Legislation, Information Systems and Public Health

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Abstract

The design of information systems is related to the design of organizations as expressed in legislation. A case study in public health serves as example. Suggestions are made for improving bureaucracies.

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This paper introduces some ideas relating the design of information systems to the design of organizations as expressed in legislation, illustrated by a case study in the public health field. I shall assert the following. Information systems can be specified by rules which bear a strong resemblance to legislation. Legislation creates some major bureaucratic institutions which should be designed as information systems. Alternatively, if confronted by a bureaucratic system which has problems, one might begin to diagnose them by analysing the legislation. In brief: the disciplines of information systems and the law can enjoy a fertile liaison.

I became interested in legislation because of my interest in the design of information systems and this led to the LEGOL–NORMA research project. The work began in order to overcome our lack of adequate techniques for designing *information* systems (as opposed to *computer* systems). The problem clearly stemmed from our inability to describe organizations in enough precise detail, an observation which suggested the research method: the study of organizations specified by legislation. Legislation defines some of the largest organizations where computers have obvious applications, for example such departments of government as Taxation, Social Security and those dealing with licensing. Hence we formulated the goal of creating a logical language capable of expressing the kinds of complex rules one finds in legislation because we believe that this language would serve to specify organizations in general. Several versions of this *Legally Oriented Language* have evolved bringing valuable insights into fields such as databases and semantics as well as law and informatics. We have always sought to apply the research ideas and they proved unexpectedly valuable on encountering the case study discussed here. The research continues and anyone interested may write for a list of papers.

Legislation distributes power. From a central norm, which confers the power to make any other norms, flow powers of increasingly specific character, almost like electricity flowing through the grid and its network of transformers and switches from a generating station. If you inspect an Act of Parliament you will find that it comprises only a few kinds of norms which have rather different functions in distributing power.

Every norm says, in relation to some agent (individual or organizational), and for some purpose:

if (condition) then (consequent)

but they differ radically according to the nature of their consequents. Elsewhere I have introduced the following classification: *structure* norms, *action* norms, and *definition* norms.¹ A structure norm leads to a string of other subordinate norms. An action norm defines what should, should not or may be done, whilst a definition norm introduces a special use of language. We only need bother with structure and action norms.

A structure norm subdivides power among agents and purposes. It may be pictured thus:

where the A_i represent the agents and the P_i , the purposes whilst the C_i represent the conditions that must be tested. When a structure norm applies it 'switches on' a list of other norms. Some or all of these, as further structure norms, could do the same thing so that a tree structure of ever more finely divided powers develops, the resulting hierarchy resembles an organizational chart but, of course, the law does not necessarily assign powers to individuals as an organization assigns them to managers, rather, it creates social contexts which require specialized patterns of behaviour. Upon this tree structure, the law hangs the action norms.

An action norm, as its name implies, determines when some action should be carried out but the actions in the consequent need further classification as:

1. Physical action.
2. Change in legal status.
3. Invocation or inhibiting of some norm structure.
4. Change to the legal structure itself.

The first kind of action norm we call a *standing order*, and only these get anything *done* outside the law itself. The second kind we call *status norms* because they change the way in which the law regards a situation. For example, whilst a standing order may have a condition such as

the offender shall pay £20 to the court

a status norm would say:

the offender shall be liable to a fine of £20,

defining the liability (a status) and leaving the ordering of payment to the discretion of the court. Standing orders generate commands to change the physical reality whilst status norms change the legal reality. The third and fourth kinds of norms deal with the exercise of powers. *Powers of legal action*, as we call the third kind of action norm, take effect upon the structure norms by invoking or inhibiting whole swathes of legal rules using expressions such as

. . . shall be dealt with under Section 3 of this Act
 . . . the Minister may suspend the regulations . . .

Notice that the law itself does not alter, only which parts apply at the time. However a *legislative power*, the fourth kind of action norm,

¹STAMPER, R. (1979). Legol: modelling legal rules by computer. In: *Computer Science and Law* (B. Niblett, ed.) Cambridge University Press.

confers upon some agent for some limited purpose, the power to make new rules. Thus action norms fall into four classes of increasing scope, but decreasing specificity about the changes they will bring about in the physical world.

With these kinds of norms as our building bricks, we can create an organization. What can we say about its architecture? We can distinguish three main areas needing attention

- the system as a whole, its purpose and the resources available;
- its interior, any subsystems it should contain;
- the environment, the systems within which our system should fit.

In the context of a case study, we can look in turn at these: the system, its subsystem and its supersystems.

The Act which established a Water Supply and Sewerage Board, has been roughly analysed in the Appendix. Of course, this contains only a sketch of the whole Act which fills 20 pages. Most of the detail takes the form of action rules which hang, like leaves, upon this tree which springs from its root purpose 'The rapid development and proper regulation of water supplies and sewerage in M', which falls within the jurisdiction of the Board. At the level of analysis shown, the only agent below the State is the Board so the structure norms in the diagram only mention the purposes governing their dependent action norms. The Appendix should contain enough detail adequately to illustrate the key ideas in this paper.

The case arose in practice during some work advising the newly created Board under great pressure of time. The analytical methods, applied even in a rough-and-ready manner to the legislation which established it, helped to reveal a multitude of organisational problems more easily than expected.

A new organization, like a new building, has a purpose and a budget; the architect needs to know both these as precisely as possible. Similar conflicts arise over *generality*, which gives the architect freedom to work out an optimal solution, and *specificity*, which imposes the client's detailed wishes. But organizations differ from buildings; they can act in these matters for themselves. The legislation gives the organization the status of an agent:

3. (2) The Board shall be a body corporate, havng perpetual succession and a common seal, with powers, subject to the provisions of the Act to acquire, hold or dispose of property, both moveable and immoveable, and to contract, and may sue or be sued by its corporate name aforesaid,

and gives it some standing orders. At this level, the standing orders lay down tasks of wide scope, e.g.,

14. The duties and functions of the Board shall be as follows, namely:
 - (a) to prepare, execute, promote and finance the schemes for the supply of water and for sewerage and sewage disposal,
 - (b) to render all necessary services in regard to water supply and sewerage to the State Government and local bodies and on request to private institutions or individuals also,

through a list of more specific duties to the catchall,

- (m) to perform and discharge other such duties and functions as are allotted to the Board under the provisions of this Act or as may be entrusted to it by the State Government.

These standing orders define the outputs of the system but it cannot produce these without adequate inputs. In the case of the Water Supply and Sewerage Board very general provisions head a list of more specific powers which provide the needed inputs, mostly income and information:

15 (1) The Board shall, subject to the other provisions of the Act, have power to do anything which may be necessary or expedient for performing its duties and discharging its functions under this Act.

(2) Without prejudice to the generality of the foregoing provisions, such powers shall include the power . . .

(a) to inspect . . .

(b) to obtain . . . information . . .

(c) . . . (d) . . .

(e) to lay down the schedule of fees

(f) . . . (g) . . .

(h) to approve tariffs for water supply and sewerage . . .

(i) . . . (j) . . .

(k) to acquire, possess and hold lands and other property . . .

(l) to abstract water . . .

(m) to raise . . . money . . .

(n) to receive grants . . .

(o) . . . (s) . . .

All these appear in the Appendix, section E.

So the legislation does deal with the whole system, its purpose and resources but at a level of generality which needs supplementing. Here we find the seeds of organizational problems; where the details begin, so begins the design work proper. Great generality does provide flexibility in the design but the draftsman can only purchase it at the expense of problems of interpretation, some of which the next paragraph will address. Notice, that the legislations must strike a balance between precision and generality that will produce the desired structure without tying the hands of the information system designer.

The quotations above allow me to draw attention to an important point concerning the use of powers of legal action. The phrase 'subject to the . . . provisions of . . . ' indicates where some agent may have the power to invoke or inhibit the relevant norms, e.g., both 3 (2) and 15 (1), above. Rightly enough, the legal draftsman inserts this phrase quite liberally to underline that one should interpret the Act as a whole, but it needs careful implementation as a control feature of an information system.

In the example considered here, the Act drastically limits the powers of the Board by requiring budgets to receive State Government approval in advance:

34, (1) The Board shall, before the commencement of . . . a financial year, prepare a statement . . . of the programme of its activities . . . as well as a financial estimate . . . and the same shall be submitted to the State Government . . .

A simpler information system would have resulted from the State retaining only a power to intervene retrospectively on the basis of accounts of activities completed, plus some other, relatively informal powers of supervision. The unwillingness to transfer relatively untrammelled responsibility to the Board will incur a high cost in bureaucratic machinery. So we glimpse some potentially large consequences of

provisions inserted in the Act for reasons of legal and political caution.

We have already started to look at the subsystems, the interior structure of the organization, as determined by the legislation. To see it more clearly, the Appendix will help; section D outlines the duties and functions of the Board, amplifying the output specification. The Act defines in remarkable detail some operational tasks. The engineering of new schemes, however, receive only a mention in a subparagraph, quite out of proportion to its organizational importance (section D, level 2, branch 3: "Prepare, execute, promote & finance") More implied organizational structure appears in those parts of the Act which detail the Board's powers—section E of the Appendix. These correspond to the input side of the system. The level of detail varies less than in the specification of duties but other problems should be mentioned. These problems looked at in information systems terms concern the perturbations with which the system must contend; as far as concerns the Board, they will arise from the activities of other bodies involved in water supply projects, such as irrigation and industrial development authorities. Here the legislation fails to deal with a major source of conflict between the government's own agencies, an omission that an information systems study of the draft legislation would have picked up. Finally, we should turn to section C of the Appendix to see some explicit structuring of the Board. The Act also specifies the membership of the Board (in the sections mentioned at the bottom of section A of the Appendix) and how to make and terminate appointments but this does not affect the subsystems. Taken as a whole, the Act has many implications for internal organizational structure in its provisions for duties, powers and constitution, but these stand apart from one another with no attempt to correlate them, whereas an information systems approach would require each subsystem to have defined inputs and outputs.

Now we turn to the super systems or principal systems surrounding the Board. To understand this view consider an engineering system such as one for satellite communications. The *basic* system does the communicating, having messages and perturbations as inputs and noisy messages as outputs. But to put the basic system satisfactorily in operation, and to keep it there and eventually remove it, requires several related collateral systems. We have systems to *design* and *construct* the satellites and ground stations, to *launch* the satellite into orbit, and *commission* the ground stations, to *maintain* or monitor and repair (if possible) the basic system and to *supply* it, and others to *standby* in case of malfunction and to *recover* normal operations, to *evolve* the system as demands upon it change, and ultimately a systematic *termination* of the basic system is required. Every system requires the support of similar collateral systems although their relative importance varies, they provide a useful basis for analysis, as I shall now explain.

An organization such as the Water Supply and Sewerage Board requires collateral systems to support it and the legislation creating the Board should specify so much of these as necessary. They differ greatly in importance. The *design* system prepares the legislation (this paper suggests that we could improve the design system by including an information systems study at the drafting stage). The *construction* system (see section B of the Appendix) assembles the property and the people required by the Board; in this example the resources come from

existing State and local Government bodies. The *launching* system, as it appears in the Act, simply deals with the commencement of the Act and some small matter of retaining temporary power to make regulations (very bottom of section B of the Appendix). The Board has to rectify its own defects, by and large, but the Act does specify ways of monitoring performance to *maintain* standards. A self-organizing system can deal with its own *standby* arrangements, its repair and recovery, can procure its own *supplies* and *evolve* its own machinery, provided it has the necessary powers. The Act incorporates these powers in addition to those required for day-to-day operations (the *basic* system), as you will find in sections C and E of the Appendix. Of course, to *terminate* the Board remains a function of the Government; its omission from the Act does not seriously matter. So we see the role which a consideration of collateral systems should play in the formulation of the Act.

The Act does deal with these matters indicated above, but not in a thoroughly systematic way; let me draw attention to some typical problems. To start with, the Act does not provide for the costs of constructing the Board, only with the vesting of property and the transfer of employees. Also affecting the same collateral system, the Act provides for vesting local government property (such as water works and distribution systems) in the Board but fails to cover the transfer of the staff involved, thus inviting industrial relations problems to infect the new organization on its inception. Yet another difficulty surfaces when one looks at the cost of acquiring assets; the Act stipulates that the Board must pay local authorities for them but says nothing about the source of funds and even seems to rule out other solutions such as giving the surrendering authority a financial interest in the Board. A systematic study of the *construction* system whilst drafting the Act would have removed these problems.

Further problems with collateral systems arise because this particular Act introduces probably too many expensive ways of monitoring what the Board does. For example (section A of the Appendix), it introduces many external controls, so that regulations, bye-laws and new funds all require prior approval by the State Government. Effectively, therefore, the Act claws back to the Government responsibilities ostensibly conferred upon the Board in the wide ranging section 15, already quoted. Alternatively the Act could have reserved formal powers of intervention to the Government based on actual performance. Such an alternative strategy would tend to reduce the need for formal, bureaucratic machinery whilst encouraging informal consultation with no significant loss of control. Generally speaking, collateral systems can operate with more informality than the basic system. Thus we have a second example of the importance of analysing collateral systems in the preparation of legislation.

I have tried to indicate how drafting legislation from an information system viewpoint might help us to specify better organizations. Let me now summarize the main ideas. Legislation and systems specifications resemble one another quite closely. Therefore the structures which one finds in information systems should have their counterparts in any legislation, especially Acts of Parliament which create organizations, such as a Water Supply and Sewerage Board illustrated here. Three main levels of structuring stand out:

1. *The basic system* (the Board performing its normal duties (output)

with the allocated resources and dealing with routine problems (input)).

2. *The subsystems* (water supply, sewerage, new schemes, policy formulation, research and so on).
3. *The collateral systems* (especially construction, launching, maintenance, supply and evolution of the basic system).

This structuring applies recursively so that every subsystem and collateral system has its own sub- and collateral systems. Finally, I made the point that this should *not* result in a proliferation of bureaucracy but, instead, a deliberate encouragement of appropriate informal systems. Thus we should have no difficulty in relating the legislation to some of the main 'architectural' features of the organization.

The legislation serves as the blueprint for the organization in legal terms but in order to build a modern organization making effective use of information technology, we also need a system specification. Can we reconcile these? A concrete affirmative answer is given by our formal languages, LEGOL and NORMA, which serve to specify both information systems and legislation, thus providing a unified treatment of the human and computer parts of the system. The Appendix, in an informal way, follows this plan and serves to present the key material from the Act in a reasonably understandable form. So I hope that the reader can see how we can merge the techniques of the legal draftsman and of the systems designer to the benefit of each.

Let us improve the bureaucracies we create. Although we tend to disparage them, bureaucracies serve us well in many fields, not least in the field of public health where probably more people benefit from simple measures such as water supply and sanitation, than from more sophisticated medicine. Simple measures, on a vast, national scale depend on bureaucratic information systems. Let us therefore have better bureaucracies, and let us begin at the beginning, with the legislation that creates them.

Let us recognize bureaucracies as the dominant machines of our age and set about improving them. First let us engineer them better using our new information technology and secondly, and as importantly, let us 'landscape' them so that we human beings find them agreeable to visit and inhabit. These improvements will depend on extending our knowledge of complex information systems and how, in particular, the formal structures needed for technology can merge into the informal structures needed by people. We can begin by making more interdisciplinary studies of law and informatics.

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Appendix

The MWSSB Act arranged as a tree structure

A. Rapid Development and Proper Regulation of Water Supplies and Sewerage in M

* Continued in subsequent sections

B = Board

B. *Transfer of Resources to Board*
(Continued from Appendix, section A)

C. Structure
(Continued from Appendix, section A)

D. Duties and Functions
(Continued from Appendix, section A)

E. Powers
(Continued from Appendix, section A)