605003

605 003

1

A THEORY OF ORGANIZATIONAL BEHAVIOR DERIVING FROM SYSTEMS RESEARCH LABORATORY STUDIES

Robert L. Chapman

3-12-56

P-802

Approved for OTS release

The RAND Corporation
1700 MAIN ST. • SANTA MONICA • CALIFORNIA

SUMMARY

A model for predicting system effectiveness is presented. The variables concern the task, the state of the system, and the forces set in motion when the system comes into contact with its task.

Four salient characteristics of the model are pointed out: it identifies task change as critical, it includes crew learning, it identifies the adaptation process as an adjustment cycle, and it describes system state in terms of qualities of the system as a whole.

How this model provides criteria for the contributions of human engineering, training, and personnel selection is illustrated by three techniques for improving system performance: the analytic-teaching method, the find-the-right-procedure method, and the build-organizational-potential method. ( )

Paper presented at the Western Psychological Association meeting, Berkeley, California, March 29-31, 1956.

A THEORY OF ORGANIZATIONAL BEHAVIOR DERIVING FROM SYSTEMS RESEARCH LABORATORY STUDIES

Back in 1952, John Kennedy of RAND presented a paper on the uses of mathematical models in psychology. He said he was in favor of them although there were no conspicuously successful ones in evidence. Kennedy also wondered right out loud whether this was because we had not supplied our friends, the mathematicians, with adequate descriptions of the phenomena. He reported that several of us -- Biel, Newell, Kennedy, and I -- wanted to get a model to predict the performance of man-machine systems and intended to start by getting a good description of what a system was like.

A lot has happened since that declaration of intent. Among other things, we've run four huge, enormous, and very large experiments, each involving a system of 40 men operating under realistic conditions for about six weeks. In the process we found that this system would perform better than had previously been thought possible -- the crews learned. As a result, a number of psychologists are now busy putting this training technique to work in improving the performance of a system important to our national security.

But I'm not going to talk about the experiments or the training principles -- these have been discussed in other places and at other times. What I want to do is tell you how we realized our initial aim: that of adequately describing a system. I will present the broad outlines of a description that borders on being a model for predicting system performance. I won't bore you with details but will confine my remarks to the identification of major variables and their interactions. Then I wish to make a couple of general remarks about the nature of the model. Finally, I would like to tell you why I think this formulation is a step forward and how it may be helpful in integrating several kinds of psychological research and application.

This formulation is based on the examination of a good deal of data, but I won't speak of that either. For one thing, there is so much context in addition to the volume of data itself that we would have to get a better running start than we can manage in 12 minutes. If you're interested, come to Santa Monica, bring provisions for several days, and we'll go into the file room and trample some raw data in our bare feet to squeeze out a few "reliable" statistics. For another thing, there are still a few wrinkles in the model. Even after four whole years, and I report this somewhat ruefully, we don't have a final answer to what makes the organizational man tick.

THE ANATOMY OF THE MODEL

As Fig. 1 shows, we need variables of three kinds: to describe the task, to describe the system and its "state," and to describe the major forces set in motion when the system comes into contact with its task.

The task variables are: s_i , the number of task events of a particular class; and p_i , the value to task accomplishment of dealing with Class i events. The latter variable is needed because systems fac many kinds of events, some of which are just noise -- whether they are dealt with or not is not important to task accomplishment.

The system's values of state are of three kinds: those having to do with operating practices, those having to do with normative processing rate, and those having to do with inertia to change of the respective operating practices.

The operating practices are represented by:

t_i which determines whether Class i should be dealt with or not,

v_i which specifies the rate of dealing with Class i events, and

d_i which tells how long a Class i event should be dealt with.

The normative processing rate is like a metabolic or habitual rate of

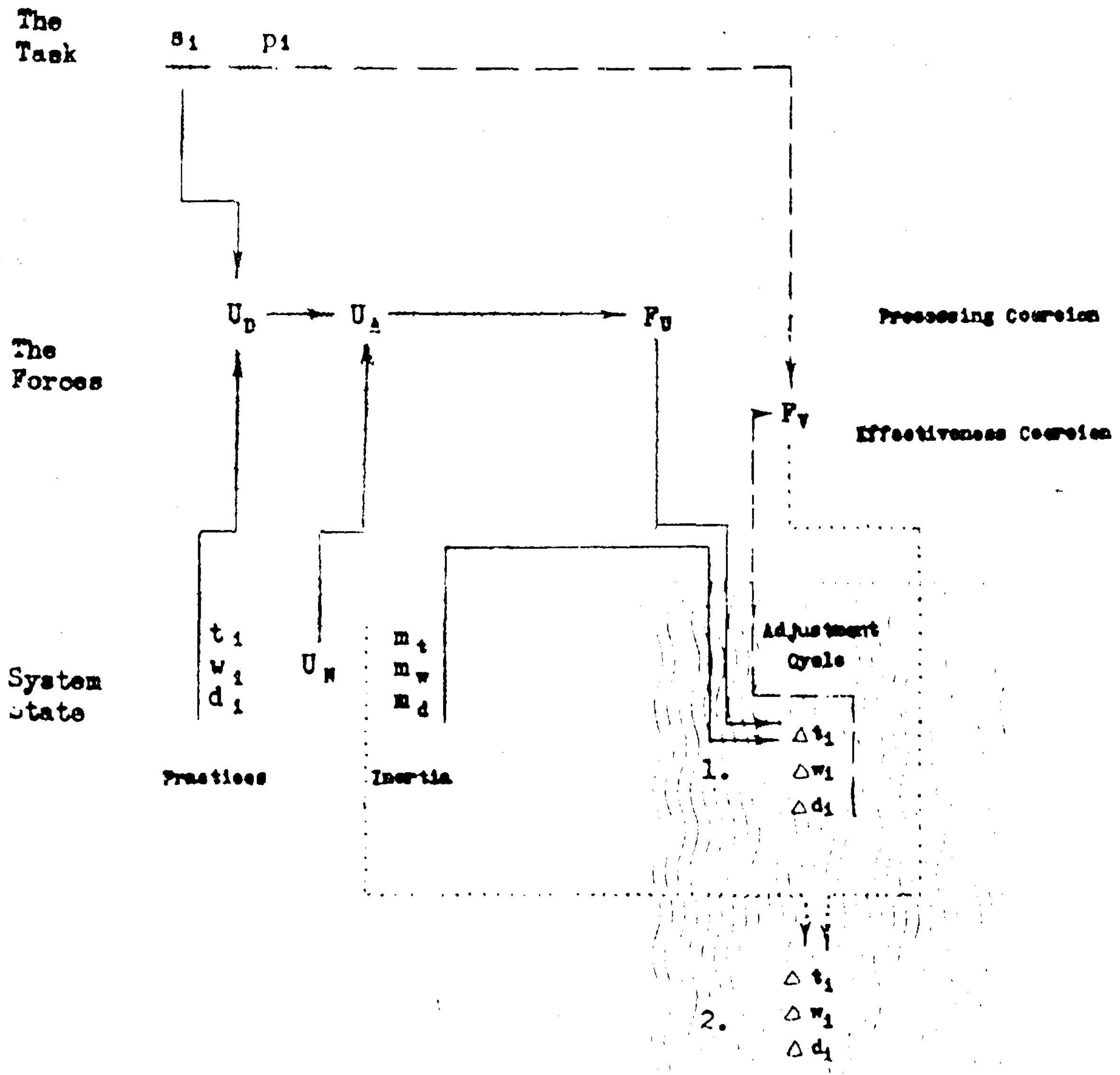

Fig. 1. How the Major Variables Interact in an Adjustment Cycle.

energy expenditure; it is not necessarily, as we've observed it, a physiological limit.

The system's inertia is represented by m_t , m_v , and m_d , for the respective operating practices. These constitute the organization's goal structure or dynamic motivational complex in the sense of "What do we do if?"

The forces arising from the system's relation to the task are the processing coercion F_U and the effectiveness coercion F_V . These can best be explained if we consider how the variables interact.

If a system is operating effectively, its state will remain steady. What then will disturb that calm and happy situation: a change in task characteristics. Let us see what will happen if there is an increase in s_1 , for example.

Because the system would like to continue to operate in the same way it has in the past, the processing demand goes up when s_1 increases. But the system would also like to maintain the same processing rate. So, its actual processing rate will be influenced by both the demand and the normative rates. Up to a certain point, the actual rate will match the demand; but there is a limit beyond which no additional increase in demand will raise the actual rate.

The system will absorb some of the difference between demand and normative rates -- the amount that the actual will stretch beyond the norm. That leaves the disparity between demand and actual that acts to change the system's state -- the processing coercion F_U . The processing coercion is scalar; it's not particular where the saving comes from -- it simply establishes the amount that must be saved by some sort of change.

The inertias help direct this saving. Some practice values of state are easier to change than others; consequently, the inertia effect is vectorial. For instance, t may involve only two men, v six, and d a dozen men. What changes: t , of course.

There is also the effectiveness coercion F_V , the pressure for task accomplishment which, in the broadest sense, is the difference between achievement and some "hoped-for" performance. It, like inertia, is vectorial in effect because reducing $\underline{t}$, for instance, may have a different influence on effectiveness than reducing $\underline{v}$ or $\underline{d}$.

So we have the processing coercion that is scalar and the inertia and the effectiveness coercion that are vectorial. Somehow as a consequence of their interactions, a new set of operating practices -- t , w , and d -- are achieved through a set of iterative adaptations that make up the adjustment cycle. These new operating practices, in turn, determine how effective the system will be under the new task circumstances.

SALIENT CHARACTERISTICS OF THE MODEL

Now, if I have talked fast enough, I should be able to proceed to explain what this means without too much opposition. I should like to emphasize four salient characteristics of this model.

First, we have identified task change as critical to operational stability of a system. This says, for one thing, beware of the stability of a system confronted by drastic fluctuations in task characteristics. Because, depending on this rate of change, the system may become so unstable as to break down completely.

Second, we are including learning in our prediction of system effectiveness. To find out how well the organization will do, we determine its new operating practices then estimate its effectiveness.

Third, we have identified the adaptation process as a cycle. Operating practices are assaulted first by one force and then another--and I have, by no means, detailed the entire cycle as we presently understand it.

Fourth, we have described state in terms of qualities of the system as a whole -- not of characteristics of individuals or components.

THREE TECHNIQUES FOR IMPROVING SYSTEM PERFORMANCE

I would like to suggest that this formulation provides criteria for the contributions of human engineering, training, and personnel selection to improved system performance. To illustrate this, let us distinguish three techniques for making a system work effectively, and find the respective criteria. These three techniques can be termed the *analytic-teaching* method, the *find-the-right-procedure* method, and the *build-organization-potential* method.

The use of the *analytic-teaching* method depends on an estimate of the worst possible task situation and the determination of appropriate *practices* for those circumstances. If you could afford the size of system necessary to support that processing rate, you could simply teach a crew those *practices* inferred from the model. Inasmuch as the coordinated skill of as many as a dozen men might be required to establish a certain value of $\underline{d}$, this shouldn't be much harder to do than teaching a golfer how to make a hole-in-one. You would want to select crew members who could learn these techniques and training program to establish these practices in the shortest order. Because you wouldn't wish the crew to vary from those practices, you would want the inertias to have very high values. So the human engineers would have to use criteria for system design quite opposite from the usual ones.

You could use the *find-the-right-procedure* method if you are not quite so confident about the appropriateness of the *practices* you can infer from your model. Of course, a crew learns by experience and sooner or later finds the right *practices*, but you might wish to speed up this learning process. Your training program would have these criteria: you would want to train the team as a whole so that the t , v , and d values would all adjust simultaneously; you would want the effectiveness coercion to work full strength so you would provide knowledge of results; you would want to keep the two forces in balance so you would increase task difficulty gradually (like building up the tolerance for arsenic by increasing the dosage in the crew's morning coffee drop-by-drop). Initially you would want the inertias low, but once the crew had found the right practices for the ultimate task, you would want to increase the inertias. So you would ask the human engineers to design a system with an on-off switch for the inertias.

If you are confident neither of what the right practices are nor of what the ultimate task will be, you might simply try to build up the organization's potential. In this case, (hang on) you would want the vectorial force of inertia to coincide exactly with the vectorial force of the effectiveness coercion. This would mean that the organization would modify its practices in response to task change precisely in terms of what the consequences might be; instead of waiting to find what the result would be of modifying a practice, the crew would "intuitively" anticipate the consequence. Your training criteria would be to invest the inertias according to the effectiveness coercion. Now you would ask the human engineers to establish a level lower limit of the "natural" limits and also to lift the top constraints on these inertias. But this might take more inventiveness than human engineers could muster alone. You could call on some group dynamics people to throw in an authoritarian character or two to build up the inertia of a practice that requires cooperation to change, or vice versa.

I've traced some implications of this model in a slightly facetious way. My point has been that if the system is considered as a whole, the criteria for the contributions of human engineering, training, and personnel selection might swing from one extreme to another. Some model of the system is needed to guide these different kinds of research and application.

Perhaps the model I have described is a step in the right direction.