Philosophica 21, 1978 (1), pp. 99–128.

A FORMAL APPROACH TO THE EVOLUTION OF GROUP STRUCTURE

Maria Nowakowska

The aim of this paper is to present a certain theory of evolution of the structure of social groups, and of the resulting phenomenon of alienation. The general theory, outlined in section 1, will subsequently be applied to the construction of foundations of theory of freedom (section 2), and next, to evolution of scientific communities, and alienation in science.

1. *A general outline.*

Let S be the set of persons under consideration (e.g. the whole society, some fixed community, etc). It will be postulated that the main factor governing the evolution of S is the distribution of certain goods among the members of S.

Let C denote generally the set of goods, to be distributed among members of S. These goods may be partitioned into two main categories, $C = C' \cup C''$, where C' denotes the set of goods which are "infinitely divisible", and C'' is the set of goods which come in restricted quantities.

For an illustration, elements of C' may be voting rights, some privileges, civil liberties, etc. The crucial point is here that goods of this type may be given to some or all members of S, and this does not restrict the possibility of giving it also to some other members of S. Voting rights is probably the best exemple here.

The other type of goods, forming the set C'', will be the main object of study in this paper. These are goods which come in limited quantities, and therefore to give them to some members of S means automatically denying them to others. A typical case may be goods such as certain positions, which may be given to one person only.

In either case, for $c \in C$, let $x_i(c,t)$ denote the amount of goods c assigned at time t to member i of S. Naturally, the manner of expressing $x_i(c,t)$ depends on the goods c. Thus, if c stands for voting rights, $x_i(c,t)$ may be 0 or 1, depending whether member i is denied those rights or not. In other cases, the amount of goods may be representable in a quantitative way (e.g. in case of finances).

The function which to each i, c and t assigns the value $x_i(c,t)$ describes the distribution of goods in the considered group S. The main mechanisms which govern the development of the group may be described in a qualitative way as collision of two factors : degree of admissibility of the distribution of goods on the one hand, and on the other — the preferences of various members of S to different distributions.

This collision leads to some polarization of the set S : on the one hand, there is a group of those for whom the existing distribution is optimal, in the sense that there is no feasible distribution which dominates it, and other group (or groups) which have a tendency to change the existing distribution into a different one.

When the considerations are restricted to goods from the class C' (infinitely divisible ones), one may interpret the distribution of such goods as "distribution of freedom" in society, and use this approach to build foundations of a formal theory of freedom. These topics will be briefly discussed in section 2.

The main object of analysis of this paper, however, will be goods of second type (not divisible). These goods will be positions, each occupied by one person only, so that instead of functions $x_i(c,t)$ it will be convenient to describe the distribution in terms of a function mapping the set of positions into the set S of persons. Each distribution will have its degree of admissibility, and the latter will be assumed to change in time. This dynamics of admissibility will be caused by changes of some underlying variable, such as level of education, professional skill, etc. The analysis will be carried out for special case of scientific community, where such an underlying variable will be the growth of scientific authority. It should be pointed out, however, that the results (especially the main assertion, about the dilemma between stability and fairness) have applicability wider than to scientific communities only.

It should also be pointed out that the analysis of freedom (goods of infinitely divisible type) is logically independent of the analysis of distribution of goods of the second category, and the first may serve as a social context for the second. In the particular instance of this paper, it means that the considerations of scientific community should be regarded in the wider social context as given in the section below.

2. *Towards a formal theory of freedom*

Let G stands for the set of goods related to freedom, such as voting rights, civil liberties, aristocratic privileges, etc. One can assume that, from the individual's point of view, he prefers to have G_i to having $-G_i$ (i.e. not having G_i), for each $G_i \in G$.

Each social system (e.g. those considered by van Gigch (1976)), as well as social systems which do not exist, but are only contemplated by politicians — may be characterized by a mapping $f : S \rightarrow 2^G$, where in this case S stands for the whole society, and f(s) is, by definition, a subset of G, consisting of those and only those goods which s has. With this notation, s has goods G_i if $G_i \in f(s)$, and is alienated from it if $G_i \notin f(s)$.

Many criteria for social systems, such as equality, participation, etc. may be expressed formally as properties of the function f. For instance, equality with respect to a set $G' \subset G$ of goods may be defined as the requirement that

$$\forall s : f(s) \supset G'$$

i.e. by requirement that every member of S has all goods from the set G'.

One could now proceed as follows. Let F denote the class of all feasible functions f. Thus, F will comprise all functions which correspond to social systems which exist at present, or had existed at some time in history, as well as certain social systems which are being contemplated by politicians, but have never been put into existence as yet. Thus, one can think of any new law introduced in the country, or defeated in the parliament, as bringing about a new function f — perhaps a slight modification of the existing one, perhaps very much different.

Provided that it is possible to specify the class F of all feasible freedom functions f, one could try to search for optimality within this class. The optimality criteria may be formulated in the following way.

One can assume that each member of the society has his "value system", sufficient to rank all elements of G from that which he feels is most important for him, to more and more "dispensable". Let $\geqslant_s$ be the preference relation of s, assumed to be transitive and connected, i.e. :

if $G_1 \geqslant_s G_2$ and $G_2 \geqslant_s G_3$, than $G_1 \geqslant_s G_3$;
either $G_1 \geqslant_s G_2$ or $G_2 \geqslant_s G_1$ (or both).

In the usual way, one can now define the relation of strict preference $>_s$ and indifference $\sim_s$ of member s

The first concept one may now introduce is that of preference-consistency of function f. Formally, f is preference-consistent, if every f(s) contains an "unbroken segment" of rankings of person s, starting from the top. Thus, f is preference-consistent, if for every $s \in S$

$$f(s) \neq 0 \Rightarrow \sim \exists G_i, G_j : G_i \in f(s), G_j \in f(s), G_i >_s G_j.$$

Thus, if s has some goods (i.e. if f(s) is not empty), then he has at least some of the goods which he prefers most.

As stated above, preference-consistency need not be a very desirable property, in the sense that one can easily point out very unfair systems, which are preference-consistent : a system which denies any right to everyone (so that f(s) is empty for all s, and the condition is automatically satisfied), or a system which denies any rights to most persons, and gives all rights to some. Thus, one needs to strengthen the above requirements; consequently, f will be called strongly preference consistent, if it is preference-consistent and

$$\forall s \quad f(s) \neq 0 .$$

This requirement, in turn, might appear unrealistic, since it means that every member of the society will have at least that goods which he values most. Such a requirement may well carry us out of the class of feasible solutions **F**.

Another concept here is the Pareto optimality, or admissibility : a freedom function f is admissible, if there is no "better" function f', that is, a function which gives as many goods to all as f does, and strictly more to some. Formally, f is admissible (Pareto optimal), if

$$\sim (\exists f') [(As) : f(s) \subset f'(s) \;\&\; (\exists s'): f(s') \neq f'(s')] .$$

One should now search for feasible solutions (i.e. solutions from the class **F**), within the class of all Pareto optimal and strongly preference-consistent functions f. Whether such a class is not empty in an open question (one could suspect that with the requirement of strong preference consistency, it is empty; consequently, this requirement ought to be somewhat weakened).

When one arrives at a class of solutions which are feasible and "optimal" is some suitable sense, it may contain more than one element, and we would be facing a dilemma, since giving more freedom to some members of the society would necessarily involve restricting the freedom of some others

Unfortunately, we are here in a situation more complex than in Arrow's Impossibility Theorem : in the latter case, the question could be resolved on purely logical grounds (a social welfare function satisfying such and such conditions of "democracy" does not exist because these conditions are jointly inconsistent). In case of "freedom functions" f, as described above, the existence or nonexistence of f satisfying some properties (such as above, or others) has to be decided on the ground of some general theory of social systems.This is because the considerations are restricted to the class **F** and before any theorems could be proved about existence of functions f with some special properties, this class must be known, i.e. one has to be able to decide, for any function f, whether it is feasible in some hypothetical world.

Nevertheless, whether or not the outlined formal approach would ever lead to a solution, this way of thinking about the problem may perhaps prove fruitful. In particular, social classes may be formally characterized as sets of those members of the society, for which the value f(s) satisfies some appropriate conditions (to use simplest example, slaves may be defined as those s for whom $f(s) = \phi$). The history of society may be viewed as a struggle resulting in a sequence of functions f_1, f_2,... showing the changes in the distribution of rights in societies.

3. *Evolution of a scientific community*

In this section, the attempts will be directed at applying the formal theory outlined in the preceding section to the description of the evolution of a scientific community. The basis intuitive notions underlying the system can be most briefly summarized as follows : scientific communities are inherently unstable, because the growth of individual scientific authority of its members will eventually make any fixed assignment of scientists to positions unacceptable.

This growth gives a permanent tendency to a change : the forces opposing it tend to create monopoles, trying to gain the control over the distribution of scientific goods. This inevitably leads to alienation of some groups of scientists and results in a tendency to form counter-monopoles.

The above mechanism can be formalized in a relatively simple way, and the formalism allows to put forward several hypotheses about some of the finer details of the process of development of a scientific community.

The formalism, extending that outlined in section 1, will be introduced gradually and refined as the need arises.

3.1. *Basic structure*

Let us at first restrict the considerations to a fixed moment t. One of the principal elements of the description of the state of a scientific community is the specification who occupies which position.

To put it formally, let S denote the set of all scientists under consideration, and let P denote the set of all positions.

The concept of "position" (being, in some sense, a primitive notion of the system) should be interpreted in such a way that one position can be occupied by only one scientist. Thus, for example, if there are n scientific institutes under considerations, then there are also n positions of directors, a certain number of positions of deputy-directors, so and so many positions of heads of departments, assistants, etc. Next, each scientific journal gives one position of the editor-in-chief and several positions of members of editorial boards; the same applies to scientific committees, scientific councils, university chairs, elected bodies in scientific societies etc.

Formally, the distribution (or : occupancy function, assignment) of positions among scientists can be described by a function

$$\varphi : P \to S$$

which assigns to each position that scientist who occupies it. The symbol

$$\varphi(p) = s$$

means that scientist s occupies position p (function φ is well defined because of the assumption that one position can be occupied by one scientist only).

It is important to note that φ means here any occupation function, not necessarily that one which actually takes place at time t. In other words, if Φ denotes the class of all functions φ which map P into S, then at any moment t the actually existing assignment is one particular function, say φ_t, from Φ.

Here the elements φ of Φ may be partial functions, i.e. some positions in P may be left vacant (no element of S is assigned to them). Also, the function φ need not exhaust the whole set S : there may be some elements in S which are not in the range of φ (i.e. there may be some scientists without positions).

It is important to mention that φ need not be one-to-one, that is, the same scientist may occupy two or more different positions.

The sets

$$P_\varphi = \{ p \in P : \varphi(p) = s \text{ for some } s \in S \}$$
$$S_\varphi = \{ s \in S : \varphi(p) = s \text{ for some } p \in P \}$$

represent respectively the class of all occupied positions, and the class of all scientists who hold at least one position. (under the occupancy function φ).

The basic type of set considered in the sequel will be

$$\varphi^{-1}(s) = \{ p \in P : \varphi(p) = s \},$$

that is, the set of all positions occupied by the scientist s under the hypothetical assignment φ. In this notation, $\varphi_t^{-1}(s)$ is the set of all positions held by s under the assignment which actually takes place at t.

3.2. *Admissibility*

The next aspect which has to be taken into account is that not every occupancy function is admissible.

The admissibility or inadmissibility of occupancy function is related to various requirements, either specified by laws, statutes of scientific organizations etc., by some unwritten traditions, or simply by common sense or common consent. To explain the nature of these requirements, it is best to give some examples of admissible or inadmissible occupancy functions.

Thus, a function which assigns the position of a director of an institute to a graduate student may well be formally inadmissible (regardless of how the remaining positions are distributed among scientists), if a law specifies that the director must have Ph.D. Another regulation might, for instance, require that director of an institute must at the same time preside over its scientific council (hence any occupancy function which assigns different persons to these two positions is inadmissible). Such function would also be inadmissible, if no such formal regulation exists, but there is a long established tradition in some institution that director presides over its scientific council. Finally, though it may not be written specifically, an assignment which gives the position of editor-in-chief of a journal in, say, nuclear physics to a linguist might not be admissible, etc.

As may be seen from these examples, the admissibility of the total assignment of scientists to all positions is related to admissibilities of "elementary" assignments of one position to one scientist.

Moreover, it ought to be clear that admissibility is not a binary concept, but rather a fuzzy one (see Zadeh 1965), hence to every occupancy function there should correspond a number between 0 and 1, representing the degree to which this function is admissible.

The "elementary" admissibility, of a scientist s to the position p, is also a fuzzy concept; moreover, this admissibility changes in time. Consequently, with every scientist s and every position p we may associate a function

$$g_{s,p}(t)$$

with values between 0 and 1, representing the degree of admissibility of s for p at time t. The condition $g_{s,p}(t) = 1$ means that at time t, the scientist s is a completely admissible candidate for p; if $g_{s,p}(t) = 0$, he is totally unacceptable, while the intermediate values represent the partial degrees of admissibility.

Treated as a function of p, $g_{s,p}(t)$ is the membership function in the fuzzy set of positions admissible for s at time t; treated as a function of s, it is the membership function in the fuzzy set of candidates admissible for the position p.

The function $g_{s,p}(t)$ is, as usual in the theory of fuzzy sets, evaluated subjectively. This does not constitute any serious obstacle, since in the sequel the use will be made only of the following qualitative

POSTULATE 1. *For any $p \in P$ and $s \in S$, the function $g_{s,p}(t)$ satisfies the relation: for $t_1 < t_2 < t_3$*

$$(1)\ g_{s,p}(t_1) > g_{s,p}(t_2) \Rightarrow g_{s,p}(t_2) \geqslant g_{s,p}(t_3)$$

This postulate asserts that $g_{s,p}(t)$ has, in a sense, a single peak: if it ever begins to decrease, it cannot increase again. Thus, the three main types of behaviour of this function within an interval may be represented schematically on Fig. 1 as "Increase", "Hump" and "Decrease".

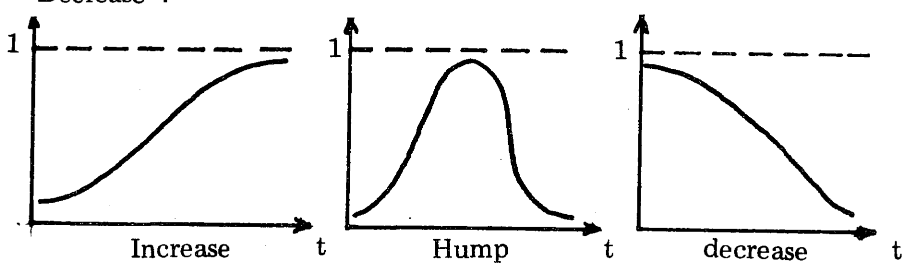


Fig. 1

Naturally, the function $g_{s,p}(t)$ may have jumps, and also periods of constancy, so that in particular cases, the pictures may look as on Fig. 2.

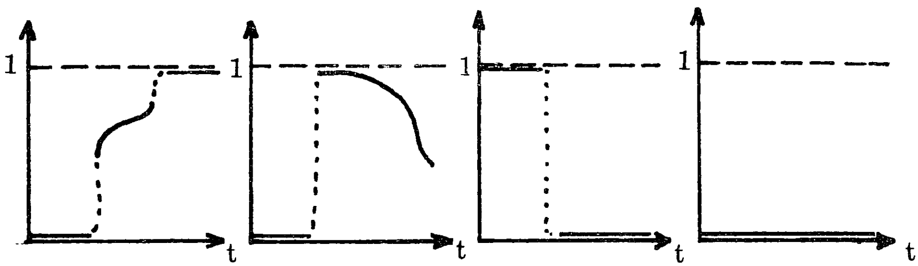


Fig. 2

The justification of Postulate 1 is as follows : imagine that at time t the scientist s is not qualified for the position p; then the value of admissibility function is 0. As his scientific authority increases, he may become more eligible for the position p, and $g_{s,p}(t)$ increases; in particular, the jumps may occur at the moments such as his Ph.D., etc.

However, as the time goes on, he may start being less and less acceptable for the position p, simply because he may be overqualified for it. The jumps downwards may occur at times such as his retirement, etc., where he may become totally unacceptable for a given position.

Fig. 3 shows a hypothetical change of admissibility of a person for the position as head of a laboratory.

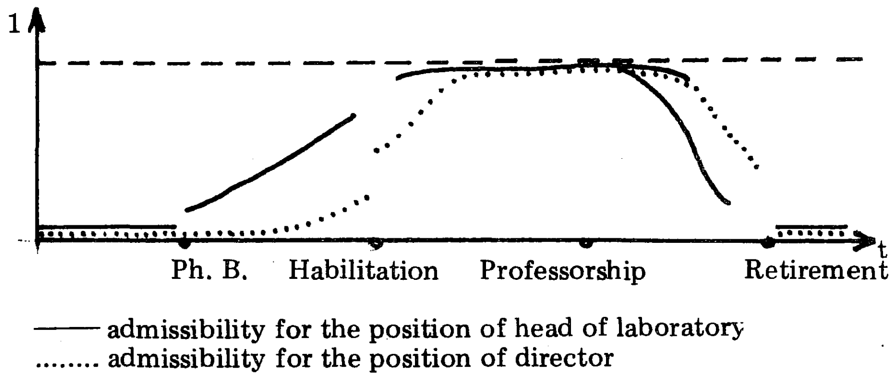


Fig. 3

Naturally, in some cases the admissibility only decreases all the time (e.g., for the position of junior assistant, beginning from the time of graduation from the university); it may also continuously increase (e.g. for the position of honourary president of a scientific society, where for a long time the admissibility stays at 0, and then may move upward). Finally, for some cases, the admissibility may be constant throughout, for instance equal identically 0 (e.g. if the scientist s is a linguist, and p denotes the position of, say, director of nuclear research institute).

Now, the admissibility of an occupancy function φ, at time t, will be determined by the "weakest link" principle, specified by the following

POSTULATE 2. *The admissibility* $a_\varphi(t)$ *of an occupancy function* φ *at time* t *equals*

$$(2)\quad a_\varphi(t) = \min\{\, g_{s,p}(t) : \varphi(p) = s \,\}$$

Thus, to determine $a_\varphi(t)$ one considers all positions p, and admissibilities $g_{s,p}(t)$ of persons assigned to these positiions under φ; the minimal of these admissibilities is, by definition, the admissibility of the whole occupancy function.

From Postulates 1 and 2 follows

THEOREM 1. *The function* $a_\varphi(t)$ *satisfies the same relation* as each $g_{s,p}(t)$, that is, for all $t_1 < t_2 < t_3$

$$(3)\quad a_\varphi(t_1) > a_\varphi(t_2) \Rightarrow a_\varphi(t_2) \geqslant a_\varphi(t_3).$$

For the proof, assume that the premise in implication (3) holds for some $t_1 < t_2$, and let s_o, p_o be the pair with $\varphi(p_o) = 0$ for which the minimum is attained at t_2. We have then

$$g_{s_o,p_o}(t_2) = a_\varphi(t_2) < a_\varphi(t_1) \leqslant g_{s_o,p_o}(t_1).$$

Thus, $g_{s_o,p_o}(t)$ decreases between t_1 and t_2, and by Postulate 1, we must have

$$g_{s_o p_o}(t_2) \geqslant g_{s_o,p_o}(t_3) \geqslant a_\varphi(t_3),$$

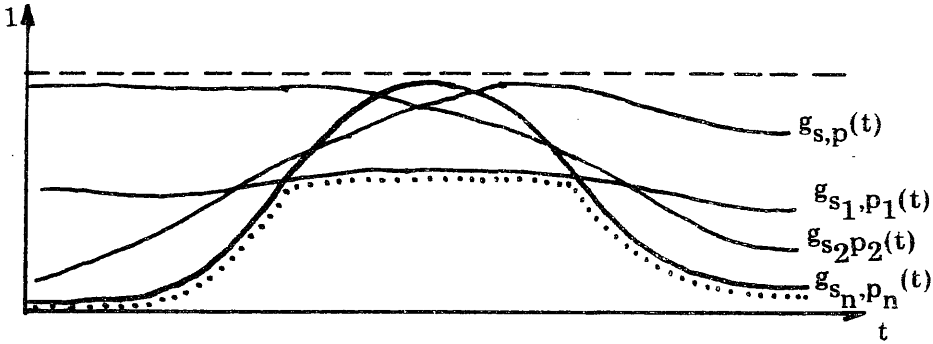
which completes the proof.

The situation is perhaps best illustrated with the following greatly oversimplified example. Imagine that $S = \{s_1, s_2, s_3\}$ and $p = \{p_1, p_2, p_3, p_4\}$, and let φ be the assignment

$p_1 \rightarrow s_1$
$p_2 \rightarrow s_2$
$p_3 \rightarrow s_3$
$p_4 \nearrow$

so that scientists s_1 and s_2 hold positions p_1 and p_2 respectively, while s_3 holds the remaining positions p_3 and p_4.

Fig. 4 shows the functions $g_{s_1,p_1}(t)$, $g_{s_2,p_2}(t)$, $g_{s_3,p_3}(t)$, $g_{s_3,p_4}(t)$ and their minimum $a_\varphi(t)$



oooo admissibility a_φ (t)

Fig. 4

Theorem 1 asserts therefore that admissibility of any occupancy function has the same "single-peakedness" property as the admissibility functions $g_{s,p}(t)$ for individual scientists and positions : in any given time interval it can be of one of the three types only, as depicted on Fig. 1.

3.3. *Preferences*

We shall now consider another important feature of the system, so far unexplored, namely the fact that various positions in P have different "values".

The discussion of the nature of these values will be postponed till the next sections. At this moment, it is sufficient to rely only on the intuition according to which the differences in values of various positions p are related to the fact that each of them gives at least partial access to some scientific goods, either directly, or by providing control over some other goods (such as distribution of research finances, fellowships, rights of publications, refereeing, etc.).

The overall effect of differences in values of positions of P is that the scientists are not indifferent with respect to various occupancy functions. Firstly, the basis for judgment (of a given occupancy function φ) for the scientist s is the set $\varphi^{-1}(s)$ of positions to which he would be assigned under φ. Secondly, given two occupancy functions φ_1 and φ_2 with $\varphi_1^{-1}(s) = \varphi_2^{-1}(s)$, that is, occupancy functions under which he would have the same positions, the scientist s need not be indifferent between them : he may judge them according to the positions occupied in φ_1 and φ_2 by his friends, enemies, superiors, subordinates, etc.

Admittedly, when a possible change of occupancy function is discussed (say, in a nominating committee), the discussion concerns usually some alternative functions $\varphi_1, \varphi_2 \ldots$ which differ very little one from another : the differences are only in the positions under discussion, the remaining positions are not taken into consideration (they are assumed to be equal to those under the "present" function φ_t). Nevertheless, it will be convenient to postulate formally that to each scientist s there corresponds a preference relation $\geqslant_s$ over the class of all functions φ. The symbol

$$\varphi_1 \geqslant_s \varphi_2$$

will mean that scientist s prefers weakly (i.e. he prefers or is indifferent) φ_1 to φ_2. The relation $\geqslant_s$ will be assumed connected and transitive for every s, i.e. we have

POSTULATE 3. *For every* $s \in S$ *and all occupancy functions* φ_1, φ_2, φ_3

(4) *either* $\varphi_1 \geqslant_s \varphi_2$ *or* $\varphi_2 \geqslant_s \varphi_1$ (or both);

(5) *if* $\varphi_1 \geqslant_s \varphi_2$ *and* $\varphi_2 \geqslant_s \varphi_3$, *then* $\varphi_1 \geqslant_s \varphi_3$.

In the usual way, the strict preference $\geqslant_s$ and indifference $\sim_s$ are defined as :

(6) $\varphi_1 >_s \varphi_2$ if $\varphi_1 \geqslant_s \varphi_2$ and not $\varphi_2 >_s \varphi_1$;

(7) $\varphi_1 \sim_s \varphi_2$ if $\varphi_1 \geqslant_s \varphi_2$ and $\varphi_2 \geqslant_s \varphi_1$.

From (4) and (5) it follows that $\sim_s$ is an equivalence and that $>_s$ is a strict order in the class of equivalence classes of $\sim_s$.

The system of relations $\{ \geqslant_s, s \in S \}$ allows now introducing some concepts relevant for the group structure of the set S of scientists.

At the beginning, let us introduce the following two definitions, which will play basic role in the considerations below.

DEFINITION 1. The scientist s_1 will be called in *preferential concorde* with s_2, to be denoted by $s_1 -:: s_2$, if

(8) $\varphi >_{s_1} \varphi' \Rightarrow \varphi >_{s_2} \varphi'$.

DEFINITION 2. The preferences of s_1 and s_2 will be called *orthogonal*, to be denoted by $s_1 \perp s_2$, if

(9) $\varphi \not>_{s_1} \varphi' \Rightarrow \varphi \sim_{s_2} \varphi'$.

Intuitively, preferential concorde of s_1 with respect to s_2 means that the preferences of s_2 are the same as those of s_1, except that in case when s_1 is indifferent between some occupancy functions, s_2 may have strict preferences among them.

In terms of motives of supporting, one can say that in this case s_2 will be inclined to support the tendencies of s_1 to change the existing occupancy towards a new preferred occupancy function, since these changes are also preferred by him. On the other hand, s_1 will not be inclined to block the tendencies of s_2 — he will either support them, or be indifferent to them (observe that the relation of preferential concordance $-::$ is not symmetric with respect to s_1 and s_2).

The relation $\perp$ of orthogonality (obviously symmetric with respect to s_1 and s_2) means that s_1 and s_2 have no motive either to support or to block one another : one is indifferent to any changes toward occupancy functions preferred by the other.

With the provisions discussed below, one can hypothesise that any group of scientists supporting one another will consist of individuals who are either in the relation of preferential concordance, or will have orthogonal preferences. Thus, the relational structure

$\langle S, -::, \perp \rangle$

could be called a *pre-structure of coalitions* in S : any coalition system which violates the relations $-::$ and $\perp$ (i.e. which contains a coalition with two or more individuals connected neither by $-::$ nor by $\perp$) is likely to be unstable. Indeed, if s_1 and s_2 are neither in relation $-::$ nor in relation $\perp$, then there exists two occupancy functions such that their preferences on these two functions are both strict and opposed. In such cases, the interests of s_1 and s_2 do not agree, and they would tend to break away from any coalition which contains both of them.

The provision mentioned above concerns the validity of this hypothesis : for the tendency to break away from a coalition containing both s_1 and s_2 it is necessary that the occupancy functions on which their preferences strictly differ are sufficiently highly admissible, so that they constitute a real possibility.

This necessitates some weakening of the definitions of relations $-::$ and $\perp$, by restricting the implications (8) and (9) to subsets of Φ which consists of occupancy functions with sufficiently high admissibility. Formally, one can define the relations $-::_r$ and $\perp_r$ by requirements :

(10) $s_1 -::_r s_2$ if for all φ, φ' such that $a_\varphi(t) \geq r$, $a_{\varphi'}(t) \geq r$
$\varphi >_{s_1} \varphi' \Rightarrow \varphi >_{s_2} \varphi'$.

and similarly.

(11) $s_1 \perp_r s_2$ if for all φ, φ' such that $a_\varphi(t) \geq r$, $a_{\varphi'}(t) \geq r$
$\varphi \not\sim_{s_1} \varphi' \Rightarrow \varphi \sim_{s_2} \varphi'$.

It follows at once that as r increases, the relations $-::_r$ and $\perp_r$ become weaker (more pairs become related), that is : if $r < r'$, then

$$s_1 -::_r s_2 \Rightarrow s_1 -::_{r'} s_2,$$

$$s_1 \perp_r s_2 \Rightarrow s_1 \perp_{r'} s_2.$$

Since the values of admissibility $a_\varphi(t)$ and $a_{\varphi'}(t)$ change in time, both relations $-::_r$ and $\perp_r$ are time-dependent. This may account for the fact that a coalition structure satisfying the stability condition at time t, need not be such at a later time t'.

3.4. *Power*

In order to be able to express the hypotheses concerning the mechanisms underlying the evolution of a scientific community, one more concept is needed, namely that of power. Power will be connected with a set of positions occupied by one scientist, and will be expressed as the force which this scientist can exert towards the change from the existing function φ_t to a new function φ, or against such a change.

If at some moment t the existing occupancy function is φ_t, then the set of positions occupied by s is $\varphi^{-1}(s)$. Suppose now that a change is contemplated, which will replace φ_t by some other function φ. Obviously, s will support this change if $\varphi_t <_s \varphi$ and will oppose it, if $\varphi <_s \varphi_t$. If $\varphi_t \sim_s \varphi$, he may support it, oppose it, or remain neutral in any efforts to replace φ_t by φ.

If the scientist occupies the positions $\varphi_t^{-1}(s)$ under φ_t, his power (speaking qualitatively) is derived from various sources : firstly, he may occupy positions which give him the right of making certain types of decisions influencing the fate of others in some specific way. Being a head of department, director, member of an editorial committee, committee which distributes funds or fellowships etc., can serve as an example. The power may also lie in the ability of exerting tacit or direct pressure on others by being in position of "transaction" (called "co-position" in Nowakowska 1976) of some kind. As an example, one can take the process of refereeing someone's Ph.D. dissertation. Barring the extreme cases of very good and very bad dissertations, the middle cases might sometimes offer the possibility of pressure on the supervisor of the given Ph.D. One could argue that the set of such informal or semi-formal ties in a scientific community is of an extreme importance for the prediction of the actual development in a given concrete situation. For the description in terms of the general laws, one can only rely on the fact that certain positions in P offer more chance of entering into such bargaining positions, hence should be assigned higher power.

For the considerations below, it will be sufficient to present the situation in terms of two summary indices, denoted by

$$f_s(\varphi_t \rightarrow \varphi)$$

and

$$f_s(\varphi_t \,//\, \varphi)$$

to be interpreted as follows. The value $f_s(\varphi_t \rightarrow \varphi)$ is the total pressure which s can exert *towards* the change from φ_t to φ. The second value, $f_s(\varphi_t \,//\, \varphi)$ is the *resistance which* s can offer against the change from φ_t to a new occupancy function φ.

The following two postulates about the forces $f_s(\varphi_t \rightarrow \varphi)$ and $f_s(\varphi t \,//\, \varphi)$ will be utilized in the subsequent considerations.

POSTULATE 4. *The forces* $f_s(\varphi_t \rightarrow \varphi)$ and $f_s(\varphi_t \,//\, \varphi)$ *are additive, that is, the total force of a group of scientists for (or against) a given* *change equals the sum of their individual forces.*

POSTULATE 5. *The forces* $f_s(\varphi_t \to \varphi)$ and $f_s(\varphi_t // \varphi)$ *depend on the positions occupied by* s *under* φ_t *and tend to decrease or increase in time together with the admissibility of* s *for the positions which he occupies under* φ_t.

This postulate means that when s is occupying some positions such that he is becoming more and more admissible for them, his force will tend to increase, while in the case when he is becoming less admissible for these positions, his force will tend to decrease.

4. *Stability and monopolization.*

We are now in a position to begin formulating the hypotheses which describe the mechanisms underlying the evolution of scientific community.

It is perhaps worthwhile to recapitulate the concepts introduced so far,·which will serve as ingredients for the further definitions and hypotheses

The logically independent concepts, which may therefore serve in some sense as "primitives" of the system, are :

— the class Φ of all occupancy functions $\varphi : P \to S$;

— the functions $g_{s,p}(t)$ which describe the changes of admissibility of scientist s for the position p;

— the preferences $\geqslant_s$ of scientists in the class Φ;

— the forces $f_s(\varphi_t \to \varphi)$ and $f_s(\varphi_t // \varphi)$ which a scientist s, under assignment φ_t, can exert towards and against the change from φ_t to φ.

The most essential among the concepts defined in terms of the above, are :

— the set $\varphi^{-1}(s)$ of all positions occupied by s under the function φ;

— the function $a_\varphi(t)$ describing the dynamic changes of admissibility of the occupancy function φ;

— the relations $-::$ and $\perp$ or preferential concordance and orthogonality between the scientists

Assume now that at the time t, when the occupancy function is φ_t, a change of φ_t into a new function φ is being contemplated.

The function φ may represent some radical changes in the whole community, or may mean a "local" change, say a nomination of a scientist to a certain position (so that, in the latter case, $\varphi_t(p) = \varphi(p)$ for all positions except a limited number of positions p).

With respect to the change from φ_t to φ, all scientists will divide into three categories :

(a) the set $A^+(\varphi_t, \varphi)$ of those s for whom $\varphi >_s \varphi_t$ (favouring the change);

(b) the set $A^-(\varphi_t, \varphi)$ of those, s for whom $\varphi_t >_s \varphi$ (opposing the change);

(c) the set $A^0(\varphi_t, \varphi)$ of those s for whom $\varphi_t \sim_s \varphi$ (indifferent with respect to the change).

We can now formulate the following

POSTULATE 6. *The change from φ_t to φ does not occur if*

$$(12) \quad \sum_{s \in A^-} f_s(\varphi_t // \varphi) > \sum_{s \in A^+ \cup A^0} f_s(\varphi_t \rightarrow \varphi)$$

where for simplicity $A^+ = A^+(\varphi_t, \varphi)$, $A^0 = A^0(\varphi_t, \varphi)$ *etc* .

In other words, the change *to* φ *will not* occur if the total force against it is greater than the total force which could possibly be gathered for it (i.e. the force of those who are for the change, plus the supporting force of those who are indifferent to it).

This allows to characterize the conditions for stability of the function φ_t : it is stable if there are not enough forces to replace it by any other function φ. Formally, we have

DEFINITION 3. The occupancy function φ_t is stable, if the condition (12) holds for any φ.

It is important to observe that the lack of stability of the existing occupancy function φ_t does not imply that it will be changed. Indeed, Postulate 5 specifies only when an occupancy function will not be replaced by another one. If φ_t is not stable, then there is one or more alternatives such that the total forces which *could* support the change exceeds the resistance. It does not imply, however, that there actually be forces strong enough to support one alternative over φ_t, since the forces for a change may split among several alternatives, and moreover, the persons indifferent to the change may not join the persons supporting the change.

The definition of stability above did not utilize the concept of admissibility of φ_t and φ. Generally, one could expect that under "normal" circumstances, if there exists φ such that $a_\varphi(t) > a_{\varphi_t}(t)$, then φ_t cannot be stable at the moment t : if there exists at least one assignment φ which is more admissible than φ_t, then the forces which block φ ought to be smaller than the forces favouring the change.

The above is a condition of "fairness" or "social justice", and its violation may in some cases signify the existence of a "blocking monopole". In terms of formal definitions, it may be summarized as follows :

DEFINITION 4. The structure of a scientific community is *fair*, if whenever φ_t is stable, then $a_{\varphi_t}(t) > a_\varphi(t)$ for every φ.

Equivalently, S is fair if a socially unfair φ cannot be stable, or if there exists a φ which in socially better than φ_t, then φ_t cannot be stable.

Since by the theorem on "single-peakedness" of a_φ, the admissibility of the "present" arrangement φ_t will begin to decrease after some time, the scientific community faces the following dilemma :

— to ensure fairness, one must make frequent changes;

— to ensure stability, one must resign from fairness.

A partial converse to definition 4 is the following

DEFINITION 5. The set

$$U \subset A^-(\varphi_t, \varphi)$$

is a φ-*blocking monopole*, if the following conditions are satisfied :

(a) $a_\varphi(t) > a_{\varphi_t}(t)$;

(b) $\sum_{s \in U} f_s(\varphi_t // \varphi) > \sum_{s \in A^+ \cup A^0} f_s(\varphi_t \to \varphi)$

where, as before, $A^+ = A^+(\varphi_t, \varphi)$, $A^0 = A^0(\varphi_t, \varphi)$

Thus, a φ-blocking monopole is a set of scientists who can successfully block the change from φ_t to a more admissible occupancy function φ.

The definition of a blocking monopole is relative to the new occupancy φ. Generalizing the above definition, we have

DEFINITION 6. A set U is a Q-*blocking* monopole, if $U \subset A^-(\varphi_t,\varphi)$ for all $\varphi \in Q$, and for any $\varphi \in Q$ such that $a_\varphi(t) > a_{\varphi_t}(t)$ we have

$$\sum_{s\in U} f_s(\varphi_t//\varphi) > \sum_{s\in A^+(\varphi_t,\varphi) \cup A^0(\varphi_t,\varphi)} f_s(\varphi_t \to \varphi).$$

Thus, a Q-blocking monopole is such that it may successfully block any occupancy function from Q which is more admissible that φ_t.

In a similar way one can now define the concept of an enforcing monopole : it is a group of scientists who are jointly strong enough to enforce an arrangement φ which is less admissible than φ_t. Formally, we have

DEFINITION 7. The set $U \subset A^+(\varphi_t,\varphi)$ is an φ-*enforcing* monopole, if

(a) $a_{\varphi}(t) < a_{\varphi_t}(t)$;

(b) $\sum_{s \in U} f_s(\varphi_t \rightarrow \varphi) < \sum_{s \in A^- \cup A^0} f_s(\varphi_t // \varphi)$,

and U is a Q-enforcing monopole, if $U \subset A^+(\varphi_t, \varphi)$ for all $\varphi \in Q$, and whenever $\varphi \in Q$ is such that $a_{\varphi}(t) > a_{\varphi_t}(t)$, then the condition (b) above holds.

Needless to say, a group U may be a blocking monopole with respect to some set Q, and an enforcing monopole with respect to some other set Q'.

5. *Hypotheses about monopoles*

From the definitions above one can obtain some consequences about the strategies of monopoles. The considerations will concern both types of monopoles, i.e. blocking and enforcing.

It is perhaps worth to observe that the concept of a monopole need not necessarily carry negative connotations. Indeed, though a monopole is, by definition, blocking some arrangements which are more admissible than the existing one, or enforce some which are less admissible than it, such an event need not be bad. The crucial point is whether the blocked or enforced arrangement will be increasing or decreasing in admissibility.

As an example, imagine that the present arrangement φ_t is declining, or about to begin declining in admissibility, and a new arrangement φ is enforced by some group. Suppose that *at time* t, the new arrangement is less admissible than φ_t. By definition, such a group forms a monopole — at first an enforcing one, and then perhaps a blocking one, in order to defend the new arrangement φ against further changes.

It may well happen that the admissibility of the new arrangement φ will increase in time (such is the case of nomination to a high position someone young and without adequate scientific authority at the time of nomination, but whose authority is rapidly growing).

In such cases the monopole cannot be assessed negatively. The negative assessment is justified only if the enforced or defended arrangement is not only worse than the replaced or alternative one, but is also becoming less and less admissible — so to speak, a monopole can be judged negatively if it creates a social injustice, or scientific unfairness, which is getting worse.

Suppose now that Q is the class of arrangements in which the monopole U is interested (say, to block). If one looks at the conditions for U to be a Q-blocking monopole, one can see that there are several ways which will enhance the preservation of the conditions under which elements of Q are blocked.

One way is by allowing φ_t with possibly high admissibility, so that there may be fewer φ in Q which are more admissible than φ_t. This leads to a

HYPOTHESIS 1. A monopole interested in avoiding an arrangement from Q will attempt to support the "fair" changes, that is, changes towards more admissible arrangements, as long as the new arrangements are not in Q.

In other words, members of the monopole will try to appear fair in matters which do not concern the interests of the monopole.

Another way of preserving the monopole condition is to preserve the defining inequality for the forces. This, in turn can be achieved in the following ways :

(a) increasing the number of summands on the left hand side (co-opting new members to the monopole);

(b) decreasing the number of summands on the right hand side (winning the neutrals to the monopole's side);

(c) increasing the individual terms on the left hand side (increasing the individual powers of monopole members);

(d) decreasing the individual terms on the right hand side (decreasing the individual powers of the opponents).

Next, the character of the set Q and the stability of the monopole may be combined into the

HYPOTHESIS 2. A monopole will be more stable, if the set Q which it is blocking is small and of minor importance for a large number of scientists.

As an example, one can use here a monopole formed out of editorial committee of some scientific journal of narrow specialty.

When one considers also the internal structure of the monopole, induced by the relation of preferential concordance —::, and the individual powers of the members of the monopole, one can distinguish two extreme types :

(a) a monopole U which has one member s_0 with high powers $f_{s_0}(\varphi_t \to \varphi)$ or $f_{s_0}\varphi_t//\varphi)$, and such that s—::$s_0$ for $s \in U$, but not necessarily s—::s' for other members of U.

(b) a monopole U with s—::s' for all $s' \in U$, and such that $f_s(\varphi_t \to \varphi)$ and $f_s(\varphi_t//\varphi)$ are small for all $s \in U$.

The first type is exemplified by a "school", consisting of a professor with high power, and a number of those whom he favours. Here the relational structure (with respect to preferential concordance —::) is "starlike", with s_0 (professor) occupying the centre.

The case (b) is exemplified by, say, a group of members of a professional society, large enough to block some decisions in voting in general assembly, yet where each member has individually small power.

In both cases one can expect some kind of stability of blocking, despite the fact that the group as such may not be too stable. In each case, the monopolizing group may fluctuate, some members of the monopole leaving it, and some others joining. How long the assignments from Q will remain blocked depends here on the power of the central figure in case (a), and on the size of fluctuations of the joint power in case (b).

Next, one could try to formulate some other conjectures about the monopoles, not derived directly from the formal definitions.

Given a present arrangement φ_t, the scientist s has positions $\varphi_t^{-1}(s)$, and he would or would not join the monopole depending on his predictions as to the rewards which he may get from joining it.

One obvious reward may lie in the possibility of blocking those assignments φ which offer him positions worse than those which he has at present, or in enforcing such arrangements which offer him better positions. The rewards, however, need not involve positions, but also other types of "goods", such as invitations for lectures, research funds, publication rights, or simply recognition of one's work.

Generally, when a person considers the possibility of entering a monopole, he takes into account such factors as his position and expected time of being in this position, expected time of survival of the monopole, and the costs and profits from membership.

HYPOTHESIS 3. If a person expects that the monopole will not survive long, he will join it only if the rewards greatly exceed the cost.

HYPOTHESIS 4. Every scientist has his subjectively optimal expected time of membership in a monopole, depending on his expected length of holding the present position. When his position changes, he will try to join a higher monopole, i.e. such monopole whose leaders have higher positions.

It is clear that the interests of members of a monopole coincide at least to the extent that they all prefer the existing φ_t to elements of Q in case of a blocking monopole, or conversely, for an enforcing monopole. However, beyond that, the preferences (interests) of members of the monopole may differ to some greater or lesser extent. In connection with this, one may formulate

HYPOTHESIS 5. The less conflicts of interests between members of the monopole, the stronger is the monopole.

Finally, comparing the expected and actual rewards, one may formulate

HYPOTHESIS 6. The more often members of the monopole receive at least the reward they expected, the more stable is the monopole.

HYPOTHESIS 7. The more often the waiting time for the reward exceeds the expected waiting time, the less stable is the monopole.

6. *Personal equilibrium and alienation.*

It is now possible to describe in terms of the suggested system the concepts of personal equilibrium, and the type and degree of alienation.

Consider therefore the actual arrangement φ_t and a fixed scientist s, whose set of positions under φ_t is $\varphi_t^{-1}(s)$. Let $p_1, p_2 \ldots$ be the positions in $\varphi_t^{-1}(s)$, and consider the functions $g_{s,p_i}(t)$ for positions $p_1, p_2 \ldots$.

According to Postulate 1, each of these functions, at the moment t, is either still in its increase period (possibly period of constancy), or is already in its period of decrease.

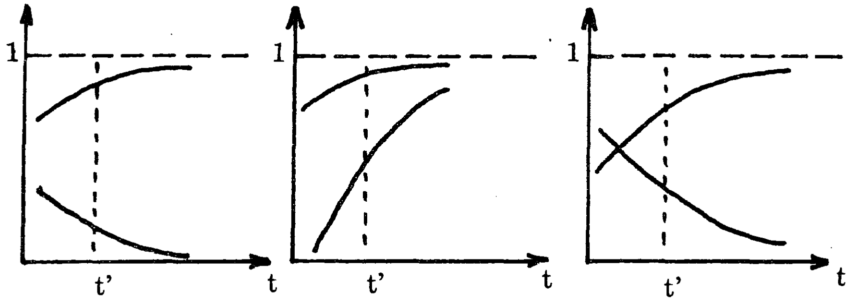
One can now define the phenomena of internal disequilibrium, external disequilibrium and alienation. Speaking first qualitatively, the external disequilibrium is characterized by the fact that some of the values of the functions $g_{s,pi}(t)$ are low and some are high. If this property is true at the moment t, but is going to diminish some time in the future, the disequilibrium may be called *apparent*; otherwise, it may be called real. Next, *potential* internal disequilibrium may be characterized by the requirement that all values of $g_{s,pi}(t)$ are close at the moment t, but some of these functions are going to decline, and some will grow up, so that there will be an internal disequilibrium at some time in the future.

Schematically, for the case of 2 positions only, the above types of internal disequilibria may be characterized on Fig. 5.

The above concepts are evident enough, so that repeating them in form of formal definitions seems unnecessary.

Now, an *external* disequilibrium occurs if — again, speaking qualitatively — at least one of the values $g_{s,p}(t)$ is low, and declining, while there exists another φ, more admissible than φ_t, and preferred to φ_t by s, in which s would have higher positions. Finally, *alienation* occurs, if there is an external disequilibrium, and the function φ satisfying the above conditions is blocked by some monopole.

To put it formally, we may formulate



Internal disequilibrium at the time t'

real apparent potential

Fig. 5

DEFINITION 8. The occupancy function φ_t leads to *external disequilibrium* for s, if the following conditions are met : there exists φ such that

(a) there exist $p \in \varphi_t^{-1}(s)$, $p' \in \varphi^{-1}(s)$ with $g_{s,p'}(t) > g_{s,p}(t)$;
(b) $\varphi >_s \varphi_t$;
(c) $a_\varphi(t) > a_{\varphi_t}(t)$.

DEFINITION 9. The occupancy function φ_t leads to *alienation* of s, if in addition to conditions (a) — (c) above, we have
(d) the assignment φ is blocked.

The intuitive justification of the necessity of all four conditions (a) — (d) for alienation is the following.

For simplicity, imagine that the present assignment φ_t gives only one position to s, that is, $\varphi_t^{-1}(s)$ consists of only one position p.

Imagine now that an alternative occupancy function exists, which assigns to s another position p'.

For the external disequilibrium, condition (a) states that under alternative assignment φ, scientist s would occupy more appropriate position.

This condition alone does not guarantee either disequilibrium, or alienation : a necessary further prerequisite is that s must prefer the new assignment φ to the present assignment φ_t (condition (b)). Indeed, some persons could be employed more adequately than they are employed, but if they do not want the new positions, there is no reason to suppose that they feel alienated.

These two conditions, i.e. (a) and (b), in turn, are still insufficient for disequilibrium : the alternative occupancy function must not only be more appropriate and preferred by s, it must also be more acceptable "socially", i.e. it must not lead to lowering the admissibility of positions of others.This is stated in condition (c).

Altogether, s is in an external disequilibrium, if there is an alternative assignment which is at the same time more fair than the existing one, and both more appropriate and preferable to s.

Blocking such an assignment (condition (d)) leads to alienation of s (with respect to the φ-blocking monopole).

One can now see that any measure of the degree of alienation must contain the components corresponding to (a)—(d), which may be referred to as

(a) individual injustice component,
(b) preference-blocking component,
(c) social unfairness component,
(d) strength of monopole component.

If (a) is highly violated, that is, the difference $g_{s,p}'(t) - g_{s,p}(t)$ is large, the scientist s will feel highly alienated, because the blocked alternative φ is such that we would be in a highly more appropriate position than at the present assignment φ_t.

If (b) is highly violated, that is, the blocked alternative is "very much" preferred to the present φ_t, the scientist s will feel highly alienated because he is deprived of the highly desired goods.

If (c) is highly violated, that is, the difference $a_\varphi(t) - a_{\varphi t}(t)$ is large, then s will highly alienated because the new alternative φ which is being blocked is not only better for him, but would also be much more acceptable socially.

Finally, if (d) is highly satisfied, that is, the blocking monopole is very strong, then s will feel highly alienated because he has more feeling of "powerlessness".

Any adequate measure of the degree of alienation would therefore combine in an appropriate way the components (a)—(d) for all alternatives blocked by some monopole U.

7. *Hypotheses about alienation, monopolization and status disequilibrium.*

Let us observe first that the concepts of internal and external status disequilibrium as defined above are closely related to the concepts of status disequilibrium of Randall and Strasser (1975). According to them, a necessary condition for status disequilibrium is status multidimensionality, and the existence of separate rankings in each dimension. Disequilibrium occurs if the ranks do not "match".

In the case under considerations, when the situation is restricted to science, the dimensions of status correspond to various positions occupied under φ_t by the same person (in case of internal disequilibrium), and also admissibilities of various positions in alternative assignments φ (in case of external disequilibrium).

It is worth to mention that the terms "internal" and "external" as used here do not carry any psychological connotations : an internal disequilibrium is such that it is defined only in terms of the existing assignment φ_t, without reference to what "could be", while an external disequilibrium calls for comparison of the actual and the potential assignment.

The main mechanisms conjectured by Randall and Strasser are formulated as a hypothesis that a person will try

(a) to maximize the highest rank, and

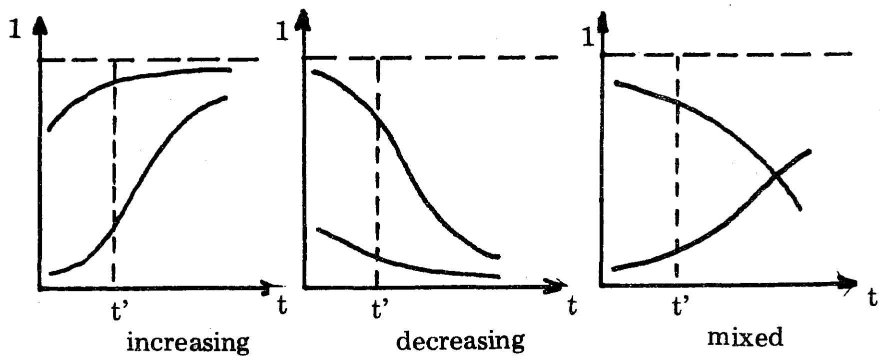
(b) to equalize all ranks by increasing the "lagging" ones.

To see how these mechanisms carry over to the present case, let us proceed systematically, and consider first an internal disequilibrium (regardless of the possible existence of external disequilibrium or alienation).

Thus, we consider only the positions *held*, without relating them to those which could be held, and suppose that the person in question holds two positions.

(a) *Apparent internal disequilibrium*

Clearly, one can distinguish here three basic types, as depicted on Fig. 6.



Apparent internal disequilibrium at time t'

Fig. 6

HYPOTHESIS 8. An increasing apparent internal disequilibrium occurs most often for scientists in the early stages of the career, when they are somewhat prematurely advanced.

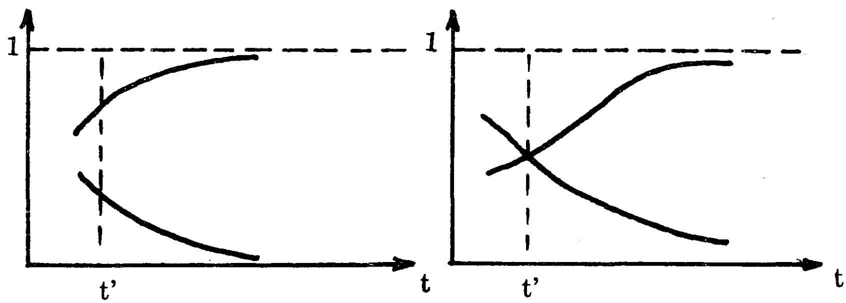
HYPOTHESIS 9. A decreasing apparent internal disequilibrium occurs most often for scientists in the late stages of the career, of for scientists who become ill or disabled.

HYPOTHESIS 10. A mixed internal disequilibrium occurs most often for scientists in the early stages in the career, when they are "selectively alienated", i.e. kept on some positions which they outgrow.

Clearly, the apparent internal disequilibrium does not present too much of a problem for a person, and there is no reason to assume that a person would display any tendency to reduce it : the situation will "equalize" in the course of time within some finite time horizon.

(b) *real and potential internal disequilibrium*

This is typified on Fig. 7 where the disequilibrium tends to become more and more severe. Here one can state



Internal disequilibrium at time t'

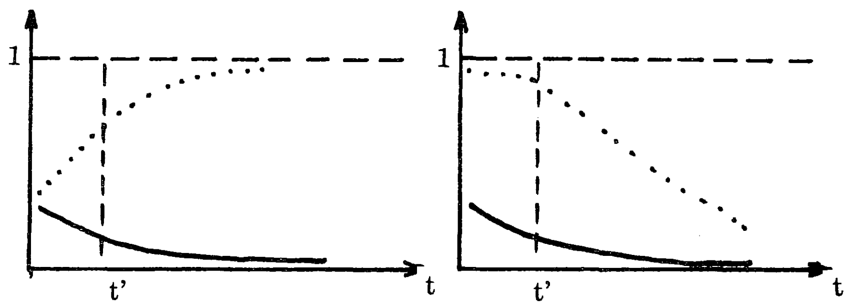
real potential

Fig. 7

HYPOTHESIS 11. In case of a real (potential) internal disequilibrium, a person will try to reduce (prevent) it by advancing in position, even prematurely (moving from "upper branch" to a lower curve), or sometimes even resigning from some positions, if they are "unbecoming" (resigning from a position represented by "lower branch").

(c) *External status disequilibrium*

Let us now consider a more interesting case, namely of external status disequilibrium, possibly combined with alienation. Here a necessary (but by no means sufficient) condition is the existence of an alternative φ which offers person s more admissible positions. For simplicity, let φ_t and Σ give the person s the position only. For an external disequilibrium, the picture must be such that the admissibility of position held (solid line) lies below that for the position under alternative φ (dotted line); see Fig. 8.



—— actual $g_{s,p}(t)$

.... potential $g_{s,p}(t)$

External disequilibrium at time t'

Fig. 8

For an external status disequilibrium, the picture must be not only such as on Fig. 8, but also the new assignment must be preferred by s, and socially more fair than φ_t. If it is blocked, there is also alienation.

Though the configuration as on Fig. 8 alone does not suffice for disequilibrium or alienation, one can make hypotheses about the types of configurations which are most likely to be associated with disequilibrium and alienation.

HYPOTHESIS 12. The external disequilibrium and alienation are more likely to be associated with cases when the two curves of admissibility diverge, than when they converge (they diverge if what s holds at present becomes less and less admissible, while what he could have becomes more and more amdissible).

Of course, the remarks concerning the measure of alienation can be translated into hypotheses, such as that (in the above case), the greater the difference between the two curves, the higher alienation, etc. Such hypotheses, as being rather tautological, will be omitted here.

One can, however, state the following hypotheses relating the levels of positions and levels of alienation.

HYPOTHESIS 13. The substitution of positions (or goods) leading to a decrease of alienation is easier to achieve for those on lower positions. More precisely : the same degree of de-alienation is achieved by smaller advancement from lower position than from higher position.

HYPOTHESIS 14. The substitution of preferences (change of preference for some positions or goals, achieved by means such as sociotherapy etc) which leads to the same level of de-alienation is easier to achieve for those on lower levels of positions than for those on higher levels of positions.

HYPOTHESIS 15. It is easier to introduce new rules of admissibility which would lead to the same level of de-alienation of those on lower positions, than for those on higher positions

HYPOTHESIS 16. An increase of strength of the monopole leads to a greater increase of alienation of those on higher positions than on those on lower positions.

The above hypotheses correspond respectively to the conditions (a) — (d) for alienation.

Let us now look at the situation from the point of view of a monopole which alienates a group of persons. Such a monopole is, generally, interested in preventing the appearance of a counter-monopole.

The hypothesis about the above may be formulated as follows :

HYPOTHESIS 17. The appearance of a counter-monopole in the group of alienated persons is *less* likely, if

(a) the variance of the degree of alienation among those alienated is large;

(b) the group structure, among them that induced by the relation —:: is loose (i.e. there are few connections altogether and no subgroups strongly connected).

The intuitive juistification of point (b) requires no comment. As for (a), the hypothesis asserts that the more "homogeneous" with respect to their levels of alienation is the group of alienated persons, the more likely it is that they form a counter-monopole.

We have also

HYPOTHESIS 18. Each person perceives the distribution of levels of alienation in his reference group. The more skew to the right is this distribution (i.e. the more highly alienated persons), the more probable that a person will have a greater tolerance for alienation.

HYPOTHESIS 19. The larger is the group of alienated persons, and the greater the density of relations —:: of preferential concordance, the greater the chance of an appearance of transient coalitions, formed in order to enforce some partial goals against the monopole's blocking.

HYPOTHESIS 20. The greater is the chance of joining the monopole, the shorter is the average time of duration of transient coalitions from Hypothesis 19.

The above hypotheses concerned the appearance of countermonopoles, and the strategies of a monopole to preserve its existence. Finally, one can formulate some hypotheses about the individual reactions of persons who are alienated.

Generally, one may categorize such reactions into two broad categories : of fight and of withdrawal. The first can take on forms such as protests and complaints in higher authorities, letters to editors etc; the reactions of withdrawal may range from change of work, illness, to suicide.

One could expect that there exist some relations between time of reaction, its type, the degree of alienation, and the person's position.

HYPOTHESIS 21. The time of reaction of an alienated person tends to be shorter, if

(a) any of the alienation components is high;

(b) the admissibility of the present position is rapidly decreasing;

(c) a person belongs to the group related by preferential concordance, who are similarly alienated as he;

(d) a person is on a higher position.

HYPOTHESIS 22. Given that a reaction occurs, it is more likely to be of withdrawal type, if

(a) the person is on a lower position;

(b) the alienation concerns more "intangible" goods, such as recognition of one's work, etc.

The reaction is more likely to be of fighting type, if

(a) the person is on higher position ;

(b) the alienation concerns more "tangible" goods, such as research grants, travel funds etc.

Generally, it is obvious that a person will join a monopole if the prospective profits, in form of a share in the monopolized goods etc., are sufficiently high; in choosing between several monopoles, he will select one which he judges to be best, in the sense of its strength, prospective horizon of existence, and goods which it provides.

When a person is in a monopole. he receives some goods, and the chances of being satisfied increase. In such case, he will try after some time to join another monopols. These considerations suggest that the distribution of the duration time of participation in a monopole has the following "aging" property :

HYPOTHESIS 23. The longer a person belongs to a monopole, the greater the chances that he will leave it to join another monopole. Formally, if f(x) is the probability that the duration of membership in a monopole will be exactly x, and F(x) is the probability that this duration will be less than x, then f(x)(1 − F(x)) is an increasing function of x.

Here f(x)/(1 − F(x)) is the conditional probability that a person will belong to the monopole for exactly x, given that he belongs to it for x or more. In other words, this quantity represents the "defection rate" for those who are in the monopole for at least x.

NOTES

[1] For the concept of status disequilibrium, see Randall and Strasser (1975); for the Marxian view of the concept of alienation, see Jaroszewski (1965).

REFERENCES

T. M. JAROSZEWSKI (1965), Alienacja (in Polish : Alienation), Warszawa, PWN.

M. NOWAKOWSKA (1976), Monopolisierung und Entfremdung in der Wissenschaft : Ein formaler Ansatz. In : M. Brenner and H. Strasser (eds.), Die gesellschaftliche Konstruktion der Entfremdung. Campus Verlag, Frankfurt/New York.

M. NOWAKOWSKA (1978), Towards a formal theory of freedom (in press).

S. C. RANDALL, H. STRASSER (1975), On the theory of status disequilibrium. Some causes and consequences reconsidered. Preprint. Inst. for Advanced Studies, Vienna.

J. P. van Gigch, (1976), Planning for freedom. Management Science. 22, 949-961