

The CTO Spectrum™: A Diverse Set of Responsibilities

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The CTO Spectrum™

The responsibilities of a CTO and his or her support organization vary from company to company. Young start-ups typically have a set of technically hands-on tasks for the CTO, while an international conglomerate may need the CTO to deal with the representatives of foreign governments and industry organizations. In spite of this variance, it is important to identify a collection of CTO activities that can generate value for the company.

The spectrum of responsibilities of the CTO and the CTO office can serve as motivation and direction for creating a new CTO office and can provide a means for evaluating the effectiveness of the CTO and their office. The spectrum provided in this paper spans a wide variety of responsibilities that include corporate strategy, mergers and acquisitions, internal processes, and relationships across the organization.



Advise Value Vision Communicate Manage Innovate Implement

Figure 1. The CTO Spectrum™

Advise

Technology has become an inseparable part of most businesses. In many cases, it is the source of a significant portion of the company's competitive advantage and future revenue generation. As such, the executive leadership of the company must make well-informed decisions regarding future acquisitions, funding decisions, and the application of technologies.

Acquisitions

In the case of an acquisition, the picture painted by the financial numbers is not always an accurate representation of the position of the company. A good deal of its future value stems from the quality and marketability of its technology. The CTO office should have access to the internal expertise necessary to evaluate potential acquisition. Or, when the expertise does not reside in-house, it should be able to locate, contract with, and manage external expertise.

In some cases, a merger or acquisition presents an obvious case for compatibility or improvements in scale. These mergers typically extend the current business base, allowing the resulting company to more strongly dominate the current market. Such mergers require less advice for merging disparate technologies, but can still benefit from such evaluations during the integration phase that follows acquisition. The CTO office is an excellent resource for identifying the best alignment of internal capabilities that hinge on technology values.

When an acquisition is designed to extend the company's capabilities into a new area, that may require detailed and trustworthy valuations of the target company's technology. The CTO office may be commissioned to conduct an investigation into the patents, competitive position, and technical product details of the target company. It is important for the acquirer to have a clear understanding of the value of the target's technology – its ability to beat competitors in the future. The value of the target's technology may be realized through licenses to component developers or system integrators. In this case, the license and relationship with the customer are issues for other members of the acquisition team. But an evaluation of the power of the technology to continue to hold the interest of the customer in the face of competitive products, new inventions, and market trends is the domain of the CTO office.

Funding

At least annually companies must determine whether to continue funding technology development, and if so, at what level. One part of these decisions is driven by the revenue and profit of the entire company. Another is the immediate need of other functions within the company.

The Directors of research organizations and technology innovators typically create an evaluation board to make these recommendations. Such a board may consist of representatives of each project, external consultants, and internal customer organizations. The CTO office is another source of expertise for these evaluations. Participation in these boards is a two-way relationship. The CTO office participates in order to assist them in making the best decisions. But, the events also provide an information-gathering opportunity. These are an excellent source of information about the internal state and activities of the company. Through participation, the CTO office is in a better position to execute many of the functions listed later in this paper.

Henry Chesbrough (2003) points out that large labs like Xerox PARC have always conducted such internal review, but have consistently missed important capabilities or given the green light to projects that provided no financial return. He compared this to the process in which a start-up is evaluated by a Venture Capital (VC) firm in order to make a funding decision. The VC typically does not have the staff necessary to perform an in-depth technical analysis. Instead they rely on the market performance of similar projects to guide their decisions. In the past, this has aided them in financing projects that Xerox PARC declined to support. The participation of the CTO office in these internal reviews is not intended or expected to make the process flawless. But, will

provide reviewers who are more objective and who, like a VC, can compare the opportunity to their knowledge of other similar technologies.

Application

In the process of collecting information from across the company, the CTO office will possess a uniquely broad and technically competent view of the capabilities of the entire company. Their encounter with new technologies in labs or application capabilities in a facility will enable them to cross-pollinate the company. They will be able to spread information from one endeavor to another. Innovative new ideas and truly new work will not be isolated to the organizational hole from which it sprang, but will be shared with every other project that the CTO office encounters.

Many companies conduct internal technology conferences specifically to encourage cross-pollination of ideas. These venues allow technologists and managers at all levels to see how business and innovation are done at other sites. These carry the advantage of exposing a large number of diverse people to an unusual combination of new ideas. They have the disadvantage that they are one-shot events that can soon be forgotten in the face of daily responsibilities. The CTO office is a logical group to organize these conferences, manage them, and follow up on the information that is shared.

Key value-add activities that the CTO office can perform related to these conferences are:

1. Organize Conference
2. Identify Best Participants
3. Compile Reference Materials
4. Facilitate Group Discussion
5. Capture Cross-Pollination Intention
6. Distribute Materials
7. Follow-up on Cross-Pollination
8. Provide Resources for Effective Implementation
9. Track and Measure Impacts of Cross-Pollination

Value

As described in the Advise section above, the CTO office can play an important role in determining the value of acquisitions. Investigations by experts who are familiar with the state of the art in a new technology can make important contributions to the valuation of a company's technical resources. However, the valuation of a company is a specialized field whose expertise is not usually resident within every company.

The ability of the CTO office to provide valuation services will vary considerably from one organization to another. If the acquiring company intends to perform multiple acquisitions, then this skill may be something that needs to reside in-house. However, if acquisition is a rare event or maximum objectivity is required, it may be best to hire a valuation consultant.

Experts in technology valuation list a number of factors that should be considered in this process, some are generally applicable and others are unique to a specific situation (Lebbon, 2004).

- Does the corporation own the whole of the technology?
- Is the technology protected?
- Do other parties have rights to the technology?
- What additional items are required to commercialize the technology?
- Is the technology enduring? For how long?
- Does the technology provide a competitive advantage?
- Are there competing technologies?
- How long will it take to get to market?

Each of these conveys a specific value to the target company. As with most predictive and qualitative measures, the exact number associated with this is an estimate and will vary based upon the characteristics of both the acquirer and the acquiree. Specific technologies have different values stemming from the current and historical business of the company. This fact is clearly exhibited by the number of successful businesses that spun out of Xerox PARC and Hewlett-Packard from the 1970's to the 1990's - creating the strong technology foundation for Silicon Valley. Many of those technologies had less value within their original parent, but, once released to seek a different type of customer, they were major businesses in their own right.

Vision

The CTO will be a core part of defining the vision of the company's future. This responsibility has typically been controlled, organized, and even performed largely by the CEO who is responsible to shareholders for the future strength of the company. However, today no single person can manage all of the details of a major company. The CEO relies upon the CFO for trustworthy financial data, the COO for a smooth, modern operating environment, the CIO for modern IT systems to monitor, report on, and empower the organization – and the CTO for a complete understanding of the technical position of the company to meet the current and future needs of current and future customers.

By no means has the CTO inherited ownership of the company's crystal ball for predicting the future of its products or the industry. But the CTO certainly must peer into those misty depths and identify an important technical feature of the future landscape of the company. As the executive officers and their designated helpers gather around the crystal ball to identify the vision for the future of the company, the CTO must not be a shy or secondary member of the crowd. His or her technical vision is going to make a significant contribution to the capabilities of the company in the future. No longer do most companies conduct business as usual - simply expanding, contracting, or modernizing existing facilities or services. The most successful companies are working hard to identify new business opportunities in the current and adjacent market areas. The company may be transformed over a number of years into something completely different from what it is today.

Companies like 3M are well known for inventing new products at the very edge of their current product space. They have moved from sandpaper to tape, electrical equipment, and the most modern computer storage media. Without vision and an appreciation for modern technology, sandpaper looks just like a tool for smoothing wood, metals, and other surfaces. But, with vision sandpaper looks like a coated thin surface with defined performance specifications. The coating may be grinding particles, tape adhesive, or magnetic data storage – all are coated thin surface products.

The Big Three automotive manufacturers are often seen as dinosaurs that have always made cars and will always limit themselves to making cars. However, each of them long ago recognized that they were in the business of extracting profits from the car-buying customer. Those profits may come from the margins on the sale of a car, the interest points in making a car loan, premium profits on premium options, and revenues from service operations. As soon as one competitor identifies a source of profits, the others must follow suite or trump the move with an even better idea. No company can afford to remain the same if it wants to be a long-term competitor.

In this environment, companies are constantly moving and shifting their business. They are searching for the sweet-spot of profits and attempting to dominate that spot for as long as possible before yielding ground to competitors and moving on to the next sweet-spot. The CTO may not be able to identify sweet spots like auto financing, but he or she will certainly be able to point the company toward magnetic storage, new materials, environmental friendly solvents, robotic equipment, and the computerization of factory operations.

Like the CFO, COO, and CIO - the CTO has a unique set of skills and a unique perspective on the problem – a unique view into the crystal ball. Expressing that view, pressing that view, and fighting for attention to that view is all part of adding value to the company. Failing to satisfy this responsibility hobbles the company and allows a competitor to reach those innovations first and reap the largest rewards.

Communicate

Within most companies there are defined communication networks and media for information on the financial position of the company, legal and personnel issues, and product marketing. But there is rarely a formal network or vehicle for exchanging technical information and keeping the people who create new products up to date with activities in the rest of the company. The evolution of the modern corporation has led to a structure in which the independence and isolation of each facility, plant, or division extends from its production capabilities into its innovation capabilities. Most manufacturing or service centers contain all of the resources necessary to carry out their operations. Each facility usually has tighter relationships with its stable of suppliers than it does with the other divisions of its own company. As innovation has evolved within these companies, those same barriers have prevented research groups and technical projects from exchanging information across division/plant boundaries.

Since the technologists within a division often share close quarters, there has been little need to enhance communications within that group. But that also allowed the innovators to work without knowledge of other technology groups across the company. Of course this led to duplication of effort, one group being stuck on a problem that another group had solved, and, most importantly, an inability to leverage the work of multiple groups toward a larger objective.

The CTO office bridges the gaps between these islands of innovation. The information that it gathers in the process must be shared across these barriers and the conferences described above are one excellent tool for accomplishing this. Newsletters, mailing lists, collaborative web sites, chat rooms, and problem-solving bulletin boards are a number of other tools for bridging these gaps.

Each of the media for information exchange achieves two primary goals – (1) the exchange of information and (2) the building of relationships. The first goal presents itself as the primary objective. But, in practice, relationships across the business are much more powerful. The real value of these communication tools is enabling innovators to build their own relationship network. Relationships allow technical experts to make their own contacts, ask their own questions, and build a web of data exchange and solution sharing that is much more powerful than a conference or newsletter.

The most successful thing that the CTO office can do in this area is to stimulate the creation of relationship networks. These relationship networks will replace much of the value of the formal communication tools.

Manage

Where does the culture necessary to foster innovation and communication within a company come from? What keeps it alive? Why is it not regulated, strangled, and marginalized in the face of daily pressures for profits?

To be sure, not all companies are able to create a culture of innovation or collaboration. Even Steve Jobs felt that creating the next generation of Apple computers required isolation in order to protect the culture of innovation from the culture of daily production and maintenance. He established the Macintosh group in a building far away from the Apple campus and regulated access to it.

On the other hand, 3M is stimulating innovation by mandating that employees work on personal projects for a defined percentage of their workday. Encouraging scientists to work on problems that interest them has been one source of valuable inventions like post-it notes and advances in data storage.

In both cases, practices are established with the explicit goal of fostering an environment and a culture that is attractive and conducive to innovation. The CTO encourages, supports, and protects these practices at the executive level. The CTO office is a key

resource in managing the culture of innovation, rather than managing laboratories, scientists, and facilities that physically house innovation.

On a quarterly basis, the heroes of a company are those who generate the biggest profit margins. They are celebrated by Wall Street and trumpeted in news releases from the CEO. Every company must have a culture that places profitability in a key position. But, the culture of a company must contain the seeds for its own future as well. Innovation, research, and process improvement are all conducted with the goal of profiting in the future. By the time the contribution is profitable, the research group or the CTO-domain has long since handed it over to design and production. Their contribution can be quickly forgotten and all recognition given to the team that designed, produced, or sold the product.

The CTO office must insure that the company rewards, encourages, and places value in the actions of the research teams just as it does the production teams. Left untended or under appreciated the energy of innovation will sputter and die. Innovation culture management must include credit for contributions to new products. It requires personnel processes that allow people to create in their own style – driven to be productive, but not driven to conform to a production lifestyle.

Once brought into existence, such an environment will attract people eager to be encouraged and facilitated in their work rather than controlled, ignored, and marginalized. Each of these people is an ingredient whose influence on the group and the culture must be managed to prevent corruption of the culture, but not to prevent its productive evolution or to enforce conformity.

Innovate

The most valuable innovation that the CTO office can contribute to a corporation is in creating and leading a process for innovation. Scientists in laboratories are the innovators of new products, components, and processes. But structuring the company's approach to managing, commercializing, and improving the innovation process is an essential task. Henry Chesbrough (2003) explored the different business models for innovation that have been used at Xerox Palo Alto Research Center (PARC), IBM T.J. Watson Research Center, Intel Corporation, and Lucent. Though all contained brilliant scientists who were making significant strides in new technologies, each practiced a different business model for commercializing their inventions.

The Xerox PARC model worked very well for a company that dominated the market for photocopiers. But, was not adept at creating and entering new business areas – such as personal computers, networking, and peripherals. The stories of Xerox's failures in the latter area are well documented (Smith, 1999).

IBM, Intel, and Lucent have all taken these lessons to heart and practice a very different model than their predecessors at PARC. IBM has created a model for commercializing innovation that includes the traditional role of research at its roots. But, they go much

further than that. They have explored the role of a system integrator of industry standard components – the IBM personal computer. They also license new technologies to competitors. In one case, they created a 2½” hard drive for their own laptop computers. But, in addition to using it to improve the sales of the IBM ThinkPad, they also licensed the drives to other vendors and doubled the revenues generated from the hard drive technology. IBM has gone on to license pure intellectual property before it has become a product at all.

The innovation business model as practiced by IBM is one of the key contributions that can come from the CTO office. Chesbrough (2003) explains the importance of the Open Innovation business model. He has documented the transformation of innovation processes from a closed corporate lab to an open collaboration among companies that can mutually benefit from working together.

Hargadon (2003) also explored the evolution of the innovation process. But, his work focused on a different aspect. Specifically, he exploded the myth of the lone inventor creating new technologies from his individual personal effort and inspiration. From Thomas Edison to the modern academic researcher, Hargadon reveals that these mythic heroes are really at the center of multiple networks of knowledge. They borrow ideas from one field and apply them in another. They also benefit from the hard work of a team of people that are largely unheralded in later accounts. Businesses have discovered that inventions sell better when they come from a single, inspiring inventor. So, they have used the press to create images that are much more heroic than was really the case.

Understanding this type of mythology is an important role within a company. Strategists and planners must pursue innovation models based on successful practice rather than on the mythology of the individual hero.

Implement

Business models, strategic plans, and visions are fantastic starting points. But they exist for the purpose of implementation - to change behavior within an organization. The CTO must follow-up on all of these and track their implementation. If they remain concepts on paper, then the organization will be robbed of their power. Rewards and punishments must be tied to the successful implementation of innovation models. Progress needs to be measured in order to determine when rewards should be bestowed.

The CTO office must implement a process for encouraging the use of business models for innovation. In organizations like Intel Corp., the innovators fall under the organizational control of the CTO. In this case, overseeing and motivating changes is within the sphere of control of the CTO. However, in other organizations, the innovators may be assigned to specific business units of geographic offices. Under this structure, the CTO office must build relationships with these dispersed offices and create partnerships in improving innovation using many of the tools described in previous sections.

Conclusion

The position and responsibilities of the Chief Technology Officer and his or her support organization have been evolving for a relatively short period of time. The title has been used for approximately 20 years – evolving first from the Director of Research, later emerging as the technical partner in a technology start-up, applied as a near-synonym for the CIO in an IT services organization, and as a technology executive contributing strategic decisions in multinational companies. With such a wide variety of implementation, it is not surprising that the position has been poorly defined.

The spectrum presented in this paper illustrates many of the recurrent responsibilities of the CTO and the CTO office. The position, under a variety of names, has become more essential to businesses each year. The technology component of products and services and the rapid pace of innovation combine to create a competitive environment in which technology and innovation are essential ingredients for success. Past centuries have witnessed predominance of production, finance, government relationships – and now technology. The CTO office has critical responsibilities to the organization and the importance of these will continue to increase throughout this century.

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