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Control loss and Fayol's gangplanks☆

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Abstract

Williamson's (1971) model of control loss in organizational hierarchies describes the cumulative decay of influence of superiors over subordinates who are separated by a number of hierarchical levels in the chain-of-command. This paper shows that control loss may be deduced from a network theory of social influence, and it shows that ties among actors at the same hierarchical level—Fayol's gangplanks—may constrain control loss in organizational hierarchies. The structural mitigation of control loss by Fayol's gangplanks increases with superiors' span of control and depends on their capacity to maintain influence upon immediate subordinates in the presence of the lateral influences among subordinates.
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1. Introduction

How does organization structure constrain the development of shared opinions among organization members and affect the ability of managers to shape these agreements? What implications do variations in the authority structure of organizations have for the regulation of the decision premises (definitions of the situation) and broader organizational culture that shape organization members' activities? If the hierarchy of formal authority in an organization is conceptualized as a network of interpersonal influences that affects actors' opinions and attitudes on organizational issues, then general social psychological theories of opinion formation and attitude change in influence networks become applicable in principle to formal organizations and may be employed to construct a theory of the effects of an authority structure on managerial control and subunit coordination.

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In this paper, we analyze the phenomenon of managerial control in organizations from the perspective of Friedkin and Johnsen's social influence network theory (Friedkin, 1991, 1998, 1999; Friedkin and Johnsen, 1990, 1997, 1999). This theory has been under development since the 1950s by social psychologists and mathematicians concerned with how opinions (including consensus) are formed in situations where actors' opinions are modified by information about the opinions held by other actors (French, 1956; Harary, 1959; DeGroot, 1974). We show that Williamson's (1971) model of managerial control loss in a scalar chain-of-command is a deducible outcome of social influence network theory. We also show that control loss may be reduced by Fayol's gangplanks, that allow influences among subordinates at the same hierarchical level. In the following sections of the paper, the *control loss* construct is described, social influence network theory is described, and based on this theory a preliminary analysis of control loss is presented.

2. Control loss in a chain-of-command

In his classic work, *General and Industrial Management*, Fayol (1949) emphasized the importance of unity of command through a scalar chain of superiors but he also recognized the limitations of such organization. Scalar chains-of-command create problems of control:

> In large concerns, where a long scalar chain is interposed between top managers and the lower grades, orders and information have to go through a series of intermediaries. Each employee, intentionally or unintentionally, puts something of himself into the transmission of information and the execution of orders (Fayol, 1949).

Tullock (1965, pp. 142–193) has also posited that control loss is ubiquitous in scalar chains-of-command and increases in severity with the organizational size, because the length of the scalar chains tend to increase with organizational size. On similar grounds, Downs (1967, p. 143) has proposed the *law of diminishing control* whereby, "The larger any organization becomes, the weaker is the control over its actions exercised by those at the top." Evans (1975, p. 250) describes the problem as follows:

> Goals are generated at the top of the hierarchy; actions to implement them are executed at the bottom; in between there are several levels of hierarchy. At each level, bosses give orders to subordinates, which represent specifications or operationalizations of orders that they in turn have received from above. But at each level there is some slippage, some control-loss; orders are misinterpreted and part of the original intention is lost. Each level adds new control-loss to that of higher levels. The total, cumulative control-loss emerges at the bottom of the hierarchy as the proportion of production workers' time that does not further organizational goals.

Williamson (1971) proposed a simple formal model of control loss in which the cumulative control loss in a chain-of-command is $1 - c^d$, where $0 < c < 1$ is the extent to which subordinates' behaviors are consistent with their immediate superiors' expectations, d is the number of superior–subordinate relations in a chain-of-command, and c^d is the extent to which subordinate behaviors are consistent with a superior's expectations when the superior and subordinate are linked through a chain-of-command consisting of d relations. Hence, Williamson's model posits an exponential decay curve for control as a function of the number of authority relations in a chain-of-command. Williamson does not provide a rationale for his model apart from the fact that it captures the familiar phenomenon of a cumulative loss of control as a function of the length of a chain-of-command. Since Williamson's aim in developing the model was to estimate the optimal size of an organization, taking into account the labor costs and total revenue of a firm, he cannot be faulted for making a tractable simplifying assumption about the nature of the relationship between hierarchical structure and interpersonal control. It is this relationship that is the specific focus of our analysis. We show that Williamson's model has more general theoretical foundations.

There is a body of literature on conditions that affect control loss in organizations. Fayol addressed the problem in an informal fashion. He noted that coordination problems arise in part because information in an hierarchical structure must travel up the hierarchy some number of levels and then down again to reach an actor located in some other unit of the organization. Fayol suggested that lines of communication among organization members at the same hierarchical level might operate to mitigate coordination problems; he referred to these lateral lines of communication as *gangplanks*. Likert (1967) has made similar proposals. Evans (1975) has examined the implications of dual hierarchies in which the principle of a unitary chain-of-command is violated by allowing subordinates to have more than one direct superior. Other related work on the control loss phenomenon includes that of Ouchi (1977, 1978), Mills (1983), and Leifer and Mills (1996). We contribute to this literature by showing that Fayol's intuition can be formalized and that gangplanks importantly mitigate control loss under certain conditions.

2.1. Social influence network theory

Social influence network theory (Friedkin and Johnsen, 1990, 1999) postulates a simple recursive definition for the influence process in a group of N actors:

$$y_i^{(t+1)} = a_{ii}(w_{i1}y_1^{(t)} + w_{i2}y_2^{(t)} + \cdots + w_{iN}y_N^{(t)}) + (1 - a_{ii})\, y_i^{(1)} \tag{1}$$

for $t = 1, 2, \ldots,$ and each of the N actors in the group, $i = 1, 2, \ldots, N$. The opinions of the actors at time t are $y_1^{(t)}, y_2^{(t)}, \ldots, y_N^{(t)}$ and their initial opinions are $y_1^{(1)}, y_2^{(1)}, \ldots, y_N^{(1)}$. The set of influences of the group members on actor i is $\{w_{i1}, w_{i2}, \ldots, w_{iN}\}$, where $0 \leq w_{ij} \leq 1$, and $\sum_j w_{ij} = 1$. The *susceptibility* of actor i to the influence of others is a_{ii}, where $0 \leq a_{ii} \leq 1$ and $a_{ii} = 1 - w_{ii}$. Simply stated, the process is one in which at each time period, every actor in the group forms a revised opinion that is a *weighted average* of the opinions of the members of the group in the immediately previous time period (including the actor's own previous opinion) and the actor's initial opinion on the issue.

Deducing Williamson's model of control loss from this network theory of social influence would place Williamson's model on broad theoretical foundations. Social influence network theory includes, as special cases, French's formal theory of social power (French, 1956; Harary, 1959) and DeGroot's consensus formation model (DeGroot, 1974; Chatterjee and Seneta, 1977; Berger, 1981). The theory has close formal relationships with the rational choice model of group decision making proposed by Lehrer and Wagner (Wagner, 1978, 1982; Lehrer and Wagner, 1981), the social decision scheme model for quantitative judgments proposed by Davis (1996), and the information integration model of group decision making proposed by Graesser (1991). The theory is consistent with and supported by a line of work in cognitive science pursued by Anderson and his colleagues on information integration theory (Anderson, 1959, 1965, 1981a,b; 1991a,b; 1996; Anderson and Graesser, 1976). Anderson and his colleagues have concluded that information integration is accomplished *as though* an individual calculates a weighted average, and they describe this integrative micro-process as a type of *cognitive algebra* that individuals appear to perform. Social influence network theory also has a close formal relationship with an interdisciplinary tradition of work on statistical models of *interdependence* in geography, political science, and sociology concerned with endogenous interactions and network effects among persons and spatial units, such as regions and cities (Duncan et al., 1968; Ord, 1975; Duncan and Duncan, 1978; Erbring and Young, 1979; Doreian, 1981; Anselin, 1988; Friedkin, 1990; Marsden and Friedkin, 1994).

In a group of N actors, the system of equations described by Eq. (1) can be represented as

$$\boldsymbol{y}^{(t+1)} = \boldsymbol{A}\boldsymbol{W}\boldsymbol{y}^{(t)} + (\boldsymbol{I} - \boldsymbol{A})\boldsymbol{y}^{(1)} \tag{2}$$

for $t = 1, 2, \ldots,$where $\boldsymbol{y}^{(t)}$ is an $N \times 1$ vector of actors' opinions on an issue at time t, $\boldsymbol{W} = [w_{ij}]$ is an $N \times N$ matrix of interpersonal influences, and $\boldsymbol{A} = \text{diag}\,(a_{11}, a_{22}, \ldots, a_{NN})$ is an $N \times N$ diagonal matrix of the actors' susceptibilities to interpersonal influence on the issue. Applying Eq. (2) iteratively,

$$\boldsymbol{y}^{(t+1)} = \boldsymbol{V}^{(t)}\boldsymbol{y}^{(1)} \tag{3}$$

where

$$\boldsymbol{V}^{(t)} = (\boldsymbol{A}\boldsymbol{W})^{t} + \left[\sum_{k=0}^{t-1}(\boldsymbol{A}\boldsymbol{W})^{k}\right](\boldsymbol{I} - \boldsymbol{A}) \tag{4}$$

for $t = 1, 2\ldots.$ Assuming that the process reaches an equilibrium, i.e. that $\lim_{t\to\infty}\boldsymbol{y}^{(t+1)} = \lim_{t\to\infty}\boldsymbol{y}^{(t)} = \boldsymbol{y}^{(\infty)}$ exists, Eq. (2) becomes

$$\boldsymbol{y}^{(\infty)} = \boldsymbol{A}\boldsymbol{W}\boldsymbol{y}^{(\infty)} + (\boldsymbol{I} - \boldsymbol{A})\boldsymbol{y}^{(1)} \tag{5}$$

and hence

$$(\boldsymbol{I} - \boldsymbol{A}\boldsymbol{W})\boldsymbol{y}^{(\infty)} = (\boldsymbol{I} - \boldsymbol{A})\boldsymbol{y}^{(1)} \tag{6}$$

If, in addition, $\boldsymbol{I} - \boldsymbol{A}\boldsymbol{W}$ is nonsingular, then

$$\boldsymbol{y}^{(\infty)} = (\boldsymbol{I} - \boldsymbol{A}\boldsymbol{W})^{-1}(\boldsymbol{I} - \boldsymbol{A})\boldsymbol{y}^{(1)} \tag{7}$$

whence actors' settled opinions are given by

$$\boldsymbol{y}^{(\infty)} = \boldsymbol{V}\boldsymbol{y}^{(1)} \tag{8}$$

where

$$\boldsymbol{V} = (\boldsymbol{I} - \boldsymbol{A}\boldsymbol{W})^{-1}(\boldsymbol{I} - \boldsymbol{A}) \tag{9}$$

More generally, by Eq. (3) we can obtain Eq. (8) if

$$V = \lim_{t\to\infty} V^{(t)} \tag{10}$$

exists. In either case, V is a matrix of reduced-form coefficients describing the total or net interpersonal effects that transform initial opinions into final opinions. The coefficients in $V = [v_{ij}]$ are nonnegative ($0 \leq v_{ij} \leq 1$) and each row of V sums to unity ($\sum_j v_{ij} = 1$). Hence, v_{ij} gives the *relative weight* of the initial opinion of actor j in determining the final opinion of actor i for all i and j. If $I - AW$ is nonsingular, then V can be derived directly from Eq. (9). Otherwise, V can be estimated numerically from Eq. (4) for a sufficiently large t when $\lim_{t\to\infty} V^{(t)}$ exists. The derivation of these total weights shows that they are an implication of the influence network of the group, independent of initial opinions.

Opinions may settle on the mean of group members' initial opinions; they may settle on a compromise opinion that differs from the mean of initial opinions; they may settle on an initial opinion of a group member; or they may settle on altered opinions that do not form a consensus. All equilibrium opinions will be in the range of the group member's initial opinions. When a consensus is formed in a group, V will commonly have the form,

$$V = \begin{bmatrix} v_{11} & v_{22} & \cdots & v_{NN} \\ v_{11} & v_{22} & \cdots & v_{NN} \\ \vdots & \vdots & \vdots & \vdots \\ v_{11} & v_{22} & \cdots & v_{NN} \end{bmatrix}$$

in which each actor's initial opinion makes a particular relative contribution to the emergent consensus.[1] Note that when the matrix of total effects has this form, then the total effect of each alternative initial position can be *aggregated* (i.e. the total effects of the persons who hold a particular position can be summed) to obtain the relative weights of the various issue positions in determining the group outcome. For example, if actors 1, 3, and 5 held the same initial opinion on an issue, then the total weight of that issue position in determining the group consensus is $v_{11} + v_{33} + v_{55}$.

Social influence network theory rests on a model of how individuals cognitively integrate conflicting opinions, but the outcome of this process depends on (and cannot be understood apart from) the *social structure* in which the process occurs. This social structure consists of the particular configuration of members' attributes (initial preferences, susceptibilities to influence) and interpersonal relations. A change in the configuration of these group attributes and relations may produce a substantial change in individual and group outcomes. In this way, groups can be said to have effects on their members.

[1] There are cases in which a consensus is produced with a V that is not of this form.

3. Application of the theory to control loss

3.1. Deducing Williamson's model

Control loss in a chain-of-command is a deducible outcome of social influence network theory. The total interpersonal effect of one actor on another depends upon the flows of influence that occur in the paths and sequences that connect the actors in the influence network. In a path of interpersonal influences (e.g. $i \to j \to k \to l$) no actor appears more than once. In a sequence of interpersonal influences the same actor may appear more than once (e.g. $i \to j \to k \to j \to l$). These influence flows are implicated in Eq. (4), that gives the total effects of one actor upon another. Consider an arbitrary term, $(\boldsymbol{AW})^k$ in Eq. (4). If all the nonzero entries in $\boldsymbol{AW}$ were converted to 1's, an entry in $(\boldsymbol{AW})^k$ would indicate the number of ways in which interpersonal influence flows in k-steps from one actor to another in the network. The contribution of a single k-step flow to the total impact of one actor upon another is the product of the k direct effects $(a_{ii}w_{ij})$ involved in the sequence. Ceteris paribus, the contribution of a single k-step flow to the total impact of one actor upon another will diminish with the number of steps involved in the sequence and increase with the magnitude of the direct effects $(a_{ii}w_{ij})$ in the sequence. Ceteris paribus, the greater the number of such k-step flows, the larger the expected impact of one actor on the other.

A simple hierarchy has properties that allow equation Eq. (4) to be considerably simplified. Formally, a simple hierarchy is *tree from a single point*—the "top boss"—who can reach each of the other actors in the network by means of a path through some number of intermediaries (Harary et al., 1965, p. 283). A simple hierarchy adheres to the principle of a unitary chain-of-command, because each actor except the top boss is influenced directly by exactly one other actor. If every subordinate in the hierarchy is subject to only *one* direct interpersonal influence (i.e. the influence of the immediate superior), then the direct interpersonal influences in the hierarchy, i.e. $i \overset{a_{ii}w_{ij}}{\longleftarrow} j$, are

$$a_{ii}w_{ij} = a_{ii}(1 - w_{ii}) = a_{ii}^2 \tag{11}$$

given $w_{ii} = 1 - a_{ii}$. Let actor 1 be the top boss for whom the self-weight is $w_{11} = 1$ and the weight accorded to others is $a_{11} = 0$. Thus, the initial opinion of actor 1 is fixed. The other actors in the network have superiors to whom they may accord some weight or not $(0 \leq a_{ii}w_{ij} \leq 1)$.

The contribution of the path from actor 1 to actor u who is d-steps (levels) below actor 1 in the chain-of-command occurs in $(\boldsymbol{AW})^d$ and is the product of the d weights in $\boldsymbol{AW}$ that are on the path from actor 1 to actor u. There are no shorter paths from actor 1 to actor u and there is only one path of length d. However, there are longer *sequences* of effects that involve loops $(a_{ii}w_{ii})$. The loop on actor 1 has a value of 0 $(a_{11}w_{11} = 0)$, because $a_{11} = 0$. Hence, the only sequences longer than length d that contribute to the effect of actor 1 on actor u are sequences that involve some number of loops on the other actors plus the effects of the d-step path from actor 1 to actor u. For an actor that is d-steps below actor 1, there are

$$\binom{k-1}{d-1}$$

sequences of length $k > d$ from actor 1 to actor u.

If all of the subordinates in the hierarchy accord a *homogeneous* weight to their immediate superiors,

$$a_{ii} = \alpha$$

then the interpersonal influences in the hierarchy are

$$a_{ii}w_{ij} = \alpha^2$$

and the actors' self-weights are

$$a_{ii}w_{ii} = a_{ii}(1 - a_{ii}) = \alpha(1 - \alpha)$$

for all $i \neq 1$. Hence, from Eq. (4), the total effect of actor 1 on actor u, who is d levels below actor 1, is the value in row u, column 1, of the total effects matrix at time t, which is

$$v_{u1}^{(t)} = \sum_{k=d}^{t} \alpha^{k+d}(1 - \alpha)^{k-d}\binom{k-1}{d-1} = (\alpha^2)^d \left\{\sum_{r=0}^{t-d}[\alpha(1-\alpha)]^r \binom{d-1+r}{d-1}\right\} \quad (12)$$

for $t \geq d$, under the change of index given by $r = k - d$. Thus, the equilibrium effect of actor 1 on actor u is

$$v_{u1} = \lim_{t\to\infty} v_{u1}^{(t)} = \left[\frac{\alpha^2}{\alpha^2 + (1-\alpha)}\right]^d = \left[\frac{\alpha^2}{1 - \alpha(1-\alpha)}\right]^d. \quad (13)$$

This limit exists since $\alpha(1-\alpha)$, $0 \leq \alpha(1-\alpha) < 1$, is within the radius of convergence of the infinite series

$$\sum_{r=0}^{\infty}\binom{d-1+r}{d-1}x^r = \sum_{r=0}^{\infty}\binom{r+d-1}{r}x^r = \left(\sum_{m=0}^{\infty}x^m\right)^d = \left(\frac{1}{1-x}\right)^d$$

for $x = \alpha(1-\alpha)$.

Since v_{u1} is the relative weight of the initial opinion of actor 1 in determining the equilibrium opinion of actor u and $0 \leq [\alpha^2/(\alpha^2 + 1 - \alpha)] \leq 1$, Eq. (13) indicates that impact of actor 1 on actor u declines with the distance between them in the chain-of-command when $\alpha < 1$. Furthermore, the expression $[\alpha^2/(\alpha^2 + 1 - \alpha)]$ indicates the extent to which a subordinate's opinion is consistent with the opinion of his or her immediate superior. This can be shown from Eq. (5) as follows: in general, whenever there is only one interpersonal influence upon an actor and $w_{ii} = 1 - a_{ii}$,

$$\begin{aligned} y_i^{(\infty)} &= a_{ii}w_{ii}y_i^{(\infty)} + a_{ii}w_{ij}y_j^{(\infty)} + (1 - a_{ii})y_i^{(1)} \\ &= a_{ii}(1 - a_{ii})y_i^{(\infty)} + a_{ii}^2 y_j^{(\infty)} + (1 - a_{ii})y_i^{(1)} \end{aligned}$$

or

$$y_i^{(\infty)} = \left(\frac{a_{ii}^2}{a_{ii}^2 + (1 - a_{ii})}\right)y_j^{(\infty)} + \left(\frac{1 - a_{ii}}{a_{ii}^2 + (1 - a_{ii})}\right)y_i^{(1)}. \quad (14)$$

Note that if actor j's initial opinion is fixed (as with our "top boss"), then $y_j^{(\infty)} = y_j^{(1)}$.

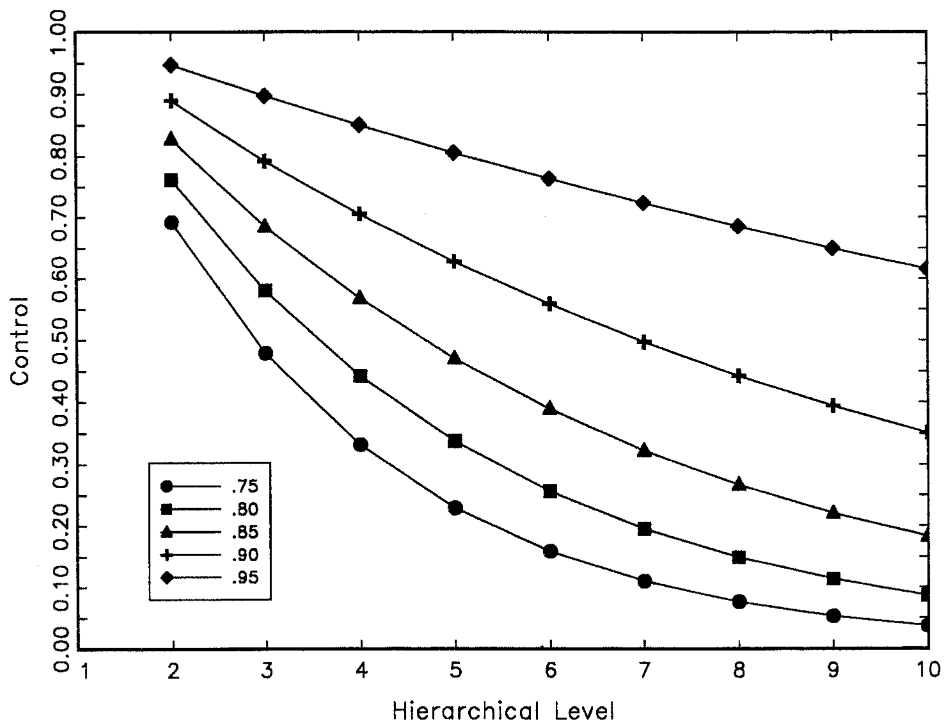

Fig. 1. Control loss in a chain-of-command.

Thus, we have shown that Williamson's control loss model, $1 - c^d$, with $c = \alpha^2/(\alpha^2 + 1 - \alpha)$, can be deduced from a more general theory of social influence.[2] Fig. 1 shows how the control of actor 1 on actor u declines as a function of the distance d separating the actors in the chain-of-command and the strength α of the direct interpersonal influences of superiors upon their immediate subordinates in the chain.

3.2. The effect of gangplanks

It now becomes possible to construct a broader theory of control loss in organizations. The various constraints under which Williamson's model was derived can be relaxed to address the effects on control loss of more general forms of authority structure and influence networks in organizations. We can assess effects of structural variations on the simple hierarchy (in which additional lines of interpersonal influence are involved) and consider the implications of heterogeneous interpersonal influences. In this paper, we restrict our attention to an analysis of the effects of gangplanks (lateral relations) on control loss.

Consider an authority structure with L levels in which there is a uniform span of control, S, for each actor. In this structure each manager has S immediate subordinates except

[2] Note that this control function c is bounded by the two simple powers $\alpha^2 < c < \alpha$ for $0 < \alpha < 1$.

for the actors at level L who supervise no one; hence, there is one actor (the top boss) at level 1, S actors at level 2, S^2 actors at level 3, and so forth. As in our derivation of Williamson's model, we will assume that the weight accorded to an immediate superior is homogeneous (i.e. α) for actors apart from the top boss, who accords no weight to others. To this structure add all the possible interpersonal influences among the actors at the same level. Hence, each manager at level 3 will now be influenced not only by his or her immediate superior, but also by the other $S^2 - 1$ managers who are at the same level in the hierarchy. These additional lines of influence open indirect channels of influence of a superior upon an immediate subordinate. These additional indirect channels do not necessarily imply an increase of control. However, an increase of control *is* implied if the managers in this enhanced structure are able to *maintain* their direct influence over their immediate subordinates and if the actors accord equal weight to the members of their *peer* group (i.e. actors at the same hierarchical level) including themselves. In such a situation, the effect of adding gangplanks to the authority structure is to diminish the self-weight of each manager and to increase the number of indirect pathways of interpersonal influence from a superior to a particular subordinate.

Fig. 2 deals with hierarchies with four levels and different spans of control. Each curve assumes fixed superior–subordinate interpersonal influence and describes how control loss is affected by the addition of gangplanks. When the span of control is 1, the hierarchy

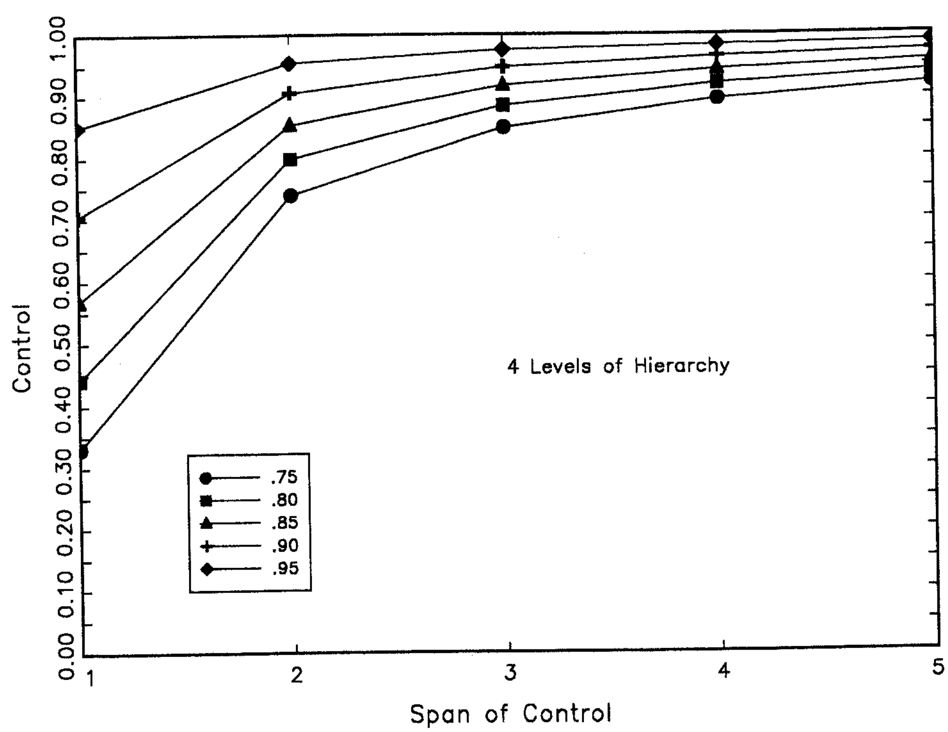

Fig. 2. Effects of gangplanks on control loss.

is a single chain-of-command in which there are no gangplanks, and the level of control loss is strictly a function of the relative magnitude of the superior–subordinate interpersonal influence; hence, the start point of each curve in Fig. 2 is the amount of control loss described for level 4 in Fig. 1. The addition of gangplanks mitigates control loss, and this mitigation increases as a function of the span of control. Hence, it seems that control can be reduced if managers are able to maintain their interpersonal influence in superior–subordinate relations while encouraging the development of gangplanks that embed managers in a cohesive peer group. To reduce control loss, such peer groups must operate to reduce managers' autonomy *without* eroding the strength of superior–subordinate relations. The effect of span of control on control loss is mediated by the reductions of managerial autonomy and increases of indirect flows of influence that are entailed by the peer groups.

4. Concluding remarks

We see the main contributions of this paper as being (1) the demonstration that Williamson's control loss model can be placed on broader theoretical foundations and (2) the opening of a line of theory on the structural foundations of control loss and its mitigation in organizational hierarchies. The introduction of gangplanks is one of the *many possible variations* on hierarchical structures that might be analyzed; for instance, structures that involve upward influences and "short-circuits" from a superior to a subordinate who is not an immediate subordinate. In this closing section, we raise two somewhat broader issues that are implicated in the pursuit of a theory of control loss.

First, to assess the effects of gangplanks on control loss, we have had to grapple with the effects of adding new lines of influence on an extant (pre-existing) influence network. We took the position that the strength of superior–subordinate relations might not be eroded by the introduction of lateral influences and increases in managers' spans of control. However, if greater span of control implies greater authority, then a superior's influence might actually *increase* in each relationship; on the other hand, if greater span of control implies a decrease of monitoring and frequency of interaction, then a superior's influence might *decrease* in each relationship. In the same vein, what would be the effect of a "short circuit" on superior–subordinate relations in a chain-of-command? For instance, given the chain $i \to j \to k$, how would the addition of an $i \to k$ influence relation affect the $i \to j$ and $j \to k$ relations? At this point, based on our theory we can describe the effects of a transformation of an influence network into some alternative state, *if* such a transformation can be achieved. This is certainly a step forward, but it leaves unanswered important issues concerning the feasibility of attaining particular transformations and the likelihood that they will be maintained over time.

Second, although control loss is a familiar phenomenon, it is a problem only in situations where top management holds a *fixed* opinion on which it is deemed necessary to establish a consensus. In many situations it may be important to form a consensus, but with some flexibility in the position that is adopted. In such cases, control loss potentially becomes a less severe problem, by definition, if top management allows its position on an issue to be modified by network influences. The formal framework that was used to document control loss also may be used to address this more complex issue of the effects of decentralization on coordination and control.

References

Anderson, N.H., 1959. Test of a model for opinion change. Journal of Abnormal and Social Psychology 59, 371–381.
Anderson, N.H., 1965. Averaging versus adding as a stimulus-combination rule in impression formation. Journal of Experimental Psychology 70, 394–400.
Anderson, N.H., 1981a. Foundations of Information Integration Theory. Academic Press, New York.
Anderson, N.H. 1981b. Integration theory applied to cognitive responses and attitudes. In: Petty, R.E., Ostrom, T.M., Brock, T.C. (Eds.), Cognitive Responses in Persuasion. Lawrence Erlbaum, Hillsdale, NJ, pp. 361–397.
Anderson, N.H. 1991a. Contributions to Information Integration Theory: Cognition, Vol. I. Lawrence Erlbaum, Hillsdale, NJ.
Anderson, N.H. 1991b. Contributions to Information Integration Theory: Social, Vol. II. Lawrence Erlbaum, Hillsdale, NJ.
Anderson, N.H. 1996. A Functional Theory of Cognition. Lawrence Erlbaum, Mahwah, NJ.
Anderson, N.H., Graesser, C.C., 1976. An information integration analysis of attitude change in group discussion. Journal of Personality and Social Psychology 34, 210–222.
Anselin, L. 1988. Spatial Econometrics: Methods and Models. Kluwer Academic Publishers, Dordrecht.
Berger, R.L., 1981. A necessary and sufficient condition for reaching a consensus using DeGroot's method. Journal of the American Statistical Association 76, 415–418.
Chatterjee, S., Seneta, E., 1977. Towards consensus: some convergence theorems on repeated averaging. Journal of Applied Probability 14, 89–97.
Davis, J.H. 1996. Group decision making and quantitative judgments: a consensus model. In: Witte, E.H., Davis, J.H. (Eds.), Understanding Group Behavior: Consensual Action by Small Groups. Lawrence Erlbaum, Mahwah, NJ, pp. 35–59.
DeGroot, M.H., 1974. Reaching a consensus. Journal of the American Statistical Association 69, 118–121.
Doreian, P., 1981. Estimating linear models with spatially distributed data. In: Leinhardt, S. (Ed.), Sociological Methodology. Jossey-Bass, San Fransico, pp. 359–388.
Downs, A. 1967. Inside Bureaucracy. Little, Brown, Boston.
Duncan, B., Duncan, O.D. 1978. Sex Typing and Social Roles. Academic Publishers, New York.
Duncan, O.D., Haller, A.O., Portes, A., 1968. Peer influences on aspirations: a reinterpretation. American Journal of Sociology 74, 119–137.
Erbring, L., Young, A.A., 1979. Individuals and social structure: contextual effects as endogenous feedback. Sociological Methods & Research 7, 396–430.
Evans, P.B., 1975. Multiple hierarchies and organizational control. Administrative Science Quarterly 20, 250–259.
Fayol, H., 1949. General and Industrial Management. Pitman, London.
French Jr, J.R.P., 1956. A formal theory of social power. The Psychological Review 63, 181–194.
Friedkin, N.E., 1990. Social networks in structural equation models. Social Psychology Quarterly 53, 316–328.
Friedkin, N.E., 1991. Theoretical foundations for centrality measures. American Journal of Sociology 96, 1478–1504.
Friedkin, N.E. 1998. A Structural Theory of Social Influence. Cambridge University Press, Cambridge.
Friedkin, N.E., 1999. Choice shift and group polarization. American Sociological Review 64, 856–875.
Friedkin, N.E., Johnsen, E.C., 1990. Social influence and opinions. Journal of Mathematical Sociology 15, 193–206.
Friedkin, N.E., Johnsen, E.C., 1997. Social positions in influence networks. Social Networks 19, 209–222.
Friedkin, N.E., Johnsen, E.C., 1999. Social influence networks and opinion change. Advances in Group Processes 16, 1–29.
Graesser, C.C. 1991. A social averaging theorem for group decision making. In: Anderson, N.H. (Ed.), Contributions to Information Integration Theory, Vol. 2. Lawrence Erlbaum, Hillsdale, NJ, pp. 1–40.
Harary, F. 1959. A criterion for unanimity in French's theory of social power. In: Cartwright, D. (Ed.), Studies in Social Power. Institute for Social Research. Ann Arbor, MI, pp. 168–182.

Harary, F., Norman, R.Z., Cartwright, D., 1965. Structural Models: An Introduction to the Theory of Directed Graphs. Wiley, New York.

Lehrer, K., Wagner, C. 1981. Rational Consensus in Science and Society. D. Reidel, Dordrecht.

Leifer, R., Mills, P.K., 1996. An information processing approach for deciding upon control strategies and reducing control loss in emerging organizations. Journal of Management 22, 113–137.

Likert, R. 1967. The Human Organization. McGraw-Hill, New York.

Marsden, P.V., Friedkin, N.E., 1994. Network studies of social influence. In: Wasserman, S., Galaskiewicz, J. (Eds.), Advances in Social Network Analysis. Sage, Thousand Oaks, CA, pp. 3–25.

Mills, P.K., 1983. Self-management—its control and relationship to other organizational properties. Academy of Management Review 8, 445–453.

Ord, K., 1975. Estimation methods for models of spatial interaction. Journal of the American Statistical Association 70, 120–126.

Ouchi, W.G., 1977. The relationship between organizational structure and organizational control. Administrative Science Quarterly 22, 95–113.

Ouchi, W.G., 1978. The transmission of control through organizational hierarchy. Academy of Management Journal 21, 173–192.

Tullock, G. 1965. The Politics of Bureaucracy. Public Affairs Press, Washington.

Wagner, C., 1978. Consensus through respect: a model of rational group decision-making. Philosophical Studies 34, 335–349.

Wagner, C., 1982. Allocation, Lehrer models, and the consensus of probabilities. Theory and Decision 14, 207–220.

Williamson, O., 1971. Corporate Control and Business Behavior. Prentice-Hall, Englewood Cliffs, NJ.