Maximizing the CTO's Contribution to Innovation and Growth

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[Note: This paper is an extension of the previous paper, "5 Patterns of the Chief Technology Officer".]

Abstract:

The Chief Technology Officer position has been adopted by a wide variety of industries that are seeking to leverage technology within products and services. The position calls for an operational executive who can make important strategic decisions that impact the competitive position of the company. However, very little research has been done to define the CTO's responsibilities, methods of evaluating the person's performance, and the skills that the person should bring to the office.

In this paper we identify five major categories of the CTO position. These are labeled the Genius, Administrator, Director, Executive, and Advocate. We also associate each of these categories with specific business phases in which they can be effectively applied. The CTO that is best suited for a company just emerging from the garage is much different from the person required to implement the strategies of a global leader. Organizations like GE Medical, ALCOA, Federal Express, the Air Force Research Laboratory, and Intel all have unique needs that call for a unique set of skills and processes.

Emergence of the CTO

The position of Chief Technology Officer is relatively new, emerging from the position of R&D laboratory director in the 1980's.[1] Therefore, the definition of what a CTO is and how this person should contribute to an organization varies widely. In some cases, this variation is driven by unique business needs or by the evolutionary path that created the position within a specific company. In other cases, the variation is a result of a misunderstanding of the role of the CTO or of simply mimicking the role used in other companies.

When asked what a CTO is, Nathan Myhrvold, the former CTO of Microsoft and head of its massive research organization, replied, "Hell if I know. You know, when Bill [Gates] and I were discussing my taking this job, at one point he said, Okay, what are the great examples of successful CTO's. After about five minutes we decided that, well, there must be some, but we didn't have on the tip of our tongues exactly who was a great CTO, because many of the people who actually were great CTO's didn't have that title, and at least some of the people who have that title arguably aren't great at it. My job at Microsoft is to worry about technology in the future. If you want to have a great future you have to start thinking about it in the present, because when the future's here you won't have the time."[2]

Though the position is new, it is being widely used in many different industries. A Google search on the term "Chief Technology Officer" returns 392,000

hits, most of which are corporate announcements of the appointment of a new CTO. These announcements span the breadth of industries, including

- IT, computer, and research organizations like SAS, Intel, and the Fraunhofer Institute;
- Heavy production companies like Siemens, ALCOA, and ChevronTexaco;
- Service providers like Federal Express, National Association of Convenience Stores, and Hewitt Associates;
- Government agencies like the CIA, Air Force Research Laboratory, and the City of Washington D.C.

Clearly each of these industries has a very different business model, customer base, internal structure, and culture. It is unlikely, if not impossible, for one definition to meet the needs of all of these organizations.

Given such a large number of CTOs in service, we would expect a solid foundation of journal, magazine, and trade book publications on the subject. Surprisingly, what we actually found from an archival database search on the term and its three-letter abbreviation were fewer than 20 published journal articles in the last 10 years.[3] It is no wonder that the position is poorly understood and unevenly applied. CTOs are not publishing their activities and academics are not researching the position.

With such a vague idea of what a CTO should do, one would expect many people in the position to be "winging it" and their superiors to be evaluating them based on trial-and-error. CTOs must define for themselves what they should

do, and their bosses must largely accept that definition without a basis for comparison and evaluation. In this article we will examine some of the prototypical forms of the CTO and their roles at various junctures in the corporate lifecycle. The goal is to identify the most effective style of CTO for a company at a specific stage in their development.

CTO Categories, Skills, and Focus

The CTO position is occupied by people with diverse backgrounds, as is common to other executive positions like the CEO, COO, and CIO. Since the CTO position is often confused or interchangeable with the CIO position, and since both are relatively new to the executive ranks, it should be no surprise that the skill and background of the CTO is at least as diverse as that found in the CIO position.
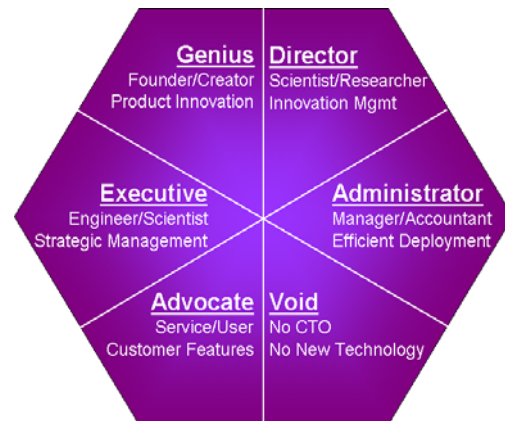

Figure 1. CTO Categories, Skills, and Focus

In studying the backgrounds, responsibilities, and missions of a number of CTOs we identified several distinct categories of CTO (Figure 1). These categories are driven by unique stages in business evolution and by the needs of specific industries. Clearly

separating these categories and associating them with a business phase or industry, sheds considerable light on references to the CTO in the trade press and corporate statements.

Genius

We are in the midst of technology revolutions in computers, information services, biotechnology, nanotechnology, medical products, and pharmaceuticals. The seeds of these industries are often traced back to a few innovators with the personal drive, talent, and opportunity to explore the unknown. People like Steve Wozniak of Apple Computer and Sergey Brin of Google have become the Thomas Edison's of this generation. They demonstrate the power of an idea championed and largely matured by single person. These are the archetypes of the Genius CTO category.

When a company, technology, or industry is in its formative stages, the CTO is often a technical genius about whom larger-than-life legends will be told by later generations. He or she (192 of the first 200 CTOs returned by a Google search are men) may be pulling together a number of available concepts and products in a new way, as Wozniak did with the first Apple computer. Or the CTO may be commercializing a new technology that has emerged from a university or commercial laboratory, as Sergey Brin did with the Google search engine.[4]

The Genius CTO is usually skilled at creating something new, possessing vision and confidence, and exploiting a unique opportunity. This ability or skill is essential to a company that is emerging from the garage or presenting its concepts before a panel of venture capitalists. Some technologies can be formed and matured largely through the efforts of a single exceptional person. When this is possible, the Genius CTO is the type of person that an emerging company needs.

However, the Genius CTO may have poor skills for managing teams of people, administering processes across an organization, or working with executives on a long-term strategy. Like Winston Churchill, their skills may be essential at a critical point in history, but they are not necessarily the best person to fill the position once the crisis is over and the company has moved on to larger problems, processes, and structures.

Administrator

In many cases, the CTO must defend the organization's budgets from overspending on technology products, services, and project labor. The CTO must be prepared to negotiate with outside vendors and service providers to insure that the company is receiving the resources it needs, but is not overpaying for these. Government offices that rely on technology-based products and services to create new products for civil, military, and intelligence applications fall into this category. Without such a person, the government buyers and users of technology are not in a position to effectively separate marketing claims for technical facts. The office then finds itself at the mercy of the vendor representatives and their claims for their products.

Jeffery Pound, the CTO of the Air Force Research Laboratory, is one example of

the Administrator CTO. Pound has been involved in two major endeavors along these lines. The first was a deal in which he negotiated a favorable licensing agreement with Microsoft that saved AFRL $9.6 million in fees. Equipped with an understanding of the laboratory's technical needs, Pound was able to identify the type and number of products that were essential and eliminate wasted licenses. He has also been working with vendors and developers to identify new ways to increase the security of the lab's networks without seriously impacting their performance.[5] These projects require an appreciation and understanding of both the technical aspects and the financial impacts of technical issues in the laboratory.

Director

As a company grows large enough to sustain and benefit from a research and development laboratory, future CTOs can emerge from that organization. He or she may be a leading scientist or researcher who has shown a talent for organization, handling exceptional people, and visioning the future. If such a person is willing to give up direct, hands-on research in order to create an environment in which others are enabled to do outstanding and valuable work, then they may become the Director of R&D and a future CTO. In some companies the title CTO is a direct substitute for Director of R&D. The organizational implications behind this are that the labs must make a direct contribution to the company's financial performance and competitive position. To encourage, enable, or enforce this, the Director is pulled into the executive ranks and retitled the CTO. In other

companies, the CTO is an additional position designed to bridge the gap between the company's strategies and its research activities.

Pat Gelsinger, the first CTO of Intel Corporation, is an excellent example of this category. Gelsinger lead Intel Labs, Intel Research, and the Intel Architecture Group. He is extremely well versed in the technical aspects of Intel's products. He is focused on the leveraging research and laboratory work into profitable products for the company. To quote from the Gelsinger's Intel bio, "As CTO, he coordinates Intel's longer-term research efforts and helps ensure consistency from Intel's emerging computing, networking and communications products and technologies."[6]

Nathan Myhrvold also exhibited the Director CTO style when he created Microsoft Research. He recognized that the world's leading software developer needed to pioneer new technologies to be integrated into its world-dominating products. It needed collaborative relationships with academic researchers and a conduit for engaging those people on problems of interest to Microsoft. The result was a world-class organization that is now investigating speech and vision interfaces, machine translation, spam filtering, new Internet technologies, multimedia and dozens of other technologies that will become part of their future products.

In creating and managing such a research lab, the CTO must be able to separate ideas with great potential from those that are challenging and exciting, but lack the ability to become or contribute to great products. The actual

Director of R&D will be more focused on sponsoring important research projects, while the CTO matches research ideas with the strategic plans of the company and its broader capabilities to move a new technology into the marketplace. He must consider whether great technology can be manufactured efficiently, priced competitively, delivered to the customer, and whether it will be a product that a customer will embrace.

Executive

Large corporations that use technology as a key component of their products or services have been the most aggressive at applying the CTO to their innovation process. Companies like GE Medical, ALCOA, Corning, ChevronTexaco, and IBM have all become known for their use of a CTO to assist in guiding strategic decisions and managing the innovation process. The Executive CTO is a businessperson who measures innovation, research, and experimentation by the contribution it makes the company's revenues and future competitive advantage.

This person's background may be just as scientific and research focused as the R&D Director described earlier, but their current focus and purpose are different. They are an integrated part of the executive staff and are relied upon just as the CFO, COO, and CIO are to assist in directing and managing the business.

Dr. Malcolm O'Neill, CTO of Lockheed Martin, is an excellent example of the Executive CTO. He is responsible for the company's research projects, but is also directly tied to the company's engineering, program management, and mission execution.[7] His role includes consideration of operations beyond the research labs. He must foster the exchange of ideas and technology between the research, manufacturing, service, and contracting operations of a 130,000 employee global company.

Advocate

Rob Carter, CTO of FedEx, has received numerous awards from the IT community for transforming the IT infrastructure of the world's leading overnight shipper. Carter and FedEx realized that over 70% of their customers used electronic transactions in shipping packages. They recognized that improving the IT experience for the customers could drastically improve the efficiency, profitability, and market share of the company. This implementation also made dramatic contributions to FedEx's expansion into international markets.[8]

Carter represents the Advocate CTO who is generally focused on the customer's experience of and interfaces with the company. This type of CTO is most often found in retail and service businesses, to include government organizations. These CTOs do not usually direct the creation of technology, but rather select and combine the best products for their specific business capabilities.

President Bush's plan to make all government services available electronically and to create an electronic conduit between every government office and their constituents, has challenged government CIOs and CTOs to build a modern, customer-centric computer infrastructure. Together, these

two executives must identify, evaluate, deploy, and maintain IT systems that meet their customers' needs.

Organizations of this type may assign these responsibilities to the CIO since he or she has traditionally been the acquirer and integrator of IT technologies. This practice has contributed to the blurring of the responsibilities of the CIO and CTO. Most writers maintain that the CIO should be focused on the internal IT needs of the organization, while the CTO should be focused on technology as it applies to products, customers, revenues, and competitive positioning in the market.[9] When the technology involved is strictly IT, it is feasible for this work to be combined with the CIO's traditional internal IT work. However, for companies when the technology is pharmacological research, new rocket fuels, and computer chip manufacturing, this combination would not even be considered.

Void

Finally, there are the companies that intentionally decide that they do not need a CTO. Many of these have stable sustaining businesses that incorporate very little new technology and do so only after the industry has already defined a stable solution. However, companies that are leading change in "non-technical" businesses are probably encountering issues for which a CTO would be very useful.

One could argue that a grocery chain does not need a CTO to improve sales of produce, meats, and canned goods. But, in-store computerization and automation argue otherwise. The Point of Sale (POS) terminals in most grocery stores

are advanced computing systems. To the degree that they collect accurate data, manage inventory, and allow a store to predict future sales, these POS systems can be seen as part of the CIOs mission. But, when they are specifically designed to improve the speed at which customers are served or the systems are strategically located to provide information in the aisles, they are becoming an application of technology aimed at the customer. Recognizing that service lines form at the deli counter, Stop and Shop grocery has installed tablet PCs in the aisles to allow customers to place deli orders to be picked up later in their shopping trip. These types of systems are competitive tools just as fresh produce, baked goods, and meats are. They allow the store to differentiate itself from competitors, attracting additional revenue. Computerized control of lighting, refrigeration, in-store advertising, bakery and deli cooking systems, and a host of others are part of the store's competitive advantage.[10] These represent a domain of the business for which a CTO can be used to identify the best solutions and implement them in the most efficient manner. Some of these responsibilities can be handled by the CIO, as has been done in other industries. But that is a misfit of function and mission. Reaching in-store customers and convincing them that the store should be their shopping site of choice requires a different focus, mindset, and talent base from those traditionally found in the CIO's organization.

The CTO and associated staff are not necessary for every business. But they are probably not being used in many businesses that could benefit from their contributions. Just as modern

corporations have developed the need for a CFO, and more recently a CIO, the continued evolution of business, technology, and society will broaden the industrial base for which a CTO is needed.

Matching the CTO to the Business Phase

Like all other positions, the skill set needed for the CTO varies based on the type of business, industry, and maturity of the company. The person who was perfect for leading the company during its early phases may be completely wrong for the same position when the company is trying to organize innovation across multiple locations, in different lines of business, and with a larger employee base. The types of CTOs we have described can be found in companies at all stages of their lifecycle. But, there are noticeable relationships between the type of CTO selected and the phase that a business has reached in its evolution (Figure 2).
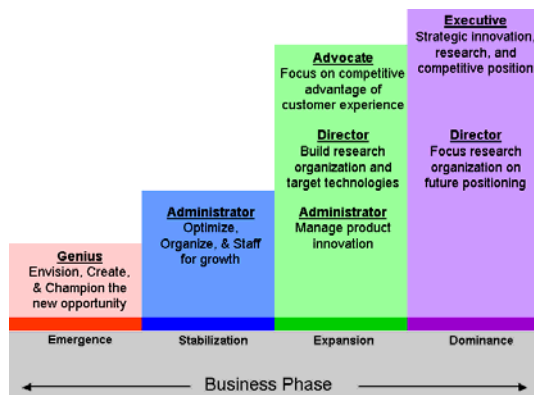

Figure 2. Matching the CTO to the Business Phase

Emergence

The Genius is most likely to hold the CTO position when the company is just emerging. He or she may be one of the original founders and may have been responsible for the key technologies or products that made the company a viable business. Such has been the case within many dot.com and IT companies in recent years. The Genius CTO earned a place in the executive ranks, but was not equipped or inclined to take a role in management, accounting, marketing, or production. But, his or her enthusiasm for the product or service provides the energy and motivation that make the company a unique place to work or that motivates the staff to work extended hours without immediate financial reward.

The Genius CTO will share in strategic decisions and the financial rewards afforded to the CEO, CFO, COO, and CIO of the business. The position places technical innovation on an equal footing with other business functions in guiding the company and influencing its direction from the very beginning.

Stabilization

After a company has successfully emerged, it will find that some of the ad hoc and chaotic processes for creating new technology and products do not extend well to larger groups. As more people are added to the company, there is a much greater diversity in capabilities, perspective, and understanding of the mission. As this occurs, the technical leader and visionary will find it necessary to apply more time and energy toward unifying people and projects. The Genius may find it difficult to shift his or her attention from purely technical tasks, toward management and communication. This leads to the need

for a more Administrative CTO that excels at working within a diverse environment of people, organizational structures, and business issues.

Since most companies do not remain in the emerging category, this transition is inevitable within the professional life of the original Genius CTO. When this occurs, the CTO must either change his operating approach or find a way to share responsibility with a more administratively skilled partner. The Genius CTO may gravitate toward the head of a small R&D center within the company, if such a unit exists. The Genius CTO may also become a "Director of Product Innovation" or some similar role. Other companies anoint the CTO as a Fellow, create a Chief Innovation Officer, or established a small research team for the person to lead. Each of these requires great tack on the part of the company and humility on the part of the founding CTO.

Expansion

As the company expands and becomes a major player in the industry, it may find itself with a number of competing candidates for the CTO position. The Administrator and Genius CTOs that had previously filled the position will still be available. But, a Director of R&D and an engineering executive can emerge as potential competitors for the CTO position.

An Administrator CTO may recognize that the resources dedicated to new products have grown significantly. From this perspective, the CTO role seems to call for additional management and organization. Therefore it is natural for the Administrator CTO to oppose

releasing the position and argue that administrative and organizational expertises are needed now more than ever.

The Director of R&D may perceive that innovations from the laboratory are having a significant impact on the company's new products and the ability to generate profits or maintain a competitive advantage. This perspective calls for more attention to research and an executive role for someone intimately familiar with and successful in that domain.

If technology forms a strong connection between the company and its customers, as in the case of FedEx described earlier, a representative of those customers may argue that the CTO position needs to be focused on improving the customer experience. Hence, the Advocate CTO becomes another competitor for the position.

Just as there was competition for the CTO position as the company moved from Emergence to Stabilization, it will face even more competition for the position as Stabilization gives way to Expansion. The selection of the CTO will lie with the CEO and an Executive Committee. They will have to decide which direction holds the most promise. Ideally, their decision will be based on an analysis of the future prospects of the company and the most profitable aspects of their chosen market.

Dominance

Companies like GE, IBM, Microsoft, and Siemens have arrived at a position in which they dominate multiple markets. Their focus is no longer on growing their

traditional market because they have already achieved a dominating position - such as Microsoft's practical monopoly of the desktop operating environment. Instead, these companies look for ways to either create new markets or leverage their expertise into adjacent markets.

Creating new markets often requires a strong contribution from the R&D labs to provide a differentiated capability upon which to build. In this case, a dominant company will rely upon the Director CTO to elicit innovation from researchers that can be turned into products. The motivation is less science and technology for its own sake, and more science and technology as the linchpin of a new product or service. Microsoft exhibited this approach when they determined to move into the videogame console market. They had no expertise in developing hardware; most of their previous products were software. They began from scratch to create a new kind of gaming console that could compete against industry leaders Nintendo and Sony, and redefine the game console at the same time. This battle is still raging, but Microsoft has been instrumental in dislodging Nintendo from their second place position. They are still struggling for an advantage over Sony's Playstation, which possesses the strongest list of game titles, largest installed base, and most productive game studios.

IBM on the other hand, has seen the strong demand for e-business services and has leveraged their expertise in both hardware and service support to become a major IT consultant and solution provider. Their WebSphere products and services have made them a strong competitor against more established IT

consultants like Accenture and PricewaterhouseCoopers (PwC). IBM recognized that computers, software, and the Internet were creating a strong connection between customers and major companies, however Accenture and PwC had traditionally focused on internal IT projects. Therefore, IBM moved into the new business area before the consulting companies could completely dominate it. Now that IBM has purchased PwC it can leverage the strengths of both companies against the remaining IT consulting firms.

The CTO of a dominant company must be involved in strategies to move into new markets or to adapt and invade adjacent markets. The Genius and Administrator CTOs do not usually possess the best perspective and experience-base necessary to work in this area. It requires someone with technical expertise who is also used to working hand-in-hand at the CEO, COO, and CFO level on very large, sometimes long-term, strategies. The CTO will be required to provide a perspective on technology that is targeted at achieving a competitive advantage and generating attractive profits. Specific technical details of products and components are not useful at this level. Neither are the skills of managing teams, overseeing production, and optimizing schedules the most effective capabilities for the CTO of a dominant company. These companies need a CTO who sees technology as a means of achieving a larger business objective.

Conclusion

Twenty years is a very short period in which to evolve a new executive

position. In this time we have seen the rapid emergence and adoption of both the CIO and CTO positions. The urgent need for information systems and common ways of applying them have driven the maturation process for the CIO much faster than that of the CTO. Since the role of the CTO is much more dependent upon the type and phase of the business, it is difficult to set a common definition for the position. We have identified several common categories of CTOs as they are found in major industries and have discussed the alignment of these categories with specific business phases. These categories and alignments are not exhaustive, but they are very useful in guiding new CTOs and assisting them in anticipating conflicts and changes that will arise in the position.

What is the CTO's Role?

Genius CTO: "The greatest CTOs that I know are the ones that take architecture seriously. Architecture guides the constraints and shows what's important and what isn't. It bridges the creativity of the engineer to something that can achieve a high impact for the company."

Greg Papadopoulos, CTO, Sun Microsystems

Director CTO: "The CTO nurtures and cultivates new ideas and innovation in both the technologies and the processes by which we build and design large complex aerospace systems. The CTO must focus the enterprise or company so it can be responsive to new technology and capitalize on it."

David Whelan, CTO, Boeing Space and Communications

Administrator CTO: "Every basic business process must work. That takes 80 percent of our time – replacing awful, ugly work process. Each one of the agencies must operate in an efficient way."

Suzanne Peck, CTO, District of Columbia

Executive CTO: "The CTO's key tasks are not those of lab director writ large but, rather, of a technical businessperson deeply involved in shaping and implementing overall corporate strategy."

W.W. Lewis, Sloan Management Review

Advocate CTO: "You get a B- to C+ grade as a CTO if you solve problems as they come along. If you want an A or a B, you have to teach your people how to prevent those problems in the first place."

Craig Humphreys, CTO, H-E-B

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