"The Role of an Antecedent Cluster, Academic R&D and Entrepreneurship in the Development of Toledo's Solar Energy Cluster"*

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Introduction

Altering a "development trajectory" is a major challenge when promoting innovation-based development in declining manufacturing regions as few regions are successful in creating *new* clusters in emerging technological areas. Toledo, Ohio, not unlike other industrial cities, is looking for new technology industries to offer opportunities for economic diversification and high paying jobs through the support and "creation" of technology clusters in selected areas that offer future promise. In 2003, Toledo's economic development organizations sponsored a study that resulted in the identification of technology clusters. Alternative energy was one of these clusters. The alternative energy cluster includes a range of technologies with solar energy as the premier area of focus. The solar energy cluster faces serious challenges but has important strengths. The first challenge is that the cluster is developed around emerging technologies that have serious technical issues to overcome through R&D before they are competitive in the marketplace. Second, the technology under development may be undercut if market conditions change in favor of traditional energy sources or if national policy supports another alternative (e.g., nuclear). Third, entrepreneurship is considered by local leaders as a local weakness. Finally, the region lacks venture capital and groups to support technology investment.

A strength of the cluster is that it builds upon an antecedent cluster in the glass industry. Toledo has deep experience on research, development and production of glass that is a component of solar cells. Second, the thin-film program at The University of Toledo (UT) provides research support, a technical workforce, and access to federal funding to support industrial initiatives in solar energy. Third, despite the dearth of entrepreneurial talent in the region, the region has produced some exceptional entrepreneurs that provided leadership in creating a local solar energy industry. Fourth, the region has the strong advocacy of the local congresswoman who has been successful in steering congressionally-directed funds to support the cluster.

Thus, while many community leaders view the solar energy as a new "emerging" cluster, looking deeper shows that this new technology-based industry grew from technology developed in an earlier era when Toledo reigned as the "glass city" of North America. Thus, if Toledo is successful in "creating" a solar energy cluster, it will have been built upon a strong foundation from an earlier era. Through most of the last century Toledo had a number of firms in the glass industry with major local R&D facilities that employed scientists and engineers who produced many innovations. This industry was largely hollowed out late in the 20^{th} century as glass R&D centers were dispersed or closed, business units were sold, and bankruptcies occurred. With recent local efforts to advance a cluster in solar energy and with UT supporting programs to serve as a source and supporter of innovation, the community is in a position to alter its trajectory from a declining manufacturing city to one competing in a rapidly growing technological field.

This chapter shows that Toledo's new solar energy cluster owes much to its antecedent glass cluster and that the new cluster has taken many years to emerge. Although the cluster has been supported in many ways, it grew with little public policy attention or nurturing. The emerging cluster has many of the attributes associated with technology clusters, including sources of innovation, entrepreneurship, ability of the region to absorb innovations, university support, and sharing of information and people. Following a brief review of the relevant literature, the chapter provides information on the growth of the solar energy industry, describes the growth of the cluster in Toledo, and provides information on prospects of the cluster's ability to sustain its growth.

Innovation-based Cluster Development

It is not necessary to review the vast literature on technology clusters here (see Cooke, 2002; Taylor, 2005, Martin and Sunley, 2003). Case studies indicate that some clusters develop without direct public policy intervention or direction and in other cases, state or regional leaders work to create a cluster in a region that does not have much activity related to the planned cluster. "Created" clusters are often associated with rapidly expanding knowledge-based sectors that are heavily dependent upon universities, entrepreneurship and skilled labor. A common strategy is to create clusters around core activities such as local industry, a major federal center, or university research centers. A rare path is the development in an emerging technological area that needs to overcome both technical and competitive market conditions before profitable returns are realized (e.g., Lester, 2005). Cortright and Mayer (2001, 8) conclude that "economic development efforts should be tailored to build on or extend existing strengths or emerging local competence; trying to create a totally new high tech center where none currently exists is likely to be a lengthy and probably fruitless endeavor."

A top-down approach has a questionable record of success when the task is to transform an "old economy" (industrial plants, hierarchical, skill-based, etc.) into a "new economy" (lifelong learning, risk-taking, teaming, etc) (Cooke, 2002, 131-156). Many regions try to create clusters in areas lacking a tradition of entrepreneurship. The approach requires that leaders redirect thinking away from the view that competing on the basis of low-cost manufacturing or attracting new manufacturing operations will revive the economy (Boschma and Lambooy, 2000; Asheim and Isaken, 2002). Even if a new development model is endorsed, the challenge is great if the area does not have local sources of innovation creation, entrepreneurs with technology experience, and investment funds or venture companies who have experience dealing with the uncertainty of technological risk in addition to the expected risk for all start-up businesses. "Technological entrepreneurs" can develop and introduce new technical ideas into the marketplace (Feldman and Francis, 2004, 131). For instance, a cluster can provide learning experiences that can assist new entrepreneurs overcome barriers to entry. For the most part, entrepreneurship is viewed in the context of new firm formation and not other variants of entrepreneurship such as that within firms, universities, or research institutes (Fromhold-Eisebith, 2006).

The expectation is for newly created knowledge to spill over into the local region if that region can "absorb" the knowledge created (Breschi and Malerba, 2001; and Feldman and Massard, 2002). This means that barriers to the exchange of information are reduced (restrictions on sharing information or post employment covenants) and that the region has individuals and organizations with the capacity to capitalize on locally available knowledge. A good example is provided by Saxenian (1994) who showed how the movement of engineers and technicians between jobs among firms in Silicon Valley helped to spread technical knowledge within that region. The growth potential and "youth" of the industry has also been shown to be important to both clustering and technology spillovers (Glaeser et al, 1992).

If innovation is central to successful long-lasting clusters, a local source of continuous innovation is imperative. The availability of specialized knowledge and the creation of new knowledge may attract firms from elsewhere into the region, may attract entrepreneurs into the region, and may create new firms through spinoff activities (Maskell, 2001). The most significant source of new knowledge creation is from research and development (R&D) activities with universities as major R&D producers (Audretsch, 1998, 20). University R&D expenditures have been shown to be significantly related to new firm formation and a contributor to economic growth (Kirchhoff, Armington, Hasan, and Newbert, 2002). Other important sources of innovation are industry R&D laboratories, federal R&D laboratories, or even "decentralized industrial creativity" within the collective capacity of small firms within a region.

Growth of the Photovoltaics Industry

Photovoltaic cells or solar cells are devices that can generate electrical energy under exposure to light. The technology can be traced to1839 when the photoelectric effect was identified. Some forty years later, the first experimental solar cell was constructed. It was not until the mid twentieth century that the first solar cell was patented based upon discoveries at Bell Labs. Soon after, commercial activity began and solar cells found use in space applications. As PV became a critical source of power for satellites and other space craft, the first oil shock of the early 1970s spurred interest in the development of terrestrial applications of PV technology.

Solar energy is one of the fastest growing technology industries in the world with growth expected at an annual rate of 35 percent through 2010. In 2000, world wide solar cell production stood at 288 MW. In 2005, production worldwide soared to 1,759 MW (Maycock, 2006). The three major producing areas are Japan (47.5%), Europe (26.7%), and the US (8.7%).

There are different solar cells technologies in use and under development, and different companies and different research groups have focused their investment and interest to advance certain technologies. The major types are silicon crystal and thin-film solar cells. Major issues driving market potential include the efficiency of the cell (how much solar energy is transformed into electricity), production cost of the cells; aesthetics, life cycle environmental costs, and balance of costs to install the entire system. Silicon crystal solar cells (often seen on highway signs) accounts for over 90 percent of the total solar cell market (SolarBuzz, 2006). The high cost of silicon wafers, which accounts for up to

50 percent of the total cost of the cell, is leading manufacturers to seek less expensive alternatives. Silicon crystal cells account for almost the entire output of Sharp, Q-Cells, and Kyocera, the world's top three solar cell producers (Maycock, 2006). Thin film technologies have taken many years to develop. Thin film technologies are promising because the material costs are driven down since the films are exceedingly thin. Systems that provide for large area deposition leading to high volume production further reduce the cost of the cells. Toledo's PV technology is focused almost entirely on thin-film technology. First Solar, Unisolar (nearby in Michigan), start-up companies Solar Fields and Midwest Optoelectronics, as well as UT's research focus are in thin film PV.

Foundations of the Toledo Solar Energy Cluster

Before technology clusters were a topic of discussion, Toledo had a vibrant glass industry cluster that included some of the leading glass technology companies—Owens-Illinois, Owens-Corning, Libbey-Owens-Ford (LOF), and many others. Toledo's advantages included its natural gas reserves, labor, and access to silica beds. Toledo was a source of major glass industry innovations with the source of innovation being entrepreneurs and local industry. In 1903, Michael Owens, of Owens Bottling Machine Company, invented the first automatic bottle-making machine, recognized as one of the most significant developments in glassmaking since the invention of the blowpipe some 2,000 years before. With this invention, a plant in 1905 could produce over 17,000 bottles a day compared to 2,880 bottles a day in a plant using hand-blown labor (Brickey, 1990b). By 1912, the plant with the Owens machine could produce over 50 thousand bottles a day. The inventions continued. Libbey and Owens assisted Irving W Colburn, who was working on a continuous drawing flat sheet glass machine to form a new company in 1916, the Libbey-Owens Sheet Glass Company, whose main product was window glass (Ward M. Canaday Center). In 1930, Libbey-Owens-Ford Glass Company was formed through the merger of Libbey-Owens Glass Company and the Edward Ford Plate Glass Company. Glass from this company was used in the construction of the Empire State Building. In 1929, Owens Bottle Company merged with Illinois Glass Company to form Owens-Illinois Glass Company. In 1935, Corning Glass and Owens-Illinois started working together in the development of glass fiber. By 1938, Corning and Owens-Illinois created a separate company, Owens-Corning Fiberglass from this joint venture changing its name to Owens Corning.

Although UT was primarily a teaching institution in the 1950s the University did support the industry, but not as a source of innovations. In 1952 the University formed The Institute for Silicate Research for a "purely scientific purpose" that included a number of industry sponsors.

Thus the "glass city," held a leadership position in glass technology and manufacturing. Over the decades, local industrial R&D declined as companies shed their research operations, and moved to administrative and management centers or as production units. The interest in silicate materials waned at UT. Some of the industrial labs spun out of local companies and moved into the community as university centers or new companies, but much of this talent was lost forever. For instance, in the mid-1980s Owens-Illinois, under increasing pressure from the plastics and aluminum industry, scaled down its research efforts in materials in favor of work on processing and manufacturing (to drive down manufacturing costs). In 1987 Owens-Illinois, UT, and the State of Ohio agreed to place the O-I R&D laboratory into the University. Likewise, Libbey-Owens-Ford had a major R&D laboratory in nearby Perrysburg that produced leading technology in plasma display systems. As late as 1990, LOF had about 275 people in its Toledo Technology Center and its R&D center was viewed as a "profit center"(Brickey, 1990a). This activity was dispersed throughout other units and much of the expertise lost. By the mid-1990, most of the local industrial and university R&D relating to glass was a chapter in Toledo's history.

Although a lack of entrepreneurship is frequently mentioned as a Toledo problem, the origins of the cluster are based solely on the initiatives of Toledo entrepreneurs. Few would dispute that Harold A. McMaster is the father of Toledo's solar energy cluster. McMaster worked as a physicist for automotive glass maker Libby Owens Ford (LOF) on wrap- around auto glass bending and tempering. Frustrated that his novel ideas were not receiving company endorsement, McMaster left LOF in 1948 and starting experimenting with glass in his basement, paying particular attention to ways to bend glass to meet specific needs (e.g., glass for dime store racks). As he continued to produce new inventions, he formed Permaglass in 1948, which merged into Guardian Industries in 1969, then, with his partner Norman Nitschke (another prolific inventor) formed Glasstech, Inc. in Toledo's neighbor city Perrysburg. They quickly constructed a new machine for "tempering" glass that increased its strength, and on breaking caused it to crumble instead of breaking into shards. Glasstech grew into a leader in the manufacture of furnaces for tempered glass. An estimated 80 percent of the world's automotive glass and 50 percent of its architectural glass is manufactured using machines developed by the work at Glasstech (The Toledo Blade, 2003). In 1984, with the support of 57 investors, McMaster formed Glasstech Solar, Inc to produce efficient solar cells by coating glass with thin layers of chemicals. Glasstech initially worked on thin-film silicon technology at its Wheatridge Colorado location. Continued research led to thin films based on cadmium telluride. This "thin-film technology" would reduce the amount of material required by standard polycrystalline photocells and reduce manufacturing time. Three years later, Glasstech announced that it would be constructing a new $15 million plant to produce 100,000 21-square-foot solar panels annually. This plant under the new name Solar Cells was located in the former Owens-Illinois Technical Center that was now on the UT campus. Thus, Toledo's first solar plant was located in a laboratory that supported R&D for the glass industry of a previous generation.

With Solar Cells locating on the UT campus, UT worked to support solar energy technology development. As McMaster and his colleagues at Glasstech advanced their technology, they sought out assistance from the University. In 1987, the University hired Dr. Alvin Compaan and with Compaan's support, two State of Ohio Edison awards were won to address processing issues in thin film solar cell development. These awards brought sophisticated thin-film deposition systems to the region. From this base of collaboration, and with the new instrumentation, Compaan and Solar Cells Inc. won a competitive award in 1989 from the U.S. Department of Energy's Solar Energy Research

Institute, the first federal research award to Toledo in the area of solar energy. Since then, UT has received continuous funding from the U.S. Department of Energy in support of its solar cell research.

In 2001, the University selected advanced thin-film materials as a premier area of research within the University. With this standing, the University dedicated an endowed chair position to this area, provided favorable cost-sharing arrangements, and approached Congress for support. With the active support of Representative Marcy Kaptur, UT received $6 million from the Department of Defense and Department of Energy for thin-film PV research over the 2002-06 period. University solar energy spin-off companies are often subcontractors on these awards. In addition to these funds, UT continued to win competitive awards from the federal government and state with external funding in support of PV research now at more than $4 million per year. Providing additional support to the cluster, the University created an alternative energy incubator in 2005 that houses small companies and university research centers.

Formalization and Local Recognition of the Cluster

Recognition of the cluster came with the winning of an NSF award, public promotion by the local congressional representative, the designation as a local technology cluster, the creation of a solar energy business council, and the winning of Ohio technology development grants. In 2002 UT won a National Science Foundation award to create a Partnership on Alternative Energy Systems. This award brought commitments from local government, local political leaders, and local industry. Significant awards from the State of Ohio provided boosts to the cluster. The UT photovoltaics group won a $2 million Ohio Third Frontier Award in 2004 and in December 2006 won an $18.6 million Third Frontier Award for its Center for Photovoltaics Innovation and Commercialization. Evidence of the recognition of the cluster in Toledo was provided when Governor Taft recognized alternative energy research in Toledo in his 2005 State of the State address.

McMaster's vision that Toledo would emerge as a leader in solar cell production is ringing true. Bringing an infusion of cash and management expertise and with its new Perrysburg location, True North Partners, LLC of Scottsdale Arizona (including Wal-Mart heir John Walton) took control of McMaster's company in 1999 (Pakulski, 2000) renaming the company First Solar, LLC. After a dispute with the new investors, McMaster's ownership stake in the company ended. The McMaster family continued work in solar energy independent of First Solar LLC, and in 2001 at the age of 84 Harold McMaster created McMaster Energy Enterprises. First Solar produced about 100,000 4'x 2'panels in 2004 (compared to 30,000 in 2003) and produced over 300,000 panels in 2005. The company benefits greatly from incentives in Germany that allows property owners to sell power generated from solar back to the utilities for 49 cents a kilowatt-hour.

Until recently, public *promotion* of the cluster was almost entirely based upon university support. Recently, however, local companies, under the leadership of McMaster Energy Enterprises CEO have formed the "Northwest Ohio Alternative Energy Business

Council." Business Council leaders have mounted an aggressive campaign in the state's capital to push state government to invest in solar energy and related technologies. Table 1 lists the major players in the cluster. This includes UniSolar of Auburn Hills, Michigan who collaborates with UT on projects. The cluster is vertically integrated and includes major corporations, such as Owens-Corning and Pilkington with entrepreneurial managers who have recognized the opportunities of the industry. The cluster includes entrepreneurs who are working to move their business from the incubation stage into the acceleration stage. The University, with its specialized equipment, expert faculty, skilled students and Clean and Alternative Energy Incubator is a central focus of the cluster. In addition to serving as a source of innovations, the University is able to increase networking and communication through regular workshops, seminars, visitors and conferences on alternative energy offering the community valuable interpretative benefits.

Table 1. Major Firms in the Toledo Solar Energy Cluster

Company	Contribution
First Solar, LLC	CdTe thin film photovoltaics
UniSolar	a-Si thin-film photovoltaics
McMaster Energy Enterprises	Thin-film photovoltaics (atmospheric deposition system)
Midwest Optoelectronics	Thin-film photovoltaics and Hydrogen production from solar cells
Innovative Thin Films	Glass Superstrates and substrates
Advanced Distributed Generation	Design and installation of solar energy arrays
Pilkington	Tech Glass for solar energy industry
Owens Corning	Building materials and building integrated PV

Challenges and Next Steps

Despite a bright outlook, there are major challenges to face including overcoming technical questions; expansion of markets; retaining talent and retaining firms; attracting talent and attracting investment; and competition from other regions. A major research goal is to increase the efficiency of solar cells. To drive prices down, it is necessary to increase the efficiency of solar cells and to reduce the cost of the entire system (invertors and installation). Commercial solar cells now have efficiencies of about 15 percent. Improving the efficiency of solar cells will reduce the size of cell needed to produce electricity, thus lowering costs for the entire system. Overcoming efficiency limits is important to an expanded commercial and residential market for PV.

Although PV systems are cost competitive in remote locations, such systems are not competitive with grid-connected power from existing conventional generation sources without federal or state incentives. The US commitment to solar energy is uneven, and although some states have taken steps to stimulate development; the nation is far behind other counties in taking a national approach to stimulate markets for new technology. Germany's 2000 "feed in law" required utilities to pay 48.1 cents per kilowatt-hour for solar energy. Not surprisingly, solar energy installations increased dramatically and now stand at over 400 megawatts. In Japan incentives were introduced to help stimulate production and installation of systems to drive down prices. As more experience was gained, the price of solar systems declined as did the incentive. Without the international market, or the promotion in certain U.S. states, the outlook for local companies would be quite uncertain.

Conclusions

Toledo appears to be approaching the completion of a full circle in its position as a technology leader. Once a global leader in glass, with major industry R&D labs supported by a well-focused university center, the region went into a period when it lost its competitive position. Now, the emerging alternative energy cluster that had its origins with people who contributed to the earlier era is emerging as a national or even international leader on a very specific solar cell technology: thin-film photovoltaics. Compared to regions that are building clusters around more technically mature and commercially successful activities, there still exists much technical and market uncertainly for the core technologies involved in solar energy. The gamble is that Toledo may be able to focus attention and develop momentum in an emerging area of technology that may position the region for greater returns. The downside is that market conditions may change, federal priorities may change, competing PV technologies will prevail or technical problems continue to thwart commercialization of the technology.

Even though the solar energy cluster is now just emerging and gaining recognition, the foundations for the cluster can be traced to the mid-1980s as Harold McMaster moved into the solar cell arena. As his company continued to make steady but slow progress toward commercial sales, UT was building research capacity that was gaining momentum. With continued development of UT's research in PV systems, the recent expansion of research into other alternative energy areas throughout campus, and the growing interest in alternative energy by local industry, regional branding is beginning to occur. The cluster now is recognized in the region and increasingly in Ohio, as indicated by recognition in newspaper stories and other state economic reports.

The case study provides further indications that clusters may help develop and encourage entrepreneurship. The existence of the cluster and the focused university support has provided opportunities for entrepreneurs to partner with university faculty in attracting grants for technology development. These include State of Ohio grants, federal grants from the National Renewable Energy Laboratory, Small Business Innovation Grants, and congressionally-directed projects. In addition, the existence of the incubation facility assists small companies. In addition, the cluster helps to draw national and international attention to the cluster, such as articles in national magazines and newspapers that highlighted the cluster.

The technology cluster literature brings forward very few examples of lagging or declining areas that have "created" technology clusters in new areas (Cortright and Mayer, 2001). The solar energy cluster may appear to some to be a new "created" cluster, but it has a foundation in an antecedent industry. Perhaps other newly emerging technology clusters elsewhere have roots in an unidentified antecedent cluster. Lester (2005, 18) goes so far to say that "…the emergence of an industry that is entirely without antecedent in the region is actually a very rare event." An interesting point is the long gestation period for the emergence of this new industry as difficult technology questions are addressed, investors come forward, and market conditions change to open the door for the new cluster. Of course it is too early to say if the solar energy cluster will take hold in Toledo and be an example of a city moving from a position of national technological leadership in one technology (glass) is able to technological leadership in a new technology (solar energy). The 1987 Toledo Blade quote predicting future fortunes with Toledo as a leader in new energy technology may be correct: "Glasstech's plant could help to give Toledo an international reputation as the global center in solar-energy technology. That easily could serve as a catalyst for attracting other solar energy-related industry, as well as research and development money and facilities to area universities."

References

Asheim, B. T. and A. Isaksen. 2002. "Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge." *Journal of Technology Transfer*. 27, 77-86.

Audretsch, D. B. 1998. "Agglomeration and the Location of Innovative Activity," Oxford Review of Economic Policy. 14, 18-29.

Brickey, Homer. 1990a. "O-I, LOF close, but worlds apart." Toledo Blade (August 14).

Brickey, Homer. 1990b. "His glass machine broke a bottleneck." Toledo Blade (August 14).

Boschma, R. and J. Lambooy. 2000. "The Prospects of an Adjustment Policy Based on Collective Learning in Old Industrial Regions." *Geojournal*. 49, 391-399.

Breschi, Stefano and Franco Malerba, 2001. "The Geography of Innovation and Economic Clustering: Some Introductory Comments." Industrial and Corporate Change. 10, pp. 817-833.

Cooke, P. 2002. Knowledge Economies: Clusters, Learning and Cooperative Advantage. London: Routledge.

Cortright, Joseph and Heike Mayer, 2001. High Tech Specialization: A Comparison of High Technology Clusters. Washington, D.C.: The Brookings Institution Center on Urban and Metropolitan Policy.

Feldman. M. P. and N. Massard. 2002. "Location, Location, Location." In M. P. Feldman and N. Massard (eds.), Institutions and Systems in the Geography of Innovation. Boston/Dordrecht/London: Kluwer Academic Publishers, 1-20.

Feldman, Maryann P. and Johanna L. Francis, 2004. "Homegrown Solutions: Fostering Cluster Formation," Economic Development Quarterly. 18, 127-137.

Fromhold-Eisebith, M. 2006. "Which Mode of (CLUSTER) Promotion for which aspect of Entrepreneurship: A differentiating view on institutional support of automotive clusters." pp. 13-28, In J. Gatrell and N. Reid, Enterprising Worlds. Dordrecht: Springer Science.

Glaeser, E. L., Kallal, H.D. Scheinkman, J. A. and A. Shleifer. 1992. "Growth in Cities." Journal of Political Economy. 100, 197-207.

"Inventor became Philanthropist," The Toledo Blade. August 26, 2003.

Kirchhoff, B.A., Amington, C., Hasan, I, and S. Newbert. 2002. The Influence of R&D Expenditures on New Firm Formation and Economic Growth. Maplewood, N.J.: BJK Associates.

Lester, R. K. 2005. Universities, Innovation, and the Competitiveness of Local Economies: A Summary Report from the Local Innovation Systems Project—Phase I. Cambridge, MA: MIT Industrial Performance Center Working Paper 05-010.

Martin, Ron and Peter Sunley, 2003. "Deconstructing Clusters: Chaotic Concept or Policy Panacea?" Journal of Economic Geography. 3, 5-35.

Maskell, Peter. 2001. "Toward a Knowledge-based Theory of the Geographical Cluster," Industrial and Corporate Change. 10, 921-941.

Maycock, 2006. "2005 World PV Market Data"

Pakulski, Gary T. 2000. "Solar Cells readies production of more economical power source." The Toledo Blade. (February 1).

Saxenian, A. 1994. Regional Advantage: Culture and Competition in Silicon Valley and Route 128. Cambridge, MA: Harvard University Press.

Solar Buzz. 2006. http://www.solarbuzz.com/Technologies.htm.

Taylor, Michael. 2005. "Clusters: The Mesmerizing Mantra." Paper presented at the IGU's Commission on the Dynamics of Economic Space. Toledo, OH. August 2-5.

Ward M. Canaday Center. "Libbey-Owens Ford Glass Company Records, 1851-1991." Toledo, OH: The University of Toledo

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