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Restructuring for Resilience

Economic crisis is compounded when structural change is amplified by cyclical downturns. Many governments respond to this situation by focusing policy initiatives on technology and innovation as a way to generate economic growth. These initiatives often result in new organizations for managing technology-based economic development that function outside the mission of traditional government agencies. Organized as a nonprofit, these entities attempt to bridge the public and private sector by offering a clear focus, flexibility, and an opportunity to accomplish a public goal without enlarging government agencies. In contrast to traditional economic development, which tends to focus narrowly on attracting business, these new initiatives emphasize longer-term capacity-building as a way to promote and anchor innovative activities and establishments. Without the traditional strictures associated with being part of state government, these organizations are often in a strong position to mediate and manage relationships between private interests and public institutions.

The last major U.S. recession in the late 1970s witnessed widespread application of this new organizational form to technology-based economic development. Well-known examples are the North Carolina Biotechnology Center, Connecticut Innovations, and Pennsylvania's Ben Franklin Program. To date, 42 states have experimented with quasi-public economic development organizations, with varying outcomes and ability to influence economic growth. Despite the importance of these efforts, we have limited understanding of how to design enduring organizations that act as catalysts for regional economic change.

The purpose of this article is to examine North Carolina's experience with the design of two dedicated industrial development organizations. The two organizations were proposed by the same state strategic plan, yet one succeeded and continues to thrive, while the other has been divested of many of its assets and core economic development functions. Initiated by the same state government in close procession, these two organizations arguably provide an example of how organi-

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zational design affects the ability of technology-oriented nonprofits to influence and guide long-term economic development planning.

Our purpose is not to evaluate the outcomes or lasting technology legacies of these two organizations, although both have arguably had a significant impact on the state economy. Rather, our objective is to offer some considerations for policymakers contemplating the creation of this type of organization. This paper offers an interpretive case study that considers the context in which the two organizations were started and emphasizes differences in organizational governance, implementation, and subsequent ability to respond to crisis.

NORTH CAROLINA CIRCA 1980

In the midst of the last major U.S. recession in the early 1980s, North Carolina suffered from the loss of its three major industries: tobacco processing, textiles, and furniture. The state's economy was especially vulnerable, due to increased competition from lower-wage countries that threatened its core manufacturing industries. At the time, the state ranked low in per capita income (40th out of 50 states).

This was a time in U.S. history that was aptly captured in President Carter's "malaise" speech: Americans told pollsters they were not optimistic about the future, and there was a general crisis of confidence nationwide.[1] American industry was losing its international competitiveness, and the unusual combination of inflation and unemployment created a poor economic outlook.

Against this backdrop, Jim Hunt's first term as governor of North Carolina emphasized technology-based economic development. Faced with an economic crisis, there was debate about how the state could best position itself. Some in the state legislature argued that North Carolina should intensify its efforts to attract the branch plants of large manufacturing companies, which would create lower paying jobs for the state's less educated workforce. One of the South's more progressive governors, Hunt favored policies that would create broad-based wealth and prosperity. He felt that the best strategy was to build capacity for high-wage, sustainable employment in technologically intensive industries. While his vision for development still involved the recruitment of outside firms, his approach differed considerably from traditional models of southern industrialization. Rather than "sell" the state on the basis of low wages and "docile" non-union labor, Hunt's goal was to create and support strong research and educational institutions that would help make North Carolina a preferred destination for technology-intensive establishments.[2]

At the time, North Carolina was already home to the Research Triangle Park (RTP), which is often hailed as an example of a successful state technology-based economic development initiative. RTP was initiated during the administration of Governor Luther Hodges (1954-1961) and supported by Governor Terry Sanford (1961-1965). Officially started in 1959, RTP had grown to include 38 firms by 1978. These were predominantly large companies, such as IBM and Burroughs Wellcome. The vibrant entrepreneurial economy that now exists contiguous to the

park was in its early stage and included just a few "home-grown" firms, most notably SAS and Troxler Electronics.

Building on the success of RTP, Hunt sought to elevate science and technology policy and create a second set of initiatives to advance economic development to the next level. Key to his strategy was the North Carolina Board of Science and Technology, which deserves some mention. The Board of Science and Technology was created by legislative act in 1963 under the administration of Hunt's predecessor and mentor, Terry Sanford. Patterned after the National Science Foundation, the agency's mission was to "encourage, promote and support the scientific, engineering, and industrial research applications in North Carolina to the end that the State will benefit from, and contribute to economic and technical developments resulting from advances in the space and related sciences."[3] The governor chaired the board, and its director reported directly to the governor—a choice administrative position. The board successfully funded $1 million in projects, until funding sources were cut in 1969. In 1973, under Governor Holshouser, the board was demoted to a committee within the Department of Commerce. This mirrored President Nixon's decision to dissolve the Office of the Science Advisor in 1971.

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In 1977, Governor Hunt re-elevated the Board of Science and Technology to a cabinet-level function. Most significantly, Hunt appointed his former professor and trusted advisor Quentin Lindsey to direct the board and design new science-based economic development policies. The 1980 "Lindsey Report" of the Board of Science and Technology advocated for the establishment of "two major efforts . . . on those 'frontiers' of science that show promise of high technology industrial application."[4] The report gave equal attention to microelectronics and recombinant DNA, as the early biotechnology industry was known.

Importantly, this policy recommendation had a theoretical grounding in balanced growth theory, which claimed that economic development was the outcome of simultaneous investments involving multiple economic sectors. This perspective reflected Quentin Lindsey's role as an economic development economist and an earlier mentor of Jim Hunt on an economic development project in Nepal,

which was funded by the Ford Foundation. Lindsey was an advocate of large government capital investments to mobilize industrial development. His 1980 report therefore advocated for concurrent sector-specific policies, recognizing that these initiatives should be calibrated and coordinated: "A major component of 'Balanced Growth Policy' in North Carolina is the provision of more and better jobs through . . . high technology industry requiring highly skilled workers and paying high wages."[5] The ultimate goal was high-wage employment for North Carolina's residents and a vehicle to support the development and deepening of scientific infrastructure.

Building on this initial momentum, the board formed two technical committees, one for recombinant DNA and another for microelectronics. University researchers with technology expertise staffed both committees. The board assigned each committee the task of conducting in-depth research on North Carolina's technology assets and opportunities in their respective technology area. Despite drawing on distinct groups of technology experts, the reports generated by the two committees were complementary and closely aligned. Both reports recommended the formation of state-funded, not-for-profit centers to promote technology development. Both recommended that these centers *not* prioritize in-house research capabilities and instead establish themselves as intermediary organizations that would bolster existing research institutions and activities in the state. Especially important was increased support for North Carolina's research universities. Both reports envisioned that these nonprofit organizations would focus on integrating and coordinating diverse research activities throughout the state, thus helping to amass and disperse government and industry resources.

Despite encouragement by the Board of Science and Technology to move on both technologies simultaneously, the Microelectronics Center of North Carolina (MCNC) was the first to incorporate in the state, on July 17, 1980. By all accounts, microelectronics was a safer technology-based economic development bet at the time and thus became an easier political sell for the governor. By the early 1980s, microelectronics was already a well-established technology-intensive industry in the United States, with a significant presence in North Carolina. Furthermore, this was a time when microelectronics firms were actively seeking out multiple new U.S. locations and thus providing large numbers of well-paying jobs for the states that were able to attract them. There also was strong national support for microelectronics research, fueled in part by concerns about increased technology competition from Japan; as one technology expert put it, in the early 1980s, microelectronics was perceived as the "highest of high technology because the underlying technology is changing more rapidly than in other high-technology industries."[6]

In contrast, opportunities to create jobs in recombinant DNA, or what we now call biotechnology, were less obvious. In fact, in 1980 there were only a handful of dedicated biotechnology establishments in the United States (e.g., Genentech, Biogen, Amgen, and Cetus). Most of these were small companies that were not in a position to move away from their university-anchored research bases in

Northern California and Cambridge, Massachusetts.[7] Only one firm in North Carolina, Burroughs Wellcome, was conducting biotechnology research in 1980.

Microelectronics: Big and Bold

In the spring of 1980, anticipated economic development opportunities in microelectronics were confirmed when executives from General Electric (GE) announced their intention to establish a $100 million semiconductor research and development facility. This was a major economic development prize that was expected to create close to 500 high-paying jobs within its first five years. North Carolina was considered a top candidate. Still, GE executives expressed initial concerns about North Carolina's limited silicon research capabilities. In negotiations with Governor James Hunt, GE executives asked that North Carolinian leaders strengthen the state's silicon-related research infrastructure. More specifically, they wanted a commitment that North Carolina's state government would support microelectronics research at North Carolina universities, and in the process help attract qualified technicians and engineers to the state. The promise of immediate job creation by General Electric was especially helpful in garnering support from more traditionalist state legislators.

The response to GE's interest in North Carolina was immediate. The Microelectronics Center of North Carolina, as it was named, was officially incorporated as nonprofit on July 16, 1980.[8] Later that month, Governor Hunt secured $1 million from a state contingency fund to finance the center.[9] Governor Hunt and his science adviser Quentin Lindsey also formed an interim board of directors. George Herbert, then president of the Research Triangle Institute (RTI), would chair the board, which was appropriate, given RTI's strong research reputation in compound semiconductors with space and defense applications.[10] Other early board members included Hugh McCall, then president of North Carolina National Bank and later, Bank of America; Sherwood Smith, president of Carolina Power and Light Company; and four university chancellors representing UNC-Chapel Hill, Duke University, North Carolina State University, and North Carolina A&T University.[11]

GE announced its decision in August 1980 and broke ground on a state-of-the-art research and development facility in Research Triangle Park on December 2, 1980. In a press release announcing the event, the governor's office stated that "General Electric's decision to locate its center in North Carolina resulted directly from the establishment of a Microelectronics Center of North Carolina."[12] In a related statement, the governor said that "General Electric's decision to build here . . . puts North Carolina 'on the leading edge of what can be a second Industrial Revolution—the Information and Communications Revolution.'"[13]

In early 1981, Hunt requested and received an additional $24.4 million from the state legislature to further develop MCNC, including financing the construction of a permanent facility that would be located in Research Triangle Park. In late 1981, after initial attempts to recruit an academic director, Don Bielman, then a

vice president of General Electric who was instrumental in the company's decision to locate its R&D facility in North Carolina, was selected as MCNC's first president.

Propelled by the successful recruitment of General Electric and the expectation that other firms would soon follow, the launch of MCNC was expedited. Completed in less than 18 months, the planning process was decisive and bold. The Microelectronics Center of North Carolina opened with considerable fanfare and media coverage. Governor Hunt went on record saying that "the microelectronics industry may be North Carolina's only chance to make a dramatic improvement in the state's wage and income rankings in the nation . . . I believe that microelectronics is our chance, perhaps the only chance that will come along in our lifetime . . . We must seize the moment."[14]

Biotechnology: Slower Moving, yet Quick to Learn

The high-impact, quick-paced implementation process that led to the formation of MCNC stands in contrast to the slower moving planning efforts that eventually led to the incorporation of the North Carolina Biotechnology Center in December 1984. The three-year lag time resulted in distinctly different organizational forms and strategies—and ultimately differences in organizational tenure and the ability of each organization to accomplish its articulated economic development goals.

In 1981, as the Microelectronic Center burst onto the national scene with an ambitious economic development mission and millions of dollars in state funding, a more modest and smaller-scale biotechnology program was percolating under the direction of the Board of Science and Technology. The governor's office provided an initial budget of a few thousand dollars to launch the board's biotechnology program and cover the initial costs associated with cataloging recombinant DNA research at North Carolina universities, as well as studying emergent biotechnology centers in Northern California and Cambridge, Massachusetts. The biotechnology program budget increased to $150,000 in 1982-1983—enough to cover the salaries of two dedicated staff members.[15]

With less attention from the governor's office and far fewer state dollars to spend, one could easily imagine that this nascent biotechnology initiative would simply wither away in the shadows of microelectronics, essentially its bigger, bolder, and more popular technology sibling. Compounding this organizational challenge was the protracted national economic recession in the early 1980s, which greatly strained North Carolina's state budget, and with it the commitment to pursue a second technology sector. Furthermore, unlike microelectronics, which at the time had a viable and highly visible industrial presence, biotechnology's economic development potential was less certain. It is not surprising then that the governor's office remained somewhat ambivalent about biotech's future in the state.

Despite initial inertia, an unexpected pathway opened that helped to reinvigorate early efforts to establish an independent nonprofit biotechnology center. In

1983, after two years of incubating as a concept within the Board of Science and Technology, the idea of forming an independent biotechnology entity was championed by Gerry Hancock, a freshman state senator. Hancock, an attorney trained at Duke University, received a detailed letter from an informed constituent telling him about the importance of biotechnology for the state's economic transformation. This motivated him to learn more about the emergent technology.

Convinced of its economic development potential, Hancock approached Governor Hunt's office with a proposal to conduct legislative research on biotechnology. With Governor Hunt's blessing and with the support of the state's senate and house leadership, a 19-member legislative study commission was established. Its membership included two of the state's more powerful legislators at the time: Robert Jordon, who would go on to become the state's lieutenant governor in 1985, and Kenneth Royall, an influential state senator from Durham, also the location of Duke University. U.S. Congressman Robert Etheridge, who at the time was a prominent member of the North Carolina house representing Harnett County, agreed to cochair the study commission with Hancock. The members also included seven other state legislators; two university representatives from North Carolina State University and East Carolina University; several industry representatives from banking, tobacco processing, and agriculture; the executive director of the Government, University, Industry Research Roundtable of the National Academy of Sciences; and one staff member from the Board of Science and Technology.[16] Hancock requested and received $30,000 from the state legislature to facilitate the review process—a sizeable budget for legislative research.[17]

The first year of meetings focused on educating commission members about biotechnology. This was especially important, given the diverse backgrounds of the state legislators, few of whom had formal scientific training. In fact, with the exception of one university biology professor and one biotechnology expert representing the Board of Science and Technology, the study commission was made up almost entirely of individuals who were initially unfamiliar with the technology.

To address this knowledge gap, the commission met with a wide range of scientific experts and conducted extensive interviews during a 20-month period that spanned two legislative sessions. They heard hours of testimony from scientists and national opinion leaders, including representatives from the National Institutes of Health, the federal agency responsible for both regulating and financing biotechnology research activities in the United States. Gerry Hancock explained the process:

> For most people, certainly including legislators, . . . it is important *who* they hear things from. They [the legislators] can't become scientists. They are going to have to trust somebody. You [as a state legislator] tend to try and find people in whom you have confidence. You ask their advice and rely upon it. We tried to bring in people who would be as persuasive, as interesting, and as authoritative as possible.[18]

The effort to educate state leaders was reflected in expert testimony. For example, a North Carolina–based scientist informed commission members that genetic engineering was already common practice in the state's agricultural industry. As evidence, he presented a tall pile of notebooks that documented traditional plant-breeding techniques that were being used to produce frost-resistant tomatoes. He emphasized that this work reflected hundreds if not thousands of years of plant-breeding knowledge and experimentation. The expert then dramatically produced a single thin notebook that detailed the use of biotechnology to isolate the specific genes responsible for frost-resistant tomatoes. He went on to argue that applications of biotechnology would help to speed up the process of crop development and would produce improved varieties within years, rather than centuries. This argument was salient, due to the economic importance of agriculture to the state.

These sessions ultimately helped establish a shared commitment among the non-technologists in the state legislature to the development of this complex and, at the time, controversial technology. Equally important, these sessions created metaphors that contributed to a common language for conversing with other non-expert constituents and colleagues about the relevance and significance of biotechnology for the state. Referring to this process, Hancock explained that "efforts like this are partly substance, in that you are trying to help everyone understand the subject matter and what the potential for it is. The other dynamic going on in a meeting like this is building champions for whatever you ultimately recommend."[19]

SECOND-MOVER ADVANTAGES

The three-year time lag not only provided time to build consensus around state support for the biotechnology industry, it also gave legislators an opportunity to observe and learn from the Microelectronics Center experience. What initially appeared to be a slow start provided second-mover advantages that allowed the North Carolina Biotechnology Center to understand and thus avoid the institutional conflicts that emerged during the early operations of MCNC. These conflicts centered on the relationship between MCNC and the state's universities.

A Perceived Research Competitor

As indicated earlier, the Board of Science and Technology originally envisioned these technology-based nonprofit organizations as mediating or coordinating bodies—that is, independent centers that would supplement, support, and connect, rather than duplicate, university research efforts. The 1980 MCNC Plan report was most explicit on this point, emphasizing that a state-funded microelectronics center should "not conduct in-house research itself" but should instead be designed to support "microelectronic education and research at the participating institutions (i.e., state universities and established research centers), provide coordination and stimulus for research in microelectronics at these institutions and serve as a linkage and information channel between the institutions and interested industry."[20] To achieve this goal, the original MCNC Plan proposed the creation

of two separate microelectronics facilities. The first would concentrate on microelectronics research and would be located at North Carolina State University; the second, to be sited 20 miles away at Research Triangle Park, would focus on complementary, downstream activities pertaining to semiconductor design and fabrication. However, the expedited planning process resulted in a dramatically different organizational structure—one that would ultimately be perceived as a threat to some of the state's universities.

In early 1981, MCNC board members—and especially the board's chairman, George Herbert—proposed an alternative model that would instead fold all microelectronics functions, from research to fabrication, into one off-campus facility located in Research Triangle Park. This recommendation reflected board members' concerns that building and staffing two separate facilities was neither cost effective nor a good model for supporting innovation activities. Specifically, several MCNC board members shared the belief that consolidating the research and fabrication functions into one location would expedite the translation into working prototypes and thus lead to more rapid advances in semiconductor development—which was viewed as essential, given increased competition between U.S. and Japanese semiconductor interests.[21] Moreover, MCNC board members were concerned that concentrating research activities at only one university campus could alienate other universities in the state and undermine later efforts to engage a wider university constituency. A letter to Governor Hunt from MCNC board chairman George Herbert outlined many of these concerns. He explained that "some of the earlier decisions were based on flawed concepts. A new set of decisions is necessary if we are to move forward."[22]

The revised model presented by the MCNC board included a single, large-scale facility to support a variety of semiconductor research, design, and production-related projects. The center, to be located in Research Triangle Park, would be available for use by university faculty and students throughout the state. In addition, the goal was to help forge deep connections between university researchers and private-sector actors by encouraging industry participation.

Despite the strong justification for this change, tensions arose among university faculty and administrators who had been excluded from this discussion and the decision-making process. Failure to resolve this initial tension soon led to a perceived lack of transparency and openness on the part of MCNC. Interviews with stakeholders reflect a high level of distrust in the early years of MCNC. Many faculty members admitted being suspicious of MCNC executives throughout the 1980s, viewing them as more interested in supporting industrial recruitment than enhancing research. Other university researchers expressed concern that MCNC—in needing to build and maintain a high-profile, expensive in-house research program—siphoned off scarce public resources that would have otherwise gone to support university development. As one computer science professor explained it, "MCNC staff just took the research outputs without consulting university researchers."[23]

While there is evidence to suggest that MCNC's presence actually helped to elevate the national status of university microelectronics research in North Carolina, MCNC leaders' unwillingness to resolve early sources of conflict set the tone for tense university-MCNC relations throughout the 1980s and early 1990s. Eventually this tension would affect relationships with the state legislature, which closely aligned itself with university interests. In fact, when faced with growing criticism from state legislators in the late 1980s, MCNC president Don Bielman turned to an established policy insider for advice. The response he received: "Well, you know, Mr. Bielman, in North Carolina you'd better not mess with the universities."[24] Unfortunately, by the time this message was internalized by MCNC management, little could be done to mend these broken institutional ties.

A Conduit for Research

The significance of mounting tensions between MCNC and the universities was apparent during the biotechnology legislative review in 1983-1984, and it greatly influenced the structure and strategy of the Biotech Center. It became clear to the study commission that "there were many university people that were not comfortable with [the microelectronics] model."[25] Top-ranking university officials helped to reinforce the message that they wanted a very different kind of model for biotechnology. Gerry Hancock recalled:

> I remember in one of our study commission sessions that [UNC system president] Dr. Bill Friday put it squarely on the table. He said, "Gerry this all sounds very promising. I think I understand where you are headed here, but I just want to make sure I am clear about something. Do I correctly understand that this will *not* be a research institution?" And because there had been preliminary discussions about this, I was fortunately ready for his question and I said, "Yes sir, absolutely. One of the things that distinguishes or differentiates this from other models is that this is not a laboratory. This is not a research institution. It will not be a place where we hire scientists for research."
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> I said, "You might see the odd PhD wandering around because the center will need people that understand science. But this will not be a research institution. Instead, it will be a leadership and catalytic institution. It will work with universities and it will fund research at the universities. It will work with businesses. It will work with financial institutions and entrepreneurs and it will try and cause things to happen."
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> And I also said this: "It is the view of this committee that improving university-based research in biotechnology is critically important. That will be the foundation of our economic success."[26]

During these deliberations, it became clear that the best strategy for the North Carolina Biotech Center was to follow the Board of Science and Technology's recommendation and act as a conduit between academic research and the private sec-

tor. The state had strong expertise in chemistry and medicine; however, molecular biology and DNA capabilities needed to be augmented. As a result, the Biotech Center's early initiatives included a grants program for university research activities and one of the country's first eminent scholars recruitment programs, which provided matching funds for new faculty hires at multiple North Carolina universities. One of the early recruits supported by the Biotech Center was Oliver Smithies, the 2007 Nobel laureate in medicine. Early on, the Biotech Center also provided financial and institutional assistance to develop university technology-transfer programs.

Organizational Governance

Partly influenced by MCNC's troubles, the legislative commission also designed the Biotech Center's board to be broadly representative. In contrast to the 11-member governing board of MCNC, the 1984 Biotech Center's Articles of Incorporation specified having 23 board members, with representation detailed to a specific sector and appointment authority broadly shared. For example, the board reserved nine seats for three representatives from animal husbandry, plant agriculture (at least one from forestry), and the marine trades. Additionally, two representatives were to be appointed from the state's pharmaceutical industry or medical establishments, with the dean of the medical school of Wake Forest University also listed. The board also included five university leaders who represented the UNC system, UNC-Chapel Hill, North Carolina State, East Carolina University, and Duke University. In contrast to MCNC, the Biotech Center's authority to appoint board members was shared equally among the governor, the lieutenant governor, and the speaker of the state house of representatives.

While the sheer size of the Biotech Center board reflected its original need to build consensus, it also served to increase transparency and guaranteed a diversity of opinions to enhance decision-making. Gerry Hancock explained:

> Board design 101 typically means you don't want any group to dominate. You want everyone to feel fully and fairly engaged in the mission. We needed the long-term support of the universities, the business community, the scientific community, the legislature, the governor, and the people of North Carolina. We needed that support initially and longterm, and that thinking was embedded in the design of the board of directors. I believe it still is.[27]

The Biotech Center board eventually increased to 36 members, including representatives from other interested constituencies.

MCNC's organizational structure, by contract, resulted in a concentration of power. MCNC had ten external board members, including five university chancellors and presidents and the chairman of the Research Triangle Institute. The remaining four seats were filled by North Carolina "citizens" appointed by the governor. Yet, unlike the Biotech Center, there was no explicit requirement for sector, geographic, or topic representation. Most of the governor's appointees were exec-

utives from banks, utilities, and real estate companies—parties potentially more concerned with immediate economic growth than with enhancing long-term technology capacity.

MCNC did form several advisory committees to help formulate a strategy. The most influential was the Industry Executive Committee, made up almost entirely of executives from microelectronics-related companies in the state. Still, rather than helping to diversify strategies, their strong influence acted to reinforce MCNC's industrial orientation. One example of this is a former MCNC executive who acknowledged that in order to encourage more companies to partner with MCNC, "we had to portray ourselves as different from the universities."[28] This meant that university researchers were often unaware of MCNC's industry-oriented research program. As one electrical engineering professor involved in early microelectronics planning efforts recalled, once MCNC's research program was under way, "campus faculty never heard the details of their science."[29]

Advisory channels to the Biotech Center were vastly different and reflected the deliberation and consensus-building that birthed the Biotech Center in 1984. In helping to establish the Biotech Center, legislative study commission members—some of whom would go on to become board members of the center—strongly encouraged developing a strategy through committee or task force review. Much like the legislative study commission, the goal was to bring various outside perspectives to the table for consideration when developing strategies and priorities. This practice of committee review continues today. One staff member from the Biotech Center recently described the steps taken to launch a new initiative involving applied agricultural biotechnology. As she put it, "We did what we always do when considering a new issue; we first created a task force to study the issue."

Communication Strategy

The two organizations also related differently to the general public. Building on the legislative study commission, executives from the Biotech Center maintained a strong commitment to citizen engagement and outreach. In doing so, the ultimate goal was to make the technology accessible to and easily understood by the citizenry of North Carolina. An illustration of this commitment to public outreach was that the Biotech Center's third employee was an educational expert with a liberal arts degree, whose primary responsibility was to translate biotechnology into accessible language for non-experts. One example of his early work is captured in the cover image from the 1986 Biotech Center annual report. This image portrays a group of scientists looking out onto a forest and a herd of pigs—a symbolic image meant to illustrate the application of biotechnology to forestry and pig farming, two important industries in North Carolina in the 1980s. The editors might have easily chosen a science-oriented cover with the then-popular double helix or a large representation of a molecule. The message they conveyed with their chosen image was clear: that the biotech industry was important to North Carolina and a resource for upgrading traditional industry. Related to this is that the writ-

ten contents of early annual reports were designed to be broadly accessible and informative.

By contrast, the cover of the Microelectronics Center's annual report from the same year—which depicted a large and looming institutional building—is representative of the report's written content. The text was a dense description of microelectronics research activities that was incomprehensible to all but the most informed expert. MCNC's annual reports were not designed to educate the public or to build broad-based public support. Rather, they tended to feature the scientific research activities and publication record of affiliated MCNC scientists. This difference is perhaps best captured by a quote from a state legislator at a public hearing: "I understand wood chips," a direct reference to the Biotech Center's discussion of applying technology to the state's forestry industry, "but I don't get microchips."[30]

ORGANIZATIONAL DESIGN DICTATES ADAPTABILITY

Putting this history together, we begin to see the influence of organizational design on each organization's problem-solving abilities. Both centers would face a series of organizational crises and challenges during the 1980s and 1990s. For MCNC, this included a 1988 budget audit by the state legislature and a protracted lawsuit involving a major North Carolina newspaper over the Microelectronics Center's failure to publicly disclose budget information. For the Biotech Center, it included the threat of deep budget cuts that reflected a shift in state politics in the mid-1980s, when the organization was in its formative years, as well as a prolonged leadership crisis in the mid-to-late 1980s that threatened the center's survival.

The Biotech Center weathered these and later challenges better than MCNC. Most notably, its organizational design facilitated the quick identification of potential conflicts and encouraged adaptive solutions. The center institutionalized deliberative and reflective processes that resulted in effective problem-solving and resilience. It also had established goodwill with the public, the legislature, and the universities. Once in trouble, Biotech Center leaders were able to call on numerous allies representing broad segments of society to defend the center's continued existence and ongoing state support. In the late 1980s, the center also brought in new leadership that reinforced its commitment to community engagement and consensus-building and provided the strong management needed to advance their economic development mission and impact.

By contrast, executives at MCNC tended to ignore or dismiss signs of deepening crisis, continued to alienate important institutional allies that could have helped them salvage their reputation, and ultimately failed to make their technology contribution clear and well understood by the general public—especially those elected to state government. The lack of public understanding about MCNC was perhaps more problematic, due to the state's initial investment of $24.4 million and the large annual operating budget that became an easy target for adversaries. It is not surprising, then, that with a deepening financial and organizational crisis

at hand, the state government decided in 1995 to end its financial commitment to MCNC. Unable to sustain itself, MCNC was forced to sell off most of its assets, including its research facilities and equipment, and significantly trim down its staff. While the hollowing out of MCNC in the mid-1990s did ultimately benefit the state by releasing top-quality researchers into the local labor market—a talent pool that was quickly absorbed by industry and by universities in North Carolina—it still represented a major policy loss for the state. A shadow of its former self, MCNC, now a privately funded nonprofit that specializes in rural broadband, has limited economic and industrial influence in North Carolina. Today it functions as little more than a specialized utility.

In comparison, the North Carolina Biotechnology Center is considered one of the most influential state-funded technology centers in the United States today. The Biotech Center's continued support of recombinant DNA research and development activities has helped catapult North Carolina to third place nationally for biotechnology establishments, behind Massachusetts and California, by-passing significant competitors along the way, including Maryland.[31] Additionally, its strong policy influence and ability to represent various needs and interests has ensured that the benefits of this technology development continue to be broadly dispersed. One important example is that the Biotech Center has played a central role in building the state's biomanufacturing industry by helping to nurture and recruit over 40 large-scale biopharmaceutical manufacturers to the state. As part of this effort, it has also partnered with the state's community college system to develop and continuously update vocational training programs. In doing so, the Biotech Center and its institutional partners have helped to lower the biotechnology career ladder to less educated job seekers in the state, especially those displaced from traditional manufacturing industries, and in the process the center has taken a national lead in promoting a more socially inclusive knowledge economy.[32]

DEVIL IN THE DETAILS

Many places consider forming quasi-public organizations as a vehicle for technology-based economic development. More flexible than state agencies, quasi-public organizations have the ability to focus on specific targeted activities, such as assisting start-up companies or developing a specific technology area or specialization. Quasi-public entities are also buffered from the vagaries of political election cycles and thus may be better suited for adapting policies over a longer time horizon. This is especially important for new, rapidly changing technology areas that may require greater policy patience and "improvisation."

The experience of two sector-specific, technology-based economic development organizations being initiated in the same state at about the same time offers insights into the importance of organizational design. Table 1 provides a summary of key design elements. The differences in the mission statements are subtle yet profound: while both mention economic development as a top priority, MCNC sought to "foster advanced programs in microelectronics and supercomputing in

	MCNC	Biotechnology Center of North Carolina
Mission Statement	Legally separate nonprofit corporation created to foster advanced programs in microelectronics and supercomputing in support of economic development and North Carolina universities and research institutes	Legally separate nonprofit corporation created to further economic development through the support of biotechnology research
Governing Board	16 members, with 11 voting members 7 of the voting members are appointed by the governor 4 serve as a result of positions with the UNC system	35 members 15 of the members are appointed by the governor or General Assembly 4 serve as a result of positions with the UNC system
Founding Date	1980	1984
Initial State Funding	$24.4M	$843K

Table 1. Summary of key design elements

support of economic development," whereas the Biotechnology Center had a more direct statement about "creating economic development through the support of biotechnology research"—its catalytic role being clear from the start.

Some individuals with a close working knowledge of these two organizations have attributed the demise of MCNC to poor technology choices—in other words, by initially prioritizing semiconductor research rather than other aspects of microelectronics and by investing heavily in a soon-to-be outdated supercomputer, the Microelectronics Center essentially bet on the wrong technologies. Locking in to a specific technology is risky and private companies do make wrong technology choices, but this explanation has its limits and ignores the influential role that organizational design can play in guiding ongoing modifications in technology development and targeting. After all, numerous organizations were created at this time that initially prioritized semiconductor research, including well-known examples like Sematech and Micron Technologies. They proved capable of moving beyond their initial narrow technology focus and remained key players in microelectronics industry development. MCNC, by investing heavily in its own in-house technology development, took on much greater organizational risk than the Biotech Center and also required much larger infusions of capital to maintain and modify those technology investments.

The size and composition of the two organizations' governing boards was perhaps a key factor in their outcomes. MCNC had a small board of 16 members, 11

of them voting members. The governor appointed 7 out of the 11 voting members—that is, the majority. The other four members served as a result of their positions as chancellors in the state, representing both public and private universities. The choice of chancellors, while certainly prestigious, did not produce active board members who had adequate time and expertise in microelectronics. In contrast, the Biotech Center started with 32 members and grew to 36. The composition of this board not only allocated political oversight but also guaranteed broad representation and diverse opinions. Board meetings were lively and engaged; topics were debated and decisions were postponed until a clear consensus was achieved.

While MCNC benefited from significant initial funding, an outcome most organizations would favor, the Biotech Center took a slower, more incremental path. In essence, the large-scale activities undertaken by MCNC required a much more flexible organizational model that would have allowed those technology choices and any subsequent changes to be accessible, widely understood, and more broadly supported. By functioning instead as a monolithic and opaque technology fortress, MCNC contributed not just to it's own technology obsolescence but, more importantly, to it's organizational demise.

REFLECTIVE CONCLUSIONS: REGIONAL IMPROVISATION

It is commonly accepted that regional innovative activities are self-organizing and that ecosystems develop through the actions of institutions and entrepreneurs. Government's role in helping create clusters is more controversial, as many public investments have not yielded the desired results. Yet the ability to create new opportunities and leverage existing resources is certainly the intention of many state economic development efforts, which have only intensified with the current emphasis on cluster initiatives as a growth strategy and the need for new growth opportunities in this recent economic downturn.

In this case study, we observe that the state of North Carolina created a quasi-public entity that was able to catalyze a local industry cluster, in this case biotechnology. Although it started with no discernable advantage and was not a likely location for the industry, the state currently has a large concentration of biotech companies. Building up slowly and studying the potential of the new early stage technology provided an opportunity to achieve public consensus about the potential and needs of the developing industry. Telling the full story of the development of the industry would require more time, but our claim is that good organizational design allowed for this successful implementation and achievement of the economic development goal.

Though they started from the same analysis and set of recommendations and were implemented in the same state, the Microelectronics Center of North Carolina and the Biotechnology Center of North Carolina evolved along different trajectories. While the concept of dedicated, sector-specified technology development agencies was appropriate, this case study reveals several lessons about organizational design, the importance of both understanding and adapting to local

contexts, and the need for transparency, community-building efforts, and inclusiveness. The Biotech Center has continued to expand and flourish, and the life sciences industry is strong in the region. While it would be difficult to pronounce MCNC a failure, in that its many investments have proven important to the state and it helped to establish North Carolina as a site for the industry, we are left to speculate how the microelectronics and information and telecommunications sector might have progressed with stronger state advocacy and shared resources. The fact that MCNC's facilities and assets were sold, the research group dismantled, and its mission changed to the provision of statewide broadband access suggests that the original vision of technology leadership has been compromised. The counter-factual example of how well the state's microelectronics industry would be doing if MCNC had continued to be strong and to advocate for innovation and entrepreneurship is an open topic.

When a local economic development crisis occurs, the tendency is to act quickly and decisively. A quasi-governmental entity provides a means for a quick response that is desirable because it can experiment and be evaluated on its accomplishments. The first step in the formation of a quasi-public economic development entity is often to build a new facility—a visible commitment to the new entity and its mission. This is unfortunate, as it ties up resources that might be used more constructively on other investments. A physical structure not only raises expectations about what the agency can accomplish, it also creates a sense that the activity takes place there rather than in the community. The ribbon-cutting excitement of a new building, while certainly a notable event, can ultimately distract from an agency's core mission.

There is no shortage of advice for policy-makers about how to engage in technology-based economic development. Most of this advice is at odds with the premise of self-organization and adaptability that underlies cluster development. Economic developers are told to undertake big, decisive investments, but perhaps the lesson from this example and the best advice for policy-makers is to follow a strategy of regional improvisation, continuous adaptation, and appreciation of context. From this limited example, the best economic development strategy may be to become educated about an industry by following a process that is inclusive, transparent, and open to criticism and debate. In this way, the Biotechnology Center of North Carolina demonstrates that it is possible to build consensus around a vision for an industry, and to implement that vision.

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