The Chief Technology Officer and Organizational Power and Influence

John W. Medcof
The Michael G. DeGroote School of Business, McMaster University
1280 Main St. West, Hamilton ON Canada L8S 4M4
medcof@mcmaster.ca

Haniyeh Yousofpourfard
The Michael G. DeGroote School of Business, McMaster University

Abstract

The proposition that the Chief Technology Officer's (CTO) primary bases for power and influence are in technical expertise and position power are critically analysed from the perspective of the upper echelons literature. This fresh perspective suggests that CTO's who aspire to have significant influence in their organizations should also build their power bases in ownership position in the firm, strong personal relationships in networks inside and outside the firm, and in general business savvy. The leadership style of the CEO can also significantly enhance or detract from the ability of the CTO to influence firm strategy. Research and managerial implications are drawn.

1. Introduction

The effective integration of technology into firm strategy is essential for the success of firms in technology-driven industries and although the Chief Technology Officer (CTO) plays a critical role in that integration (Roberts, 2001; Smith, 2003), relatively little research and practitioner attention is given to that important leadership position. The CTO is usually the highest ranking technology manager in the firm and in some organizations the position is called Vice President of Technology or some other variant. We will subsume all of these under the most common title, CTO, for ease of discussion. Uttal, Kantrow, Linden and Stock (1992) have identified three levels of technology leadership which the CTO might take; functional leadership, strategic leadership, and supra-functional leadership. As their titles suggest, and as will be discussed in more detail below, these involve increasing levels of strategic responsibility and in many firms the CTO sits at the executive table with the CEO, CFO and other top managers. Broadly, the CTO has an important role to play in leading innovation in the organization, and the leadership of innovation has been given considerable attention in the literature (e.g. Berson and Linton, 2005; Elkins and Keller, 2003; Hirst and Mann, 2004; Thamain, 2003; Mumford and Licuanan, 2004). However, this literature, although it has much of value for our understanding of the CTO's role as a functional leader, has little to offer for the strategic and supra-functional roles that the CTO might play (Medcof and Yousofpourfard, 2006). There is another literature which directly addresses the role of the CTO (Giordan and Kossovsky, 2004; Gwynne, 1996; Harris and Lambert, 1998; Larson, 1996; Roberts, 2001; Smith, 2003; Uttal *et al*, 1992) and it also makes contributions to our understanding of the CTO's functional role but is sparse in its attention to the strategic and supra-functional roles (Medcof and Yousofpourfard, 2006).

This shortage of attention to the strategic and supra-functional roles of the CTO might be remedied, at least in part, by a consideration of the literature on upper echelons management.

This literature received a great impetus from the work of Finkelstein, Hambrick and their colleagues in the 1980's and 90's (e.g. Finkelstein and Hambrick, 1996) and has been continued in more recent years through work such as that of Arendt, Priem and Ndofor (2005) and of Roberto (2003). The upper echelons literature concerns management in the strategic apex of the firm where the strategic and supra-functional activities of CTO's will be focused.

This paper will apply the literature on upper echelons management to the case of the CTO to provide insights into the strategic and supra-functional roles of the CTO which have not received much research attention in the past. These insights will suggest avenues for research and advice for managers. We will begin by discussing the appropriate organizational role for the CTO.

2. The Appropriate Organizational Role for the CTO

A number of papers have discussed what the duties of the CTO are in practice and what they should be, ideally Giordan and Kossovsky, 2004; Gwynne, 1996; Harris and Lambert, 1998; Larson, 1996; Roberts, 2001; Smith, 2003; Uttal *et al*, 1992). Uttal *et al* (1992) found that many CTO's believe that they, and technology, are undervalued by their organizations and that they have not been accorded sufficient degrees of influence in their organizations. They argue that this neglect of the CTO, and of technology, contributes to an under-consideration of technology when setting and executing firm strategy and this undermines firm competitiveness. Roberts (2001) collected data showing that, in his sample of technology driven firms, the degree to which technology strategy is integrated into overall strategy is correlated with such organizational effectiveness measures as overall corporate sales growth and percentage of sales from new products and services. This suggests that in some firms the potential of technology has not been realized because CTO's are not given roles of sufficient stature to lead the integration of technology into firm strategy. The tone of some discussions seems to suggest that CTO's, universally, should be elevated to the top tiers of their organizations.

However, this view needs to be tempered with a contingency perspective on the appropriate role of the CTO, such as that advanced by Uttal *et al* (1992). Although the appropriate management of organizational power is essential for competitive advantage different organizations need to manage it in different ways (Medcof, 2001). As noted above, Uttal *et al* proposed three roles of increasing strategic importance that the CTO might take; functional, strategic and supra-functional; as shown in Table 1. Also included in Table 1 are the activities of CTO's identified by other authors, categorized according to Uttal *et al*'s roles. **Functional Leadership** involves the delivery of what is traditionally expected of an R&D department, the generation of new products and ideas. The functional leader manages the R&D department, follows budgets and schedules for R&D projects, and ensures coordination between R&D and other departments in the organization. In **Strategic Leadership** the main goal of the CTO is to integrate R&D strategy with corporate strategy. The CTO ensures that core technical competencies are aligned with the organization's strategy. If the organization changes its strategy, mission or focus, the CTO changes the R&D direction as well. **Supra- functional Leadership** involves the formulation and execution of organizational strategy ensuring an appropriate role for technology. This goes beyond the traditional activities assumed for the leader of R&D. The CTO is actively involved in guiding the corporate strategy and the organization's strategic decision making process. The supra-functional leader manages innovations and ensures their application in other departments of the organization. The CTO also serves as an advisor to the CEO, specifically when acquiring new technology.

Table 1. Leadership Functions of the CTO Classified According to Leadership Roles

	Leadership Roles		
Sources	**Functional**	**Strategic**	**Supra-Functional**
Uttal et al (1992) **Definition of Roles**	Managing day-to-day R&D tasks	Ensuring technology strategy is effectively integrated into the broader strategy of the organization	Participating in the formulation and execution of organizational strategy, ensuring a role for technology
Uttal et al (1992) **Examples of Functions**	• Create teams within lab to work with the business units • One-on-one meetings with business unit heads learn what's on their minds and help them see how technology can improve their performance • Informs CEO when there's a significant change in his budget or schedule • Juggles programs to compensate for changes	• Discuss technical competences at twice-yearly strategy reviews • Assign labs responsibilities for building needed competences. • Push the company to adopt customer-based strategic planning that integrate technology issues • Work directly with business units on their strategic plans. • Sell answers to problems that won't arise for several years	• Has corporate responsibility for building and maintaining core technical competences and for seeking out technical linkages among the businesses. • CTO is a member of the three-person operating committee that makes all important project decisions. • The CTO is the architect of a corporate-wide reorganization designed to accelerate commercialization.
Smith (2003)	• Manage portfolio of research projects to value added to firm • Monitor new technologies assessing commercial potential	• Internal network coordination • Nurture effective relationships with key people thorough the company • Participating in government, academic and industry groups • Explaining company products and future plans to the trade media	• Providing reliable technical assessments of potential mergers and acquisitions. • Contribute to the strategic direction of the company
Gwynne (1996)	• Producing added value to the organization		
Giordan and Kossovsky (2004)		• Integrate R&D into the process of commercial development	• Lead global market strategy teams • Develop global IP entity partnerships • Develop branding concepts for newly forming offerings • Co-develop and own market and commercialization strategies

	Leadership Roles		
Sources	**Functional**	**Strategic**	**Supra-Functional**
Larson (1996)	• Leadership role in driving the innovation process	• Interact with and utilize the resources of universities and government laboratories	
Harris and Lambert (1998)		• Linking the work of teams to the organization's strategy • Clarifying responsibilities among related teams • Measuring team performance, including process, people and customer metrics • Expecting transfer of technology between teams • Assessing the effectiveness of team-to-team coordination • Facilitating the resolution of conflicts between teams • Ensuring that teams have access to the right people at the right time • Making the best use of a team's time and energy • Treating the organization's customers as important stakeholders • Partnering/communicating with multiple team leaders	

Uttal *et al* (1992) proposed that if a firm is in an industry in which technology is not an important strategic differentiator then technology should not be given high strategic importance and the CTO should not be significantly involved in setting firm strategy. In that case the CTO's role should be confined to functional leadership. In industries in which technology has very little strategic importance a CTO may not be needed at all. Firms in the industry may compete most effectively with their technology function headed up by a "Manager of Research" or a "Lab Manager" who reports through the marketing or manufacturing function. In industries in which technology is an important competitive differentiator, the complementary logic applies. The technology function should be fully represented at the strategy-making table so it is fully integrated into firm's strategies. In some industries and firms technology might be **the** prime strategic consideration. In such cases a supra-functional CTO is probably most appropriate.

Uttal *et al* (1992) proposed two important factors for determining which of these roles the CTO should play. The first is the industry in which the firm operates, as just discussed. They suggested that a good measure of the degree to which technology is strategically important in an industry is the technological intensity of that industry. The second contingency factor is the importance of technology in corporate strategy. Within an industry, different firms give different levels of strategic importance to technology and, within a certain optimal envelope, these different priorities can support equally effective competitive strategies when appropriately combined with other considerations. The more strategically important the role of technology in the firm's strategy, the more strategically involved should be the CTO.

If we focus on influence, which varies across the roles of the CTO, we can apply the Strategic Contingencies Theory (SCT) of organizational power (Hickson, Lee, Schneck and Pennings, 1971) to the issue of CTO influence and power. SCT states that the power accruing to an organizational unit is determined by the strategic importance of the contingencies it handles for that organization. The more critical the strategic contingencies, the more power the unit has. Finkelstein (1992) and Harpaz and Meshoulman (1997) extended this logic to individuals in the firm, such as the CTO. It follows that, if the CTO is the key individual handling technology contingencies for the firm, the more strategically important technology is for the firm the greater will be the power of the CTO.

These several threads of logic can be summarized in the following statements.

1. **The more strategically important technology is in an industry, the greater should be the influence of the CTO on firm strategy.**
2. **The leadership roles; functional, strategic and supra-functional; embody respectively increasing levels of CTO influence on firm strategy.**
3. **The greater the critical contingency of technology in an industry, the stronger will be the basis upon which a CTO in that industry can build power and influence.**
4. **In industries in which technology is an important critical contingency, there will be a positive relationship between the CTO's power/influence and firm performance.**

These propositions are founded upon the assumption that the organizations in question operate in a more or less rational way. For example, it is assumed that executives in the firm have a mutually agreed upon understanding of what contingencies are critical for their firm and that that understanding is an accurate reflection of the reality of the firm's environment. It also assumes that the ability of an executive to deal successfully with critical contingencies is acknowledged by the others and that they acquiesce to the leadership of that executive. This, of course, is not always the case, as noted by Finkelstein (1992). Probably no firm handles these influence issues flawlessly, but it seems likely that those which come closest to getting it right

will be the most successful. This analysis has brought into focus the role of influence in CTO leadership. It raises the question of how different degrees of influence might play out in upper echelons dynamics, the focus of the next section of this paper.

3. The Processes of Executive Decision-Making Groups

Recent empirical work by Roberto (2003) on the dynamics of executive decision-making groups gives us insight into the context in which CTO's may be called upon to exercise power and influence. Roberto's data show that "executive" meetings (usually consisting of about 10 people) are made up of a constantly changing set of players, whose presence depends upon the issues under consideration. People from well down in the organization are brought to the table if their expertise is relevant to the matter at hand. Conversely, members of the executive team are often not included if the matter is not related to their functional role. Roberto found that in most organizations a small group of key executives is involved in and works intensely on all strategic decisions. This group he called the **stable core** and it always included the CEO. The other members, who were included on a contingency basis, he called the **dynamic periphery**. Roberto also found that these senior teams spent only about 20% of their time on strategic decision making. Most of their time was spent on monitoring and evaluating various facets of organizational performance, as shown in Table 2.

Table 2. Percentage of Meeting Time Spent on Various Activities by Top Management Teams

Type of Activity	**Percentage of Meeting Time Spent on Activity**
Monitoring/ evaluating of financial/ operating performance	23.2
Updates/reviews of major projects and Initiatives	22.2
Planning/ formulation of business unit strategy	20.1
Review/ discussion of important human resource issues	14.6
Evaluation/ discussion of administrative policies/ procedures	6.6
Other activities	5.8
Review/ discussion of organization structure/ reporting relationships	4.2
Review/ approval of major capital appropriation requests	3.5

From Roberto (2003), page 124.

Roberto's (2003) findings dovetail nicely with the above discussion of CTO roles and influence, and we have developed the concept of the inclusion gradient to help us with the analysis. The **inclusion gradient** is the degree to which an individual is included in executive decisions. Members of the stable core are at the highest point on the inclusion gradient, as seen in the case of the CEO and a very few other executives. The lowest point is to never be included. Members of the dynamic periphery occupy intermediate levels. Their levels of inclusion are reflected in the percentages of executive meetings they attend. Over time an individual might progress up or down the inclusion gradient, depending upon career and organizational dynamics.

Roberto (2003) also investigated the reasons why people are included in top management strategic decisions and identified three. (1) **Expertise**. People are likely to be included if they are perceived to have appropriate expertise for the decision. (2) **Implementation Role**. People

are likely to be included if they are likely to be involved in the implementation of the decision. We might infer two reasons for this. One is that expertise in implementation, such as the ability to judge feasibility, may be helpful in making the decision. Second, inclusion builds buy-in on the part of those included and increases the likelihood of motivated execution (Vroom and Yetton, 1973). (3) **Personal Relationship**. A person with good personal relationships with one or more members of the stable core is more likely to be included. This third reason is noteworthy because it is not as intrinsically related to decision effectiveness as the other two. A common theme in the CTO literature (e.g. Smith, 2003) is that CTOs' expertise in technology issues is the key reason they are included in executive decisions. Roberto's findings suggest that expertise might not always be the only reason, or even the primary reason, for inclusion. This point merits further consideration and research and will be discussed further below.

Roberto's (2003) findings also suggest the following for CTO's. The expectation that when one is promoted to the CTO position one will immediately be included in the stable core of the executive decision-making group, with participation in all important decisions, is probably unrealistic in most organizations. More probably, the CTO would start in the dynamic periphery, and there would be a gradual ascension up the inclusion gradient, which might culminate in membership in the stable core. But even this expectation may be overly optimistic. If the firm is in an industry in which technology is not a high strategic contingency, and the CTO's premise for inclusion in the core is based primarily on technical expertise, membership in the core may never come about. The ambitious CTO should turn to other bases for inclusion, such as good personal relationships with members of the stable core. The work of Uttal *et al* (1992) suggests that inclusion in the stable core as a supra-functional leader requires more than a reputation as a good manager of the technology function and expertise in technical issues. It requires also a reputation as a tech-savvy business person who understands business issues and the bottom line.

The following capture some of the implications of Roberto's findings for the CTO.

1. **The higher the CTO on the inclusion gradient the greater the influence of the CTO on the strategy of the organization.**
2. **The order of CTO leadership roles along the inclusion gradient, running from lowest to highest, is; functional, strategic, supra-functional.**
3. **The greater the critical contingency of technology in an industry, the higher should be the CTO on the inclusion gradient.**
4. **In industries in which technology is an important critical contingency, there will be a positive relationship between the CTO's position on the inclusion gradient and firm performance.**
5. **The less critical technology is in an industry, the more likely it is that a CTO will have to turn to bases other than technical expertise to ascend the inclusion gradient.**

Arendt *et al* (2005) have also done work on the processes of executive decision-making which has implications for CTO's. Arendt *et al* describe three general models of how such decisions are made. In the **CEO Model** the CEO is portrayed as ***the*** decision-maker, gathering information from various associates inside and outside the organization before processing that information and making the decision on his or her own. In the **CEO-Advisor Model** the CEO has various associates provide information, help with the interpretation, and make recommendations, before making the decision him or herself. In the **TMT Model** the CEO is the leader of a top management team (TMT) which works as a decision-making team considering all aspects of the issue together and making the decision by consensus. Arendt *et al* surveyed the literature and found clear evidence of all three models in use by executives.

Arendt *et al*'s (2005) model suggests the same basic point as does Roberto's (2003), that CTO's, on appointment, should not expect to find themselves operating as a peer in a top management team led by an inclusive CEO who makes decisions by consensus. In the worse case scenario, if the CTO's organization has a strategic apex operated on the CEO Model, the CTO can expect to be consulted for information from time to time but not to be included seriously in decision-making. A fortunate CTO might find him or herself in an organization in which top decisions are made on the TMT Model, but even then may have to spend some time in the dynamic periphery before being admitted to the stable core. Although Roberto's and Arendt *et al*'s work imply this same fundamental point, they frame their perspectives in somewhat different ways. Further conceptual analysis will have to be done to reconcile and integrate those different frameworks.

Arendt *et al* (2005) present further considerations for the CTO hoping to have significant influence on the organization's strategic decisions. They note that top management decisions are characterized by complexity and ambiguity and usually have to be made with incomplete information. Many firms can be described as, "organized anarchies in which decision making is plagued by shifting preferences, unclear technology and fluid participation. These attributes can render optimizing decision making problematic, if not impossible." (Arendt *et al*, 2005: p. 686) They also note that top managers, "rely on advice from social networks that include friends, suppliers, customers, financial institutions, alliance partners, trade associations, and others." (Arendt *et al*, 2005: p. 687) There is some evidence that at least some CEO's depend more on these informal, personal connections than upon the formal advisory systems of their organizations. These observations are consistent with Roberto's (2003) findings, which led him to conclude that one basis for inclusion in top management decisions is personal relationships.

Arendt *et al* (2005) also marshaled evidence to show that organizational environments and strategy influence decision-making processes, and have implications for CEO's. Research evidence supported their proposition that, as environmental dynamism increases, CEO's are more likely to depend upon informal networks rather than formally constituted bodies for help in making decisions. Innovative high technology firms generally operate in dynamic environments so we can well expect their upper echelons to depend heavily upon informal networks. Arendt *et al* (2005) also argue, with supporting evidence, that organizations with differentiation or prospector strategies, as opposed to defender or cost leadership strategies, (Miles and Snow, 1978) are more likely to use informal advisory systems. Innovative high technology firms are more likely to be innovators or prospectors than cost leaders or defenders. This is another factor fostering informal decision-making in CTO's firms.

The general implication of Arendt *et al* (2005) is that there are matters beyond the critical contingency of technology and the technical expertise of the CTO which have an effect upon the degree to which the CTO has an influence upon the strategic decisions of the firm. Arendt *et al* draw attention particularly to the importance of the CEO in strategic decision making, the usual practice of having the CEO be ultimately responsible for those decisions, and the consequent tendency of CEO's to run decision-making processes in ways that suit their own idiosyncrasies.

The following statements capture a number of the implications of Arendt et al's (2005) work for the CTO.

1. **The CEO's decision-making style can restrict the inclusion gradient such that, with the CEO Model, there is very little inclusion of others in strategic decision-making; with the CEO Advisor Model, there is more inclusion; and with the TMT model there is the maximum inclusion.**

2. **These decision-making style differences can restrict or enhance the CTO's opportunity to have an influence on organizational strategy.**
3. **Other aspects of the CEO's style that influence the approach the CTO should take to gaining influence in strategic decisions are the degree to which the CEO depends upon informal personal ties when choosing advisor/consultants, and the degree to which the CEO draws on people who are not formal members of the organization.**
4. **Maximum opportunity for CTO influence occurs when the context includes decision-making by consensus in a TMT model, with the CTO in the stable core with a strong personal relationship with the CEO and when the CEO does not look outside the organization for advice very often.**
5. **Being in a firm with a prospector or differentiation strategy in a dynamic environment puts more value on informal networks, internal and external, as a means for the CTO to gain greater influence on organizational strategy.**

4. Sources of Power and Influence for the CTO

Finkelstein (1992) has done empirical and theoretical work on power and influence in top management teams which has implications for CTO's. He argues that power and influence play an important role in upper echelons strategic leadership and so understanding the sources of power of top team members is critical to understanding the strategic decision-making processes there. He identified four power bases for TMT members; structural, expertise, ownership and prestige. Finkelstein developed empirical measures for each of these bases and demonstrated their reliability and validity. His data also showed that these four bases do influence the perceived power of executives. We will now develop the implications of Finkelstein's work for CTO's, beginning with his discussion of the conditions in the strategic apex which foster the use of power and influence.

Finkelstein (1992: p. 506) defined power as the "capacity of individual actors to exert their will over others". He also referenced the literature showing that TMT's often do not operate as "teams" at all, at least not in the ideal sense. TMT members operate with strong motives of self-interest in an atmosphere of intra-team competition, high uncertainty, lack of information and highly ambiguous contingencies. This characterization is consistent with that of Arendt *et al* (2005) discussed above. In such conditions, informal influence, power and politics rise to the fore as the tools for carrying decisions. Expertise can fade to insignificance as a leaver of influence. The wise executive builds power bases in advance in order to prevail when the decisions are made. The CTO who intends to enter the stable core of the strategic apex must take note. There is advice for the CTO for each of the power bases identified by Finkelstein.

4.1 Structural Power

Structural power comes from the position that an individual holds in the formal hierarchy of the firm and the amount of power assigned to each position in the hierarchy (Finkelstein, 1992). Most organizations have formal charts which identify the positions and their relative power. Finkelstein proposed three measurable indices of structural power which can be applied to the CTO as follows. (1) The fewer positions there are above the CTO in the organizational chart, the more power the CTO has in the organization. (2) The closer the compensation of the CTO to that of the highest paid executive in the firm, the more the CTO's power. (3) The more different positions the CTO holds in the organization the greater the CTO's power. Structural power is not the only source of power in organizations but it is usually an important one.

CTO's can assess their own levels of structural power by considering Finkelstein's (1992) indices. In addition, there is a bit of history behind the current structural position of the CTO. Smith (2003) outlines the rise of the CTO position in the structural hierarchy of organizations during the 1980's and 1990's, from the lower hierarchical level of "Chief Scientist" or "Manager of R&D" to the newly named position of the CTO at the executive level. This conscious elevation of the structural power of the ranking technology manager was intended by organizations to increase the role and influence of technology in organizational strategy. For the most part it probably has, but as discussed above, ascension to this relatively high structural position does not necessarily guarantee significant influence upon strategic decisions.

4.2 Expert Power

In the context of strategic decision making, expert power is based on the executive's ability to deal with the strategic contingencies of the firm (Finkelstein, 1992). Such expertise may arise from a number of sources and Finkelstein proposes that a good proxy for these is the expertise of the executive in the different functional areas of the business. He suggests three measures of expert power, all based on the premise that the more positions the actor has held in the organization the more expert the actor will be about the organization's strategic contingencies. Finkelstein's measures of expert power can be applied to the case of the CTO as follows. (1) The more different positions the CTO has held in the firm, the greater the power of the CTO. (2) The greater the number of functional areas (e.g. marketing, manufacturing, R&D) in which the CTO has worked, the greater the power of the CTO. Finkelstein also considered how critical the functional areas were to the success of the firm to yield a third measure. (3) The greater the number of critical functional areas the CTO has worked in, the greater the CTO's power.

The direct study of CTO's by Uttal *et al* (1992) strongly reinforces these implications from Finkelstein (1992). Uttal *et al* emphasized the importance of the career histories of CTO's for their credibility with their CEO's and other members of the organization. Uttal *et al*'s data showed that CTO's who have credibility with their CEO's have usually previously served as line officers with profit-and-loss responsibility, sometimes for an entire line of business. In some cases they will have spent a few years directing staff functions other than R&D. Uttal *et al* propose that this non-technical experience equips the CTO to appreciate the non-technical facets of strategic decisions, most particularly the financial pragmatics of running a business. They propose that CTO's will not have credibility with their CEO's unless they are seen to have business as well as technical savvy. Assuming that "credibility" translates into power and influence, we see a convergence of Finkelstein's (1992) research on executives in general with Uttal *et al*'s (1992) data on CTO's. We can further suggest that CTO's are unlikely to enter the "stable core" of executive decision makers (Roberto, 2003) if they do not have experience as line managers in areas other than R&D. Consistent with this point, Gwynne (1996) makes the case that firms should adopt the policy of requiring CTO's to concurrently hold a line management position to foster their sense of the business and to gain credibility.

In making the case that non-technical experience is essential to CTO influence, we should not lose sight of the point emphasized by Bridenbaugh (1992) and Smith (2003), that technical expertise is the cornerstone of CTO credibility in the upper echelons. The primary reason for the creation of the position has been to foster the inclusion of technical understanding in strategic decision making. This point is validated by their research. The CTO will have credibility, influence and power at the executive level only if perceived to have expertise in both the technical aspects of the business and general business savvy.

There is one final point on Finkelstein's (1992) three indices of expert power. They all focus on the number of different significant positions the CTO has held in the organization. While it is true that this experience will give expertise in the functioning of the organization and its environment, the experience will also have been the basis for building a personal network in the organization at large, and beyond. Such networks are also a source of power, as will be seen below in our discussion of prestige.

4.3 Ownership Power

Formatted: Bullets and Numbering

Ownership power is based upon the ownership position in the firm of the actor, and the ability to act as an agent on behalf of shareholders. Links to the founder of the firm can be important if the founder still has significant ownership and/or influence. Family relationships with other officers of the company can also enhance power. Finkelstein's three operationalizations of ownership power can be applied to the case of the CTO as follows. (1) The greater the proportion of the firm's shares held by a CTO and his/ her spouse and children, the greater the power of the CTO. (2) The greater the proportion of the firm's shares held by the CTO's extended family (brothers, sisters, parents, grandparents), the greater the power of the CTO. (3) The closer the CTO's family relationship to the founder of the firm, the greater the power of the CTO.

One facet of ownership power is, in a sense, an extension of structural power. An executive with an ownership position usually has the voting rights attached to it. Under the legal system this gives a mode of influence on organizational affairs beyond those accorded through the employment contract as executive. The right of the CTO and other executives to influence organizational affairs is ultimately resident in the legal system as well, through the legal charter of the organization and the employment contract of the CTO. In this sense, ownership power is a higher level extension of structural power. As with structural power, as defined above, ownership power can be discounted if it is not exercised appropriately.

Another facet of ownership power, as Finkelstein (1992) defines it, has to do with the relationships involved. If it is the CTO's relative(s) who actually hold the ownership position(s), the CTO cannot wield the ownership power directly. The CTO must depend upon the quality of the relationship with that relative in order to influence him or her to exercise power as the CTO suggests. This recalls Roberto's (2003) third basis for inclusion in strategic decisions, personal relationships. The quality of the CTO's personal relationship with those holding ownership positions is an important consideration for wielding power and influence in the organization.

Finkelstein (1992) has empirically demonstrated the effect of ownership position on the perceived organizational power of executives yet the review of the literature on CTO's by the current authors found no mention of this power base. The importance of personal relationships in executive influence and power has also not received nearly the same level of attention in the literature on CTO's as it has in the upper echelons literature. Both ownership and relationships deserve more attention from CTO researchers, and from CTO's who want to make an impact on their organizations.

4.4 Prestige Power

According to Finkelstein (1992), prestige power is based on the prestige of the executive's positions and contacts in the organization's environment. The executive's powerful friends and connections bring security to the organization from the institutional environment. Standing in the institutional environment is an indication of the connections, knowledge and influence that can be used to deal with the critical contingencies facing the firm. Finkelstein's four indices of prestige power can be applied to the CTO as follow. (1) The greater the number of corporate

boards on which the CTO sits the greater the CTO's power. (2) The greater the number of non-profit boards on which the CTO sits the greater the power of the CTO. (3) The stronger the financial positions of the firms upon whose boards the CTO sits, the greater the power of the CTO. (4) The more elite the universities from which the CTO has graduated the greater the power of the CTO.

Like ownership power, prestige power has several facets, not all of which were explored by Finkelstein (1992). One part is expert power. CTO's who are well connected with the external environment will have expert knowledge of how it operates, how it is likely to respond to proposed or intended actions of the organization, and other information critical to the organization. The quality of relationships also plays a role in prestige power. CTO's who are able to leverage good relationships with external contacts to obtain privileged information, or to persuade them to take action on behalf of the organization (in government circles, for instance) are well positioned to deal with some of the critical contingencies facing the organization. This should enhance their power and influence within the organization.

A number of papers have discussed the role of the CTO in external collaborations, but mostly with respect to the functional role of the CTO. Little attention is given to the strategic and supra-functional aspects of external relationships and their importance as a source of power for the CTO. Smith (2003), for example, discusses the importance of having the CTO participate in government, academic and industry groups and explaining company products and future plans to the trade media. Giordan and Kossovsky (2004) discuss developing market, commercialization and IP strategies with other firms. Larson (1996) outlines the role of the CTO in technical collaborations with universities and government laboratories. Harris and Lambert (1998) discuss partnering and communicating effectively with other firms and treating the organization's customers as important stakeholders. We can thus see that what Finkelstein calls prestige power can operate at multiple levels fort the CTO. Good relationships with prestigious external actors give the CTO power at the executive level because of the strategic contingencies that can be handled through those relationships. These high level relationships can also foster activities at the more functional level, such as marketing or research alliances, which can be important in the execution of organizational strategy.

At this point we can now make further comment son the inclusion gradient which was introduced earlier to discuss Roberto's (2003) and Arendt *et al*'s (2005) work. The inclusion gradient refers to the degree to which an individual is included in upper echelons meetings of members of the organization. It is a useful proxy for organizational influence because it seems a reasonable assumption that such inclusion is related to organizational influence to some degree. However, our discussion has shown that, at least in some organizations, a great deal of influence activity occurs outside the formal channels of upper echelons meetings. For example, some CEO's consult friends and external colleagues to a significant degree and some firms operate on a CEO Model of upper echelons management, whether or not there are executive meetings. It seems appropriate, therefore, to introduce the concept of the **influence gradient**, defined as the degree to which an individual has an influence on organizational decisions. The individual in question might be internal to the organization or external. The influence gradient is imperfectly correlated with the inclusion gradient.

Overall, Finkelstein's (1992) work draws our attention to multiple bases of power and influence for the CTO. The structural and expert bases of power have already received attention in the CTO literature (e.g. Smith, 2003; Uttal *et al*, 1992) and Finkelstein's work confirms their importance from a broader perspective. The analysis here has suggested that there is more to

expert power for the CTO than just expertise in technology. A CTO who wishes to become influential must also become an expert on environmental contingencies that are non technical, for example, by sitting on the boards of other companies, by getting to know individuals in government agencies that influence the industry, and by learning the scuttle-but on competitive firms through informal networks. Finkelstein brings attention to ownership and prestige as bases of power and these have been given little if any attention in the CTO literature. The lack of attention to these bases makes them particularly rich subjects for further conceptual development and research, particularly with respect to CTO's. Ownership and prestige-based power are heavily dependent upon building strong, informal, intra- and extra- organizational networks.

The following statements capture some of the implications we have derived for the CTO from Finkelstein's (1992) work.

1. **The high levels of ambiguity and uncertainty found in the strategic apexes of firms pursuing differentiator and prospector strategies based upon technological innovation foster the use of informal and unstructured strategic decision-making processes there.**
2. **Although technical expertise and formal organizational position can be the platforms upon which CTO's can gain influence in the upper echelons, the decision-making conditions there require the development of other bases of power, such as ownership, prestige, and informal relationships, both internal and external to the organization.**

This completes our substantive consideration of the issues raised when the upper echelons literature is brought to bear on the situation of the CTO. We will now turn to implications for research and management and general conclusions to the paper.

5. Implications and Conclusions

Selected parts of the upper echelons literature have been brought to bear on issues of technology leadership as embodied in the CTO and a number of avenues for research are now evident. As the analysis progressed, summary statements were made which captured the implications of those analyses. Many of those statements can be immediately translated into testable research propositions. For example: The higher the CTO on the inclusion gradient (percentage of top team meetings attended) the greater the influence of the CTO on the strategy of the organization (perceptual measure from executives, number of mentions of technology in annual report of the firm). Another example: In industries in which technology is a critical contingency (technology intensity of the industry) there will be a positive relationship between the CTO's position on the inclusion gradient (percentage of top team meetings attended) and firm performance (sales, ROI, etc.). Another source of readily testable propositions is in the detailed discussion of Finkelstein's (1992) measures of organizational power bases. For example: The more different positions the CTO has held in the firm (by interview or access to resumes) the greater the power of the CTO (Finkelstein's perceptual measure). Another example: The greater the number of corporate boards the CTO sits on (by interview or access to resumes) the greater the power of the CTO (Finkelstein's perceptual measure).

Although these readily identifiable hypotheses can provide the basis for an immediate program of research, the more important long term contribution of this paper may be in opening the door between CTO research and upper echelons research. Now that it has been shown that upper echelons theory and models can guide our understanding in areas of CTO research that have been relatively neglected (strategic and supra-functional leadership), the possibilities for substantial further conceptual development and empirical confirmation are before us.

The power and influence of the CTO have not been examined before in the depth provided here, although they have appeared from time to time in the literature. This careful examination should open new possibilities for CTO's to consider as they strive to enhance their influence on the strategic directions of their firms, for the benefit of their firms; and for furthering their own career goals. The importance of structural and expert power have been assumed for many years, but the analysis here suggests that CTO's should look beyond these traditional mainstays. This analysis even suggests that in many organizations these may not be the mainstays at all. Depending upon the dynamism of the industry, the strategy of the firm and the decision-making style of the CEO, other bases of power and influence might be of more importance to the CTO. Strong professional and personal relationships, memberships on corporation boards, and ownership position can all be very important. Each CTO must examine his or her own circumstances and plan accordingly. This analysis suggests that the CTO's best career move will be to leave the current organization and move to another in which the conditions for CTO influence are better.

innovations and ensures their application in other departments of the organization. The CTO also serves as an advisor to the CEO, specifically when acquiring new technology.

The more critical technology is to a business the more important it is that the CTO have a significant influence on organizational strategy and the better the CTO is positioned to gain such influence through his or her techspertise. But, because most high technology firms operate in environments of high ambiguity and uncertainty, techspertise and organizational position will not be a sufficient basis to ensure an influential posture for the CTO in the firm. The CTO must develop other bases for influence which are largely informal, such as: strong personal relationships with the CEO and other influential people, a strong informal network both inside and outside the organization, a significant ownership position in the firm and general business savvy. The decision-making style of the CEO can constrain or enhance the degree to which the CTO has an influence on organizational strategy. As the CTO ascends the inclusion gradient, there is a shift in the relative importance of the different bases for influence, with techspertise waning in importance and the other bases increasing.

These conclusions go beyond the main themes found in the current CTO literature; which are that techspertise and organizational position are, by a wide margin**, the** most important bases for the CTO's influence in the organization; and that techspertise is **the** most important contribution that the CTO can make to the organization. Two other prominent assumptions of the CTO literature are that the CTO's main job is to manage the technology function well and to be an advocate for the importance of technology in the firm. These are now all open to more critical consideration as we develop a broader understanding of the CTO's role and the research and practitioner implications that follow.

Bibliography

Arendt, Lucy A.; Priem, Richard L. & etc, 2005. A CEO-Adviser Model of Strategic Decision Making. Journal of Management 31 (5), 680-699.

Berson, Yair, & Linton, Jonathan D., 2005. An Examination of the Relationships between Leadership Style, Quality and Employee Satisfaction in R&D versus Administrative Environments. R&D Management 35 (1), 51-60.

Bridenbaugh, Peter, 1992. Credibility between CEO and CTO-a CTO's perspective. Research Technology management 35 (6), 27-33.

Elkins, Teri, & Keller, Robert T., 2003. Leadership in Research and Development Organizations: A Literature Review and Conceptual Framework. The Leadership Quarterly 14, 587-606.

Finkelstein, Sydney & Hambrick, Donald, 1996. Strategic leadership: top executives and their effects on organizations. West Pub. Co., Minneapolis, St. Paul.

Finkelstein, Sydney, 1992. Power in Top Management Teams: dimensions, Measurement, and Validation. Academy of Management Journal 35 (3), 505-538.

Giordan, Judith C.; Kossovsky, Nir, 2004. It's Time to Think Differently about R&D Assets and the CTO's Role. Research Technology Management 47(1), 9-12.

Gwynne, Peter, 1996. The CTO as Line Manager. Research Technology Management 39 (2), 14-18.

Harpaz, I., and Meshoulman, I., 1997. Intraorganizational Power in High Technology Organizations. The Journal of High Technology Management Research 8(1), 107-128.

Harris, Richer C. and Lambert, Jean Truscott, 1998. Building Effective R&D Teams: The Senior Manager's Role. Research Technology Management 41(5), 28-35.

Hickson, D.J., Lee, C.A., Schneck, R.E., and Pennings, J.M., 1971. A Strategic contingencies theory of Intraorganizational power. Administrative Science Quarterly 16, 216-229.

Hirst, Giles & Mann, Leon, 2004. A Model of R&D Leadership and Team Communication: The Relationship with Project Performance. R&D Management 34 (2), 147-160.

Larson, Charles F., 1996. Critical Success Factors for R&D Leaders. Research Technology Management 39 (6), 19- 21.

Medcof, John W., 2001. Resource-based Strategy and Managerial Power in Networks of Internationally Dispersed Technology Units. Strategic Management Journal 22, 999-1012.

Medcof, John W., and Yousoufpourfard, Haniyeh., 2006. The Strategic Leadership of Technology Management. Proceedings of the Annual Meeting of he Administrative Sciences Association of Canada, 2006.

Mumford, Michael D., Scott, Ginamarie M., Gaddis, Blaine, & Strange, Jill M., 2002. Leading Creative People: Orchestrating Expertise and relationships. The Leadership Quarterly 13, 705-750.

Roberto, Michael, 2003. The stable core and dynamic periphery in top management teams. Management Decision 41(2), 120-131.

Roberts, F., 2001. Benchmarking Global Strategic Management of Technology. Research Technology Management, 25–36.

Smith, Roger, 2003. The Chief Technology Officer: Strategic Responsibilities and Relationship. Research Technology Management 46 (4), 28-36.

Thamhain, Hans J., 2003. Managing Innovative R&D Teams. R&D Management 33 (3), 297-311.

Uttal, Bro, Kantrow Alan and etc, 1992. Building R&D leadership and credibility. Research Technology Management 35 (3), 15-24.

Vroom, V., and Yetton, P., 1973. Leadership and Decision Making. University of Pittsburgh Press: Pittsburgh, PA, 1973.