a position. Alternatively, scope rules may narrowly restrict the number of state variables which a participant is allowed to affect.

I have not yet made much progress in developing an adequate language for expressing different types of scope rules. von Wright's system distinguishes between unconditional (or absolute) obligation, permission, prohibition and conditional obligation, permission, or prohibition, but not much more. In regard to state variables, a statement such as:

(12) Pp or P~p

can be read as an unconditional permission to produce or destroy a state variable p at will. The conditional statement:

(13) P(p & qT(~pIp))

expresses "permission to destroy the state of affairs p if it obtains together with the state of affairs q.

More work is obviously needed here!

While I am uncertain about how best formally to express scope rules, examples may help us understand the type of rules they are and how they operate.

The first ten amendments of the U.S. Constitution include several scope rules. The First Amendment, for example, states:

> Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the Government for a redress of grievances.

This is a very broad prohibition that covers all actions situations within the U.S. Congress.

Rules related to the operations of cable TV stations list upper and lower bounds on particular state variables which a station is forbidden to exceed. (Bill E-B: Could you provide us with a few specific examples of these rules to help illustrate this type of rule? Also, examples of rules related to actions rather than to outcome variables?).

When the term "property law" is used in everyday parlance, it refers in part to the use of scope rules. In order to analyze property law, one needs to break up the various aspects of the concept. There are at least three different aspects to the concept:

(1) The right to use and to exclude others from using a state variable.

(2) The right to dispose of or transfer the control over some state variable to someone else.

(3) The right to the "fruits" or products produced by the state variable (Montias, 1976: 116).

The first aspect is primarily affected by scope rules. The second aspect is primarily affected by authority rules. The third aspect is primarily affect by payoff rules. The three aspects can be separated. A renter has a temporary right to use and to exclude others from using the property being rented. The owner of rented property can transfer title to the property to someone else subject to the rights of the renter to continue to use the property for the duration of an agreed upon contract. A person who has been adjudged mentally imcompejntent may not be able to use or to transfer ownership, but may benefit from its fruits in the form of income.

The <u>right to use</u> property can thus be conceptualized as the result of a scope rule which places an open array of potential actions in the permitted action set of one position -- an owner or a renter -- and removes these actions from the permitted action sets of other positions. Scope rules affect action sets through their affect on outcome variables. Thus, scope rules do not directly enumerate action sets.

The right to use property may be limited by a set of scope rules which specify that in using one's own property, one may not harm the property of others in particular ways. Thus, conditions may be set down that must be met in taking actions primarily affecting state variables assigned to a position but indirectly affecting state variables assigned to others.

Information Rules

An important part of any action situation is the information available to participants about the overall structure of that situation, the current state of individual state variables, the previous and current moves of other participants in positions, and their own past moves. Information rules affect this level of potential information available to participants.

Information rules authorize channels of information flow among participants, assign the obligation, permission, or prohibition to communicate to participants in positions at particular decision nodes, and the language and form in which communication will take place.

Channels of Information Flow

Rules concerning the establishment of information channels relate to the set of all possible channels connecting all participants in a situation. The connections can be represented as a perfectly connected polygon of whatever dimension equals the number of participants. If there are five participants, there are nine possible connections between these participants as shown in Figure 3. Information rules partition this set of possible connections into subsets of required (a channel must exist), forbidden (a channel must not exist), and permitted (a channel may exist). In a recent paper, for example, Mueller, Chanowitz, and Langer (1983) conduct several experiments (at the action situation level) of communication patterns under two different structures: a ring structure shown in Figure 4 and a star structure shown in Figure 5a. Mueller, et al., do not discuss the type of rules that would create either of these two structures. (Figure 5b is the same set of channels, but arrayed in tree form to emphasize the one-level hierarchical structure of the "start" pattern.)

A rule that would establish the ring structure is:

(14) Let $C = \{C_1, C_2, \ldots C_m\}$ where every i INC M is connected to one and only one j INC M.

A rule that would establish the star or one-level hierarchical structure is dependant upon a prior rule establishing two positions -- central member and peripheral member and the following rule:

(15) Let $C = \{mC - 1\}$ where the central member is connected to all other i E M, but no peripheral member position is connected to any other peripheral member.

Given that the number of potential communication channels among any large group is very large, the set of possible rules requiring, permitting, or forbidding channels is also very large, it will be necessary to identify specific types of channel rules. Suggestions concerning an approach to this task will be appreciated.

Frequency and Accuracy of Communication

In addition to specifying which channels of communication may or may not exist between positions in a situation, information rules also specify frequency of exchange of information and how the accuracy of information is to be monitored and controlled. In many action situations, regular reports must be filed containing certain types of information on either a regular basis or at any time that a participant wishes to obtain certain actions or rewards from others. A person who is on probation is supposed to report to a probation officer on a regular basis and provide a report about their conformance or nonconformance to a set of rules about the actions that they can or must not do. Most bureaucratic life is filled with requirements to complete regular reports about recurrent events in these organized settings. These rules also effect what type of indicator will be used as evidence about the state of the world. In essence, some of these rules state the kind of meter that needs to be placed on a state variable and who is to read the meter.

Subject of Communication

Information rules often limit the topics that can be discussed among participants. In a courtroom, a witness is forbidden to refer to "hearsay" evidence. In industrial meetings, participants are not supposed to discuss price setting decisions. In many laboratory experimental sessions, participants are frequently limited to the following type of condition:

> . . . subjects were told that they were free to discuss any aspect of the experiment or any other subject, provided that they did not discuss the dollar amounts of individual payoffs, the dollar amounts they had contributed in past periods, or anything amounting to a side payment. . . (Isaac, McCue, and Plott, 1982: p. ____).

Official Language

Information rules also often specify the official language for communication in a situation. These types of rules are quite familiar to us in international settings where there is always an official language in which the business of an international organization or conference will be conducted. All nations also have their official languages. But all organizations also establish official languages, including coding systems assigned to products, customers, order numbers, invoices, etc.

Payoff Rules

Payoff rules are a set of functions which assign external rewards or sanctions to particular actions that have been taken and to particular readings on outcome state variables. An example of a payoff rule is the pay schedule that is used by a government agency or by a private firm to assign salaries to participants in particular positions. This payoff schedule will vary in terms of the variables taken into account and the complexity of the schedule. Such payoff rules frequently are very simple. They involve a computation of a wage for certain number of hours considered to be the official working hours of an employee during a set period. (How many hours have been recorded on the time clock?) Someone being paid according to piece work will, on the other hand, be paid by formula, attaching a weight to a quantity of intermediate or final goods attributed to the work of the participant. Performance contracts for corporations frequently are very much more complex. A contract may state that a corporation will receive "x" amount if some physical transformation in the world (like a particular apartment building) is completed to someone else's satisfaction by a set date. If the time period is greater than "x", then the payment is reduced according to a formula including the amount of time of delay.

An example of a payoff rule used in recent experimental studies is the one used by Isaac, McCue and Plott (1982) which was simply a function which assigned rewards to participants depending upon the total amount of a public good the participants jointly provided and the contribution made by an individual. The researchers had provided an initial stake in the form of an payment guarantee.

> The earnings of a subject in a period was the individual's payoff as determined by the level of public good provided that period on the individual's payoff chart minus the amount the individual contributed toward the provision of the public good that period. Thus, the total earnings of an individual during the experiment was the initial payment guarantee plus the sum over all periods of the earnings for each period (Isaac, McCue and Plott, 1982).

In this experiment earnings were related to a state variable and an action variable.

Aggregation Rules

Position, authority, scope, information, and payoff rules are transformations which structure all action situations no matter how individual actions are linked to outcomes. An additional set of rules -- aggregation rules -- are necessary whenever authority rules assign multiple positions partial control over the same set of action (control) variables. The problem that aggregation rules must clarify for a group is "who is to decide" which action or set of activities is to be undertaken. Thus, in any action situation in which multiple members could each potentially have partial or total control over the selection of an action at a decision node, aggregation rules are used to determine who will participate in the choice, how much weight each participant will have relative to others, and the specific formula to be used in adding up the contribution of each person's decision to a final decision about the action. There are many different types of aggregation rules. One major difference among these rules is whether they are non-symmetric or symmetric.

Non-Symmetric Aggregation Rules

All non-symmetric aggregation treat the participants in a situations differently in regard to some decision to be made at some point in a decision process (Straffin, 1977). Some named individual or named subgroup is designated as the participant who is to make the decision for the group. When only a single person is assigned full authority to select the action, the person can be called a dictator for that decision. The dictator can pick which action will be the action for the group. (Such a rule gives a single named individual the capacity to select any of the feasible actions as well as to avoid any of the feasible actions -- full active and blocking capacity.) The individual holding that position can act or makes an authoritative decision without gaining the prior agreement of others. (An individual holding such a position may consult with others prior to action, but unless regular expectations have been established about the rules used to aggregate the expressed preferences of others, such consultation is not the use of an aggregation rule.)

A subgroup may be named from the full group and assigned the capacity to make a decision about actions for the entire group. The subgroup will need an aggregation rule of its own in order to make its decision. Such a decision rule may be called an oligarchy for that decision.

The full set of participants may participate in the decision but each individual participant may be assigned a "weighted vote". This type of non-symmetric aggregation rule is used in some types of special districts where each member of a council votes, but each is assigned a set of votes depending upon some formula. Citizens electing representatives to the U.S. Senate and House of Representatives are assigned unequal voting weights due to the design of the federal system and the vagaries of districting within states.

A subgroup may be named from the full group and a decision must be agreed to by this subgroup as well as by the full group using one or more aggregation rules. Such a rule would be associated with many "committee" arrangements. Members of such a committee have greater voice in determining group actions.

Symmetric Aggregation Rules

When joint control over an action has been assigned to multiple participants and all are treated alike, a symmetric aggregation rule is being used. One symmetric aggregation rule is that of unanimity -- everyone must agree prior to action. A unanimity rule may be built into a process in such a manner that participants do not self-consciously "vote," but each is required to agree before an action can be taken. A bank clerk, for example, is not authorized to open safety deposit boxes unless the owner of the box or an authorized agent signs a registration form and produces a second key to fit the box. The dual and equal authority and unanimous aggregation rule are built into the locking mechanism which requires two keys assigned to different individuals to open the box. Similar conjunctive authority to act and unanimous aggregation rules occur in the military when the results of action could be extremely serious for national security. In addition to the necessity of receiving positive approval from positions higher in the military hierarchy, taking some actions -- such as launching an intercontinental missile -- cannot physically be undertaken unless multiple persons are present and all agree.

Aggregation rules are frequently used in groups that are assigned the joint responsibility to make authoritative decisions for an organization and in selecting individuals to be members of such groups. The outcomes in such cases are not changes in specific state variables, but changes in the relationships that control state variables. Such changes have to be implemented and enforced by other public officials. Instead of assigning each position a "key" or some other physical control variable, positions are assigned votes that may be cast each time the position is authorized to participate in making a particular decision.

Once the votes are cast, rules specify what proportion of the total must be in agreement before an authoritative decision can be made and what happens if the minimal agreement is not reached. For votes that are weighted equally, it is possible to conceptualize a simple voting rule as ranging from allowing any one member of those given joint authority to make the decision for the collectivity (the anyone rule) to requiring all those given joint authority to agree prior to a decision (the unanimity rule). Between the two extremes of the anyone rule and the unanimity rule lies a variety of other specific rules, the most familiar being the requirement that 50 percent plus 1 person agree (majority rule) or some large percentage, such as two thirds of three quarters (an extraordinary majority rule). The array of decision rules between these two extremes can be thought of as the proportions of the persons in the group required to agree prior to a decision.

Default Rules

The formula for determining a joint decision (for either symmetric or nonsymmetric) rules must also include a default condition stating what decision will happen if no agreement is reached under a rule. The possibility of no agreement is always present whenever a unanimity rule is used. For rules requiring less than unanimity and greater than a single vote, a default rule is necessary in case of a tie vote or a vote which does not achieve the required proportion. The default condition is the reference point for the final decision. It states what will happen if a certain proportion of the participants do not agree to a proposed action.

Several types of default rules are possible. One type continues the status quo distribution of outcome variables. A second presumes that no one receives any outcome variables if a default occurs (all relevant state variables are reduced to 0. A third default rule is to assign state variables randomly. A fourth type of default rule is to apply some external rule (or turn to some external decision maker) to allocate outcome variables.

Grether, Isaac, and Plott (1979) used three default rules in a series of laboratory experiments simulating the allocation of landing slots at airports. The first rule was the continuous of the status quo allocation of slots. The second rule was a random assignment of slots. The third rule was the application of an external rule which would take slots from those who had the most and give them to those who had none or only a few (a Robin Hood rule!). These three default rules were combined with a unanimity rule. What is interesting about the findings from a set of experiments using each of these default rules, combined with unanimity, is that the results of the experiment were strongly determined by which default rule was in use.

> In summary, the committee decisions are substantially influenced if not completely determined by the consequences of default. Under the grandfather arrangements "hardnosed" committee members will simply default rather than take less than the default value. Social pressures do exist for those with 'large' initial endowments to give to those with 'small' endowments, but even if there is no default because of concessions to social pressure the final outcome is not 'far' from the 'grandfather' alternative. On the other hand, when the consequence of default is an equal chance lottery, the slots will be divided equally, independent of the initial allocation. . . . Default values literally determine the outcomes in processes such as these (Grether, Isaac, and Plott, 1979: V-7.

That default values have such an important effect on outcomes is quite important for study of a rule configurations. One of the arguements I am advancing is that a full rule configuration is needed to generate the structure of any action situation. Secondly, I have been arguing that there is substantial interactive effect among rules. Third, for analysts to predict behavior at the level of an action situation, they must implicitly assume a full rule configuration even when they do not explicitly list the full set of rules generating the action situation they are modeling. A considerable literature has been generated about the likely effects of using unanimity rules in different situations. Very few theorists have explicitly stated the default rule they are assuming. Yet, one might speculate that once an analyst assumes a unanimity rule, that the most important assumption driving analysis is the default rule presumed in operation. Without careful attention to the full rule configuration, implicit assumptions about rules may have been the most important part of some of the earlier analyses of institutional arrangements.

Some Concluding Thoughts

Obviously, the above is only the beginning of a long-term effort. I am sharing an incomplete paper with you so that we can discuss this initial effort and I can gain your comments and criticsms at this intermediate juncture.

You may be asking by now what is the value of all this. I surely ask myself this question all the time! I can't address the value of the incomplete effort arrayed above. It only begins to show what may be possible. But, let me begin to address what I think will be the value of a more fully worked-out effort.

A Consistent Language for Expressing Rules

We do not yet have an accepted language, nor even a relatively complete language for expressing the type of rules that we wish to study when we do institutional analysis. Theorists state rules in a wide variety of different forms. Frequently they state what the result should be after the operation of a rule. Thus, Mueller, Chanowitz, and Langer (1983) draw us a picture of a ring structure and a star structure which is the result of a rule establishing communication channels. Stating results tells us the function that produced those rules. Another frequent strategy is to state the rule in a natural language. This strategy does tell us what produces the structure of a situation but not in a form that is easily analysed and compared to other rules.

Determination of Rule Equivalence and Difference

Once we have a more fully worked out language, we can then attack the problem of establishing logical operations that will let us identify which rules are equivalent and which rules are different. Such a wide variety of apparently different rules exists in our experience, that we are overwhelmed with the seemingly endless difference. While I expect that a systematic study of institutional rules will indeed identify a large number of clearly different rules, I also expect that once a language for expressing and talking about rules is developed, we can identify some rules as being logically equivalent that have a surface appearance of being different. The interdefinability of the deontic operators gives us some clue to this. We already know that there are certain transformations we can perform in substituting one deontic operator for another without changing the meaning of the rule (see rules 4, 4', and 4"" above). Once we have carefully worked through permitted operations to transform rule statements into equivalent rule statements, we can also address the question of difference. Rules with the surface appearance of being the same may not be the same once we examine the formal statements representing the rules.

The Minimal Set of Necessary Rules

Eventually, I think we will be able to identify a minimal set of rules necessary to establish an "elementary" action situation. For some time, formal theorists have used the concept of a simple game (Bloomfield and Wilson, 1972; Shapley, 1962) as their elemental set of formal rules. A simple game allows participants to group themselves into coalitions and then gives a rule for which coalitions will be considered "winning." As Shepsle has argued, the concept of a simple game is not adequate to the task of generating predictions about likely behavior of individuals in an action situation. Some of the problems of relying on a simple game have been alluded to above. For example, a simple game would allow unanimity as an aggregation rule but does not state a default rule. Since the default rule so dominates the outcomes, an analyst can only predict outcomes by implicitly assuming one or another default rules. Thus, a candidate for the "minimal set of rules" is obviously a default rule. Or, another way of thinking about it is that aggregation rules are essential whenever multiple participants have partial control over an action and an aggregation rule without a statement of what happens in the default condition of rules with a minimal set of tasks each rule must accomplish.

It will take a lot of work to determine the minimal set of rules, but it is an important question to be addressed. Institutional analysis should eventually get to the point where it is possible to infer the likely range of outcomes to emerge from a particular set of rules (given the model of the individual being used and the nature of the goods, etc.) If such inferences are dominanted by implicit and unstated assumptions, then the predictions will not be very useful when applied to the world.

Consistency and Completeness of Rule Systems

The discussion of consistency and completeness of authority rules sketched above, illustrates the type of analysis we can undertake once we have identified a full rule configuration as it relates to particular types of empirical conditions. For any really complex physical setting, I presume that most rule systems are incomplete. By this I mean that there are situations which are not fully covered by specific inferences derived from the set of rules. I presume that individuals in on-going settings must develop rules to cover new situations as they come into being.

Finding that a set of rules leads to inconsistent conclusions about what may, must, or must not be done in a particular case is an important enterprise. Many systems are inconsistent and may be inconsistent to trap the unwary. There are many Catch 22 systems in the world!

The Role of Rules as Information Transformation Mechanisms

Once we have developed a way of expressing rules in a systematic fashion, we can begin to address a number of quite important and exciting questions. One of these has to do with the generative capacity of rules -- their productive and reproductive capacities. If we consider institutional rules to have a broad similarity to grammatical rules and genetic codes, questions concerning the information processing capabilities of institutional rules are similar to those of grammar and of the genes can be addressed. Any mechanism which transmits information about how to produce something (a protein, a sentence, or an action situation) is itself subject to noise, to random error, and to distortion. Institutional rules are probably more vulnerable to these problems than either grammatical rules (since humans are motivated to try to make others understand their utterances and thus to follow grammatical rules) or genetic codes (since these "instructions" do not rely on humans themselves to carry them out). Rules which are repeatedly found in many different types of situations are apt to be more reliable "building blocks" than rules that are only infrequently included among the set of rules constructing social arenas. Once we have a way to express rules, we can study diverse institutional arrangements in a manner to identify those rules which are components of large number of situations which have a surface appearance of being quite different. That may begin to give us some clues concerning the use of redundancy and of the iteration and re-iteration of a rule to make much more complex structures.

Table 2

The Inferred Legal Status of Restitution Under ARS-1

				Rules			
				Rule 1 OR/~A	Rule 2 OR/~B	Rule 3 OR/~C	Rule 4 PR/A&B&C
1.	A	B	C				Pr
2.	A	B	~C			Or	
3.	A	~B	C		Or		
4.	A	~B	~C		Or	Or	
5.	~A	B	C	Or			
6.	~A	B	~C	Or		Or	
7.	~A	~B	C	Or	Or		
8.	~A	~B	~C	Or	Or	Or	

Table 3

Four Rules Systems Compared

Cases				ARS-1				ARS-2				ARS-3		ARS-4		
				R1	R2	R3	R4	R3	R4	R5	R6	R3	R6	R2	R3	R7
1.	A	B	C				Pr		Pr							Pr
2.	A	B	~C			Or		Or				Or			Or	Pr
3.	A	~B	C		Or					Or				Or		
4.	A	~B	~C		Or	Or		Or				Or		Or	Or	
5.	~A	B	C	Or							Or		Or			
6.	~A	B	~C	Or		Or		Or				Or			Or	
7.	~A	~B	C	Or	Or					Or				Or		
8.	~A	~B	~C	Or	Or	Or		Or				Or		Or	Or	

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