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Clusters, Innovation and Entrepreneurship

Chapter 7

The University-centric High-tech Cluster of Madison, United States

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This chapter shows the central role played by the university in promoting economic development, innovation and knowledge across the region. The initiatives of the national and regional governments to spread the outcomes of the university to the regional economy are well illustrated in this chapter. The case of Madison, Wisconsin, also illustrates the various efforts made by the university to encourage commercialisation, licensing and technology transfer from the university to industry. With the support of related bodies such as the alumni association, the faculties and the technology transfer bureau, the University of Wisconsin Madison shows that universities can also play an important role in linking innovations to venture capitalists and industry, in stimulating the creation of spin-offs, and in facilitating the identification of the market for new products.

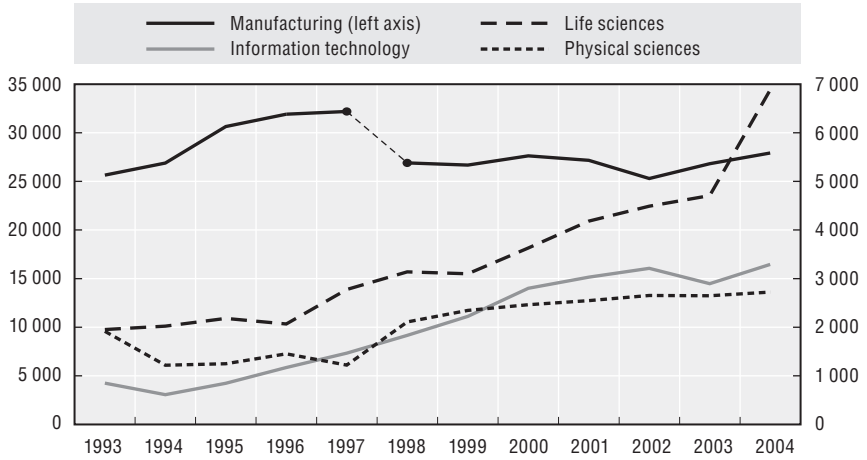
Introduction

The city of Madison, Wisconsin covers 111 km^2 in mid-western United States and is surrounded by farmlands and rolling hills. Within this farmland sits a hotbed of high-technology activity. Home to a flourishing biotechnology industry, the city of Madison is particularly interesting as a focus of high-technology cluster research as it is a location that has undergone a reinvention in the last two decades. In 1980, the city was dependent upon public sector employment due to its position as Wisconsin's state capital and the presence of the state's flagship public university, the University of Wisconsin, Madison (UWM) – an educational institution with a large student base and significant direct employment. The private sector was composed of services, smaller manufacturing plants, and significant industrial food processing, in particular meat processor Oscar Meyer. The manufacturing and food processing portions of the Madison economy have collapsed. Despite this loss the public sector would certainly have been sufficient to prevent too precipitous an economic decline, though Wisconsin itself has experienced economic difficulties.

In roughly 1980, UWM began to experience an upswing of entrepreneurship from its faculty – a development that is roughly contemporaneous with the commercialisation of university molecular biological research (Kenney, 1986). This trend has accelerated in recent years. While Madison area employment in manufacturing has remained essentially static from 1998 through 2004 (3.6 per cent growth over six years), employment growth in the life sciences has been 54.4 per cent over this same time period. Similarly, employment growth in information technology (44.3 per cent) and physical sciences (22.6 per cent) between 1998 and 2004 indicates that Madison is increasingly dependent upon high-technology enterprises to provide employment opportunities. (See Figure 7.1 and Table 7.1 on Dane County, Wisconsin [Madison area] employment.)

In 2007, Madison had a vibrant entrepreneurial cluster that was motivated by the knowledge and innovation of the UWM faculty, students, and local alumni. We report on the genesis and evolution of this cluster using primary source material on the origin of the entrepreneurial start-ups, various secondary sources of aggregated statistics, and the results of personal interviews.

Figure 7.1. **Dane County employment, 1993-2004**



Source: County Business Patterns Data, US Census Bureau.

Table 7.1. **Dane County employment**

	Life sciences	IT	Physical sciences	Manufacturing
1993	1 952	849	1 916	25 652
1994	2 022	612	1 218	26 896
1995	2 181	847	1 250	30 640
1996	2 066	1 172	1 453	31 916
1997	2 777	1 468	1 220	32 192
1998	3 138	1 834	2 107	26 902
1999	3 099	2 224	2 345	26 681
2000	3 630	2 801	2 463	27 623
2001	4 183	3 031	2 546	27 166
2002	4 489	3 214	2 653	25 299
2003	4 707	2 897	2 646	26 823
2004	6 883	3 294	2 722	27 920
Growth rates (%)				
1993-2004	71.60	74.20	29.60	
1993-1997	29.70	42.20	–57.00	20.30
1998-2004	54.40	44.30	22.60	3.60

Source: County Business Patterns Data, US Census Bureau.

Nature and evolution of the cluster

Madison, located in southern Wisconsin, has a population of just over 220 000 persons and has one of the highest concentrations of advanced degrees in the US at 2 per cent of the residents. Actually identifying the number of "high-technology" firms in Madison depends upon definition. For

example, the broadest definition, which includes small PC assembly and routine blood testing laboratories, is typical as many jurisdictions in the US and around the world inflate their number of high-technology firms and entrepreneurial start-ups. Therefore some sources claim that there are currently between 450 and 500 high-tech firms in Madison – this would be a growth of approximately 14 per cent over the last five years (Ladwig, 2004; MG&E, 2006). If all of these firms are taking together, they provide greater than 8 per cent of the region's total employment or 26 000 jobs (MG&E, 2006). The statistics on biotechnology firms are even more discrepant. For example, Willis (2004) claims there are approximately 250 biotech firms in the region that have revenues of nearly USD 5 billion annually. The Madison Gas and Electric (M&GE, 2006) claims there are 112. Our rigorous count of only the entrepreneurial biotechnology firms that excludes blood testing laboratories, hospitals, seed testing laboratory and the like finds there are 59 such firms, 33 of which are direct UWM spin-offs by founder. Clearly, definitions are all important.

Madison is one of the most politically liberal (in the social democratic sense, not traditional English liberalism) cities in the Midwest, and yet it also is considered business friendly. This has been recognised in the US media. For example, in 2004 Madison was ranked the number one US city for business by Forbes, a well-known US business journal (Tatge, 2004). A senior editor of the magazine justified this in the following way, "Madison's number one ranking is a result of its labour supply, strong income growth, as well as the fact that the city ranked tops in per capita number of PhD's and third highest in the US in terms of people with college degrees" (MG&E brochure, no date). In addition to the economic success of the region, it attracts residents with a vibrant downtown area and multitude of recreational opportunities, including boating, biking, skiing, art and entertainment.

Madison is a knowledge cluster, based largely on research, in particular, in biotechnology done at the UWM. Of the 182 high-technology firms identified by our research, just under half have direct ties to founders from UWM. The extent to which UWM is a direct source of these firms varies considerably by sector. Over 62 per cent of the 59 biotechnology start-ups in our population are directly related to the university through one of their founders. This level of involvement declines to 50 per cent for biotech support firms, 43 per cent for engineering start-ups, and just one of the 16 IT start-ups has a founder that came directly from UWM. Table 7.2 provides this data in greater detail.

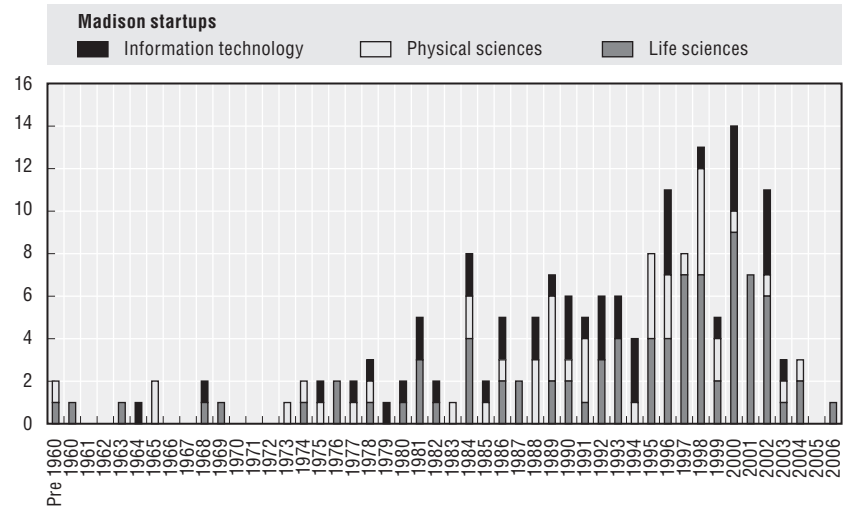
On average, firm size is small with most companies employing 5 to 500 individuals. Early firm creation began in the late 1970s, but the majority of growth in the cluster has occurred in the last 15 years. Figure 7.2 presents new firm formation from before 1960 to the present.

Table 7.2. **Relationship to UWM of the start-up founders**

Industry	UWM founder	No UWM founder	Total
Biotechnology	18	11	29
Biotech Support	15	15	30
Medical	15	8	23
Vet/Ag	4	1	5
Total life sciences	**52**	**35**	**87**
Electronics	9	11	20
Engineering	10	13	23
Telecom	0	2	2
Total physical sciences	**19**	**26**	**45**
IT	1	16	17
Software	11	14	25
Internet	0	3	3
Total information technology	**12**	**33**	**45**
All firms	84	98	182

Source: Author's Database © Martin Kenney and Donald Patton.

Figure 7.2. **New firm formation in Madison, Wisconsin by year**



Source: Author's Database © Martin Kenney and Donald Patton.

As a field of entrepreneurship, biotechnology is well suited to the university environment because for the most part new biotechnology firms are direct results of university/medical school laboratory developments whose research was funded by the US National Institutes of Health. Much of

this research results in products that a small firm can protect with patents, which if sufficiently promising can attract the interest of angel investors or venture capitalists (for one of the earliest explications of this process, see Kenney 1986).

Though biomedical-related firms make up approximately 50 per cent of the high-technology start-ups in the region, the other 50 per cent are from the physical sciences, engineering, and the IT fields. In these other fields, UWM start-ups are relatively small and have not experienced the growth that IT spin-outs such as SAS from North Carolina State University; Sun Microsystems, Yahoo!, and Google from Stanford; Paypal and Netscape from the University of Illinois, or Cadence and Synopys from UC Berkeley. Having said this, there are a number of high-technology firms in Madison that are not the direct products of UWM, though the university ambiance pervades the city.

Unlike many other high-technology and particularly biotech clusters, around half of the Madison biotech firms are concentrated in the areas of biomedical inputs and services. There are many reasons that can be cited for this focus, but on a basic level, this type of technology involves less risk and less capital. As Randall Willis points out in his 2004 article on Madison, these companies rarely "hit a home run" and accumulate great wealth for the founders or shareholders. However, when successful they can provide consistent and solid returns and good employment opportunities (Willis, 2004). While they may never create enormous capital gains, the start-up costs for input and service firms are relatively low. Harry Burrill from local start-up Lucigen notes that, … "you can 'bootstrap' starting a products company with much less money, then get products on the market relatively quickly to generate a revenue stream for survival and growth *(ibid)*".

The biotech cluster in Madison does not resemble the "typical" cluster formation based on interaction between similar firms. In reality the cluster is, in large part, a hub-and-spoke morphology with UWM at the centre. UWM dominates the region and is the source of most of the firms. In contrast to Silicon Valley where there have been wave after wave of entrepreneurial spin-outs, in Madison there have been far fewer firms whose founders came from another firm.

The biotechnology research materials firm, Promega, is the notable exception. Promega was founded in 1978 by William Linton. Today, it operates in 11 nations, has 850 employees, has revenues of approximately USD 175 million, and sells 1 450 different life science research materials. Not only is Promega a successful firm, but between 1987 and 2005 three firms have spun-off from Promega. One of the founders of these firms came directly from Promega, while another firm was established with key personnel from Promega. The third firm was PanVera, a company that develops technology

used to determine drug components. Former Promega employees founded the company in 1992. Since then six additional companies have spun off of PanVera on the basis of key personnel and founders from the firm.

Although our methodology in establishing firm genealogy is based exclusively on founder(s)' previous employment, a greater understanding of the movement of key personnel allows us to recognise the true importance of these firms to the Madison cluster.[1] Key personnel from PanVera were directly involved in the creation of five firms from 1995 through 2000, although none of them were identified as a founder.

Serial spin-offs are not atypical of the cluster. It has, however, been vital in speeding the expansion of the cluster. Promega was a pioneer and not only have other firms spun-out of Promega and its progeny, but also many employees at other local firms once worked at Promega. So it is a source of entrepreneurs and seasoned executives. As Feldman *et al.* (2005) observe, the early entrepreneurs, if sufficiently successful, actually begin to change their environment. In effect, the environment is not a simple unchanging selection grid, but actually evolves with its resident actors. So, for example, the second-generation entrepreneurs are able to leverage the knowledge and experience gained from initial endeavours in their new firms. The earlier entrepreneurs create awareness and reputation in the community enabling not only them, but next-generation founders to use the pioneers as "proof" that their new concepts have a similar possibility of success thereby allowing them to attract funding and support. By virtue of its success, Promega has been an icon and model for other entrepreneurs in the Madison cluster.

Entrepreneurial support network in Madison[2]

The focus on biomedical inputs and services provides a partial explanation for the lack of venture capital in the region, as these firms do not grow sufficiently quickly and to sufficient size to justify venture capital investment.[3] Conversely, the focus may be a result of this dearth in funding. Although Dane County ranks in the top 100 counties nationwide for venture capital funding, Wisconsin as a whole falls in the bottom half of all states for venture capital investment (Table 7.3).[4] According to PanVera founder Ralph Kauten[rdquoe] there is little venture capital in Wisconsin so most of the start-ups have worked without it[rdquoe] (Kauten, 2006). In 2005 California received the bulk of the nation's venture capital funding (USD 10 220 million or 47.1 per cent of the total). In contrast, Wisconsin received USD 68 million, less than one per cent of the funding (Rosen, 2006).

Venture capital often emerges in entrepreneurial clusters, and many researchers consider venture capital an important indicator of the dynamism of a cluster.[5] Of course, some Madison firms have received venture capital.

Table 7.3. **Venture capital firms operating in Wisconsin**

Firm name	Location(s) in Wisconsin	Date established (date closed)	Reported capital (USD million)	Fund size (USD million)
Advantage Capital Partners #	Madison	1993		
Avolte Venture Fund Midwest # (a sector fund of the Peak Ridge Capital Group)	Madison	2006		
Baird Venture Partners #	Madison and Milwaukee	2001		
Kegonsa Capital Partners, LLC	Madison	1997	11.0	10.7
Madison Capital CIP Corp.	Madison	1982		0.4
Mason Wells Biomedical Fund	Milwaukee	2000 and 2006		
Pangaea Partners	Madison	1989		
State of Wisconsin Investment Board*	Madison	2002	61 500.0	
Venture Investors, LLC	Madison	1982	80.0	9.0
Wisconsin Investment Co.	Madison	1985	1.0	

* Government affiliated.
# Firm has multiple offices, some may be located outside of Wisconsin.
Source: Venture Expert 2007; OCR 2007.

Overall 14 per cent of all Madison start-ups have received venture capital funding. 18 per cent of the life sciences and physical sciences firms have received VC funding, while just 2 of the 45 information technology firms received VC funding (see Table 7.4).

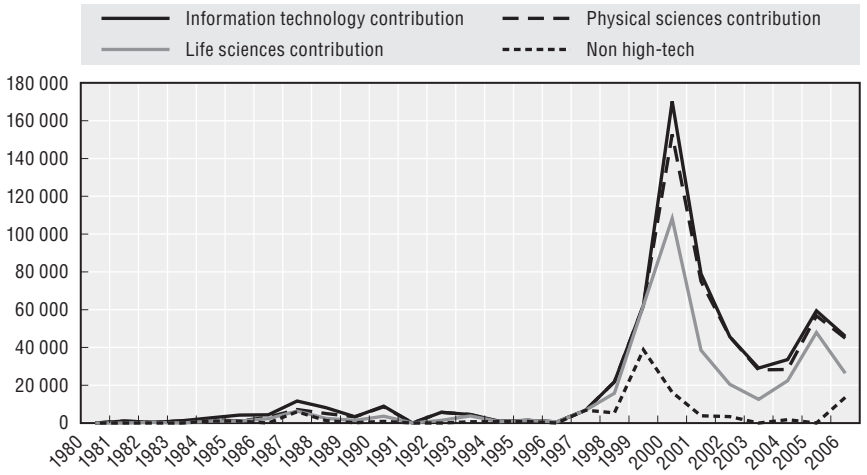
Table 7.4. **Madison start-ups and venture capital funding**

Industry	VC funded	Not VC funded	Total
Biotechnology	8	21	29
Biotech Support	5	25	30
Medical	3	20	23
Vet/Ag	0	5	5
Total Life Sciences	16	71	87
Electronics	2	18	20
Engineering	5	18	23
Telecom	1	1	2
Total Physical Sciences	8	37	45
IT	2	15	17
Software	0	25	25
Internet	0	3	3
Total Information Technology	2	43	45
All Firms	26	156	182

Source: Author's Database © Martin Kenney and Donald Patton.

The funding Madison high-technology start-ups have received reflects this higher interest by VC firms in science-based firms. In the year 2000 information technology firms received just 10 per cent of all VC funding in Madison, compared with life sciences which received 54 per cent of the total. In 2005, after the dot com bubble, life science-based firms increased their share to 80 per cent of all VC funding. Figure 7.3 presents this data in greater detail.

Figure 7.3. **VC backed firms – Dane County Wisconsin**
Venture capital investments, excluding acquisitions, in USD '000s



Source: Thomson Venture Economics/National Venture Capital Association, 2007.

Madison differs from clusters such as the San Francisco Bay Area, San Diego, Boston and the Washington DC area because it has successfully created an environment encouraging the formation of new technology businesses without having a concentration of venture capital. To some degree, this absence was mitigated by WARF which was willing to substitute for the venture capitalists in the earliest stages. But the success of Promega, PanVera and others also created an environment within which bootstrapping was understood. In particular, scientists understood how they could use Small Business Innovation Research grants to carry their firms through the early stages of the firm's development. Like traditional VC funding, in lieu of payment WARF frequently accepts equity in a start-up as compensation for their services.

Location

It is not just the business climate in a region that draws entrepreneurs and sparks new firm creation. The programmes and factors discussed above have encouraged and supported the creation of Madison's biotech cluster, but the

physical and social environment also plays a role. For Richard Florida,"place has become the central organising unit of our time, taking on many of the functions that used to be played by firms and other organisations," (Florida, 2002: 6). Florida cites diversity and high quality of life as well as a vibrant nightlife and outdoor recreation as important factors that attract and retain individuals.

Though we did not conduct a scientific sampling, there is a general belief in the region that Madison is a desirable location in terms of life style and that the university is an attractive employer. As the founder of Madison company NimbleGen Systems states, "UW is a highly respected research facility and draws talent from across the nation. In the end, the talent really does not want to leave Madison, due in part to the relationships people have formed with a wide range of like-minded people and the attractive standard of living they experience" (Potera, 2004: 2).

Most studies agree that Madison has an excellent public school system, reasonably priced housing, and a wide range of recreational activities. In the winter, skiing is popular, and in the summer Madison offers an extensive bike trail system, golf and hiking. City boosters cite the downtown area as being "vibrant" with the "character of a small city but the amenities of a major metropolitan area" (MG&E, 2006). One widely mentioned drawback is that its relative small size discourages airline connections, thereby making travel more burdensome. For example, one entrepreneur observed that, "there are direct flights to only a very limited number of destinations, and there also seems to be a psychological barrier that hinders companies on the East and West coasts from working with companies in the Midwest" (Willis, 2004). Though logistically it suffers from some handicap, the social amenities appear to provide a level of compensation.

Success factors

This section discusses the institutional drivers of the Madison cluster. The institution at the centre of the Madison high-technology cluster is the UWM. Of all of the technology-based start-ups in Madison, 46 per cent have at least one founder from the university.[6] UWM has a unique institutional model for commercialising research in that the university does not have an office of technology licensing. As a parenthetical note, because UWM is the only major research university in Wisconsin it has increasingly been involved in encouraging entrepreneurship around the state.[7] As the outcome of a historical accident discussed in more detail later, its technology licensing is channelled through an affiliated non-profit organisation called the Wisconsin Alumni Research Foundation (WARF), which is not directly controlled by the university. It is UWM and WARF that have had the greatest impact on the inception and growth of Madison's entrepreneurial ecosystem.

The university

UWM is at the core of Madison cluster and has been the source of many start-ups. Very importantly, because a university is a decentralised organisation, just because the UWM is at the centre does not mean that the various start-ups have technologies or personnel in common. For example, a software spin-out of the university may share no information transfer paths with a biotechnology start-up. Furthermore it is difficult to establish precisely how many of the start-ups have their origins in the university. In many cases start-ups are direct spin-offs from the university. But in many cases entrepreneurs are emerging from university spin-offs to start yet other firms as is the case with Promega, PanVera and NimbleGen Systems. Of course, these connections are only the most visible and in the discussion of Promega we show that there are many more connections to the point at which it would be fair to say that there is a biomedical materials sub-cluster in Madison that exhibits the "buzz" that geographers have identified with dynamic clusters (Pinch *et al.,* 2003; Bathelt *et al.,* 2004).

UWM follows a typical hub (UWM) and spoke (start-ups) morphology. The most important exceptions to this are the firms that are genealogically connected to Promega, which is discussed further below.

Founded in 1848, UWM is a public university that was designated as a land grant institution in 1864. It was in the early 1900s that university president Charles Van Hise verbalised the concept of the "Wisconsin Idea". In keeping with the US land grant university tradition, he, and other members of the school's faculty and administration, believed that university knowledge should spread to the borders of the state or that, "the boundaries of the university are the boundaries of the state" (Sobocinski, 1999: 9). This established the continuing mission of "service to the state" (UWM Board of Regents 2003). For the last decade, UWM has been among the Top Five universities in the US in terms of R&D expenditures (see Table 7.5).

In 2004, the last year for which US National Science Foundation (2004) data is available, UWM (and the other University of Wisconsin campuses, which are statistically insignificant) expended in excess of USD 763 million. In 2004, the life sciences received USD 474 million while math, computer sciences, and engineering (MCE) received USD 113 million (NSF, 2004: 78) (see Table 7.6). The disciplinary expenditures show the strength of UWM in the life sciences. MCE at UWM is respectable, but it is not as strong as at some other Midwestern universities such as the University of Illinois. Not surprisingly, this strength in the biological sciences is expressed in the start-ups.

Table 7.5. **R&D expenditures by year (USD '000)**

Rank	Institution	1997	1998	1999	2000	2001	2002	2003	2004
	All institutions	24 370 716	25 856 006	27 530 968	30 068 664	32 793 818	36 367 358	40 056 637	42 945 081
1	Johns Hopkins University	829 241	853 620	874 518	901 156	999 246	1 140 235	1 244 132	1 375 014
2	University of California, Los Angeles	398 865	447 367	477 620	530 826	693 801	787 598	849 357	772 569
3	University of Michigan, all campuses	483 485	496 761	508 619	551 556	600 523	673 724	780 054	769 126
4	University of Wisconsin, Madison	419 810	443 695	499 688	554 361	604 143	662 101	717 044	763 875
5	University of California, San Francisco	343 384	379 970	417 095	443 013	524 975	596 965	671 443	728 321
6	University of Washington	409 959	438 191	482 659	529 342	589 626	627 273	684 814	713 976
7	University of California, San Diego	376 655	418 790	461 632	518 559	556 533	585 008	646 508	708 690
8	Stanford University	395 310	410 309	426 549	457 822	482 906	538 474	603 227	671 046
9	Pennsylvania State University, all campuses	339 955	362 643	379 402	427 575	458 066	492 739	533 427	600 139
10	University of Pennsylvania	296 141	333 477	383 569	430 389	469 852	522 269	564 635	596 756

Source: NSF 2006, Table 27.

Wisconsin Alumni Research Foundation

The Wisconsin Alumni Research Foundation (WARF) plays a critical role in the UWM ecosystem as an intermediary in the commercialisation of university research. It was established in 1925 as a non-profit patent organisation funded initially by UW alumni and managed by a Board of Trustees composed of alumni, but it has always been independent of the university. As such, and as a result of a historical accident relating to the patenting of ultraviolet irradiation of food to increase Vitamin D, it is a unique institution unlike that of any other US university. The independence allows it to operate in an entirely business-like fashion and it is not involved in university politics or managed by the academic administrators. WARF's primary purpose was and is to manage patents based on UWM research. Since 1928, WARF has provided more than USD 750 million to the University to support further research. As such, WARF has been a major force in the development and growth of the university as a research institution and in the entrepreneurial environment in Madison (WARF, 2007).

Table 7.6. **R&D expenditures by discipline, University of Wisconsin, Madison, 2004 (USD '000)**

National rank	Field	R&D amount
29	Agricultural Sciences	43 238
6	Biological Sciences	155 682
17	Chemistry	17 115
23	Computer Sciences	13 457
14	Engineering	94 860
10	Environmental Sciences	54 127
7	Life Sciences	473 733
24	Mathematical Sciences	4 803
11	Medical Sciences	272 640
14	Physical Sciences	51 853
15	Physics	21 969
1	Psychology	29 329
4	Social Sciences	41 686

Source: NSF 2006, Tables 45-62.

WARF was successful nearly from its inception due to faculty assigned patents on the use of ultraviolet irradiation to increase Vitamin D in foods (in 1927), derivatives like coumadin and warfarin (a rat poison) (series of patents from 1941 through 1948), methods of preserving organs for transplantation (series of patents from 1967 through 1987), and magnetic nuclear resonance technology (WARF, 2007). WARF still receives between 60 and 70 per cent of its total income from Vitamin D technology (Gulbrandsen, 2003). Many of these lucrative patents were not commercialised through start-ups, but rather through licensing to large firms.

In 2005-06 alone WARF filed for 300 US patents on UWM technology and gave USD 65 million to UWM to support research. The process of patenting through WARF is described as:

> If WARF accepts the invention for patenting and licensing, the foundation provides an attorney to help the researcher with the patent application. The researcher also agrees to assign ownership of the invention to WARF. It is at this point WARF may contact companies considered good matches for the technology. WARF's policies call for 20 per cent of the gross licensing revenue from an invention to be returned to the inventor (or inventors). The remainder is shared with the UW Madison Graduate School, and the inventor's laboratory and department (WARF, 2007).

In addition to logistical support with the patent, WARF is able to help put scientists in touch with venture capital money (or other funding sources), offer loans and physical space for their company, and to provide advice and

counselling in the early years. Deepak Divan, a UWM professor and founder of SoftSwitching Technologies describes WARF as "a gorilla standing beside you", who can enforce patents and act as an advocate (Ladwig, 2004).

The WARF support, and the connections, experience and funds it can provide help create an environment in which research and innovation are highly valued. This is especially important in the field of biotechnology, where the majority of advanced research is done at the university level, as opposed to in private or industry labs. Critical to the impact UWM has on the business landscape in Madison, and vital to the function of WARF, is the fact that professors retain the rights to the fruits of their research. This is unusual among research universities, as ownership tends to belong to the institution itself, not the individual. WARF has been able to capitalise on this fact.

Business school

Though it is debated as to what direct role business school programmes can have in assisting high-technology entrepreneurship, the UWM business school has become quite active in the field of entrepreneurship. (There are other programmes and departments within the UWM that have had roles in the development and evolution of the cluster.) A recent addition to the ecosystem is the Weinert Center for Entrepreneurship within the University of Wisconsin, Madison School of Business, which interacts with the high-tech firms in a novel way. Through the Weinert Applied Ventures in Entrepreneurship (WAVE) programme founded in 1998, 12 MBA students are selected each year to work with a new local firm. The students get experience while creating comprehensive strategic, operating and financing plans for the firm (Weinert Center, 2007). In return, the firm may benefit from the student's knowledge, a set of skills very different from those of the professors who are developing the technology. This programme is unique, and helps to create an environment where entrepreneurship is encouraged and enabled. The WAVE programme allows professors to market the products of their research while remaining an active member of the University's faculty by limiting their involvement in day-to-day business operations.

Though there have been no evaluations as to its impact, the Small Business Development Center, founded in 1979 and also a part of the University, offers courses in fundamental business areas. The SBDC's stated mission is, "[t]o enhance the success of small business owners and managers in our three county service area of Dane, Sauk and Columbia counties and encourage growth in our economy. We strive to achieve this mission by providing practical, customer-focused management education, training, counselling and networking" (SBDC, 2007). Class offerings range from what you need to know before starting a business to leadership skills and how

to protect your firm in the case of a natural disaster. The organisation also has business counsellors available at no charge who can assist with specific issues.

Office of University-Industry Relations and Office of Corporate Relations

Established in 1963 as the University-Industry Research Program and renamed in 1994, the Office of University-Industry Relations was the campus link to small and large business, as well as the office that managed campus invention disclosures. Its mission was "to establish the most productive relationship possible between the private sector and the University of Wisconsin, Madison…". Some of the methods used to achieve that goal included campus tours of faculty research, the introduction of industry to UWM research consortia, and facilitation of partnerships through federal programmes such as Small Business Innovation and Research grants (SBIR). In 2005, the state of Wisconsin received USD 35 million in these federal grants for commercialising research (Wisconsin Department of Commerce 2005). As Table 7.7 indicates, the overwhelming bulk of this money went to Dane County where Madison is located.

Table 7.7. **State of Wisconsin SBIR grants by county in 2005**

Geographical distribution of awards	# of companies	USD amount	% of total
Dane County Alone	37	36 508 922	86.8
Dane, Sauk, Iowa Counties	39	36 649 227	87.1
Southeastern Wisconsin	10	3 414 004	8.1
Northwestern Wisconsin (Eau Claire)	1	456 965	1.1
Northeastern Wisconsin (Appleton)	1	69 345	0.2
Central/Northcentral (WI Rapids, Chili)	2	1 471 431	3.5
TOTALS	53	42 060 972	

Source: www.commerce.state.wi.us/NEWS/releases/2005/157.html (Accessed 30 January 2007).

Following a recommendation of the Chancellor's 2002 Task Force on University-Business Relations, UIR was phased out and replaced by The Office of Corporate Relations (OCR) in July 2003. The task force determined that the operating model of UIR was unable to keep pace with the rapidly changing needs of the business community in Madison and did not provide a visible, single point of contact for Wisconsin business. The new office, now located at the University's Research Park, is central point that provides clear access to a variety of programmes.

According to Allen Dines, Assistant Director at OCR, the role of the office is as "broker, connector, consultant and cheerleader" (personal interview, 2007). The OCR does not oversee programmes related to business start-up and industry support, rather it behaves as an interpreter of and liaison between

these programmes and current businesses. It also works to connect new, start-up companies with the outside world. "We interpret the company's needs and refer them to University Programs *(ibid)*". In addition, the OCR serves as a public relations manager; Dines sees public relations as one of his, and his colleagues, major tasks as they act to "promote the idea that the University is friendly and open to business". It should be noted that, while the OCR is located in Madison and has a special interest in the city, their support of business reaches to the rest of Wisconsin as well as across the United States.

Research parks/small business incubators

Madison has experienced a proliferation of small business incubators. The principle behind business incubators is that new firms may be unable to mobilise the resources necessary for success.[8] The University supports one such incubator, but there are many others. The UWM-sponsored incubator, University Research Park (URP), is a non-profit entity established in 1984 that develops land to lease to start-up companies (Sobocinski, 1999: 306). The profits from this development are donated to UWM. There are currently 110 tenants, who have access to core services on such as accountants, lawyers and venture capitalists (Potera, 2004; URP, 2007).

The URP also houses the Madison Gas and Electric Innovation Center financed by the local utility and opened in 1990. The Innovation Center provides office and laboratory space for small companies, as well as shared support services and equipment. For companies beyond the start-up stage, but not ready or unable to move, the University Science Center at URP provides flexible space with room to expand. There is also land available at the Park where companies can build their own facilities. In early 2007, the URP plans to complete a second phase of development, which will add 270 acres and 53 buildings to the site, allowing an increase in the number of tenants to more than 200.

A second incubator, not associated with the University, is the TEC Incubator Center. It is geared toward technology firms and provides conference, classroom, and computer lab space as well as high-speed internet and phone service (TEC, 2007). The region is also home to the Fitchburg Technology Campus with a focus on nanotechnology research. Since the mid 1990s, Madison has experienced a proliferation of firm incubators not limited to the ones mentioned here.

Role of SMEs

The Madison cluster is a university-centric cluster. Whereas, biotechnology clusters like North Carolina will have large multinational corporations at their core, there are no such giants in Madison. Invitrogen, a biomedical input firm based in Carlsbad, California, employing 4 500 worldwide does have an operation

in Madison. When understood from this perspective, entrepreneurial firms and SMEs drawing upon the university's research are the cluster. With the university, the SMEs are central to the cluster and new entrepreneurial firms are not unusual.

The success of small and medium sized businesses has reached critical mass and entrepreneurship has become an accepted path. Jane Homan, a UWM professor and co-founder of local biotech firm Gala Designs established in 1996 reflected upon the earlier ethos in Madison, "we were considered the mavericks of the University … Now we're pretty normal" (Fikes, 2000). Absent these start-ups, it is likely that the Madison economy would be a typical public sector economy served by a small services-based private sector. Moreover, the state economy would have no growth regions or industries.

Barriers to cluster development

Despite the success of the region in creating start-ups, there are difficulties. The lack of airline connections has already been mentioned. A more important obstacle is a shortage of seasoned executives *in situ* that can be recruited to provide the business experience to the university-related innovators. The success of any start-up is predicated as much upon the ability to attract top-notch business talent as having first-rate scientists. An important recruiting ground for these seasoned executives are established firms within the industry. In biotechnology that would be the large pharmaceutical firms and in the IT sector it would be firms like IBM, Intel, and Microsoft; none of which have significant facilities in Madison or even Wisconsin. There can be little doubt that this is a handicap to Madison firms. Pam Christenson, acting administrator in the Business Development Division of Wisconsin's Department of Commerce believes workforce development is one of the biggest barriers facing the cluster to this day (Christenson, 2007). The University and the business school have responded to this shortage by creating various programmes such as entrepreneurship and technology management specialties and a master's of science in biotechnology, but ultimately these cannot overcome the lack of large firms with seasoned management in the region.

A lack of venture capital funding is also cited as an obstacle to the growth of the cluster. However, Allen Dines of the OCR has a slightly different perspective. For him, the obstacle has been the ability to create "fundable deals that are attractive to investors" (Dines, 2007). Many Madison start-ups have not sufficiently clearly identified their markets as they make the transition from technology to product. Were this identification more clear, then he believes the search for funding would be more successful. He also notes that most of the Madison start-ups are not attractive to VC funders,

because the types of products and services they intend to produce will not serve sufficiently large markets. Conversely, the small specialised (but very lucrative) markets do not require such large expenditures in the establishment of the firm.

The barriers to the further development of the cluster are difficult to predict. Obviously, one barrier is the number of highly-educated university faculty and graduates that have developed technology worthy of commercialisation. Further, if they have developed technology worthy of commercialisation, do they wish to be involved in commercialisation. In terms of technologies and markets, it seems likely that there will be a continuing flow of opportunities to commercialise various research technologies, materials, and services. For example, a UWM professor through WARF holds key patents on stem cell lines, patents that may create an ample income source, but which have also created much controversy due to the severe licensing restrictions WARF has imposed on industrial and academic researchers.[9]

Role of policy

Together with the University and WARF, public policy plays a role in the development and maintenance of the high-tech cluster in Madison, Wisconsin. What follows is a discussion of some of these policies.

Federal policies

The US is quite different from other nations in that the Federal government has had very few region-specific policies with the possible exception of the major support for defence firms and bases on the West Coast during World War Two. The US government's most significant policy for UWM has been enormous and unremitting funding of university research particularly the life sciences; some small portion of the research results are commercialisable. In the case of UWM, the most important research funding has been in the biomedical and, to a lesser degree, agricultural fields. UWM has not been one of the elite US computer science and electrical engineering schools so DARPA funding was not as significant for the local start-up economy.

Bayh-Dole is credited by some such as Howard Bremer, emeritus patent counsel at WARF, as being important to the development of a commercialisation ethic at UWM, though it should be noted that many of WARF's greatest successes came long before Bayh-Dole was signed. UWM was the first school to sign an Institutional Patent Agreement (IPA) with the then US Department of Health, Education, and Welfare that granted UWM the right to license inventions to firms without having to clear it with the federal government (WARF, 2007). Use of IPAs quickly spread to other major US research universities

(Mowery *et al.*, 2004), and they were the precursor to the Bayh-Dole Act of 1980 that was a blanket transfer of the rights to federally-funded university inventions to universities.

The passage of Bayh-Dole and the success of firms, such as Genentech, Amgen, Hybritech, and many others, in commercialising the new biotechnologies that had been developed in university laboratories piqued the interest of university administrators searching for new sources of income. The result was a rush of universities establishing offices for technology licensing. At UWM, WARF was already established for commercialising university faculty inventions and, unsurprisingly, it moved into this field. One change in the environment was that increasingly professors wanted to be involved in the commercialisation of their inventions through establishing a firm. And, frequently, the firm was located close to the university. It is this dynamic that led to the emergence of a local cluster of technology firms in Madison.

The SBIR programme provides about USD 35 million to the Dane County economy, and has been significant in the growth of some firms. Since SBIR funds substitute for early stage venture capital, and the Madison area has only minimal amounts of venture capital, the SBIR programme probably is of some importance to entrepreneurship in the Madison. Despite the debates about the overall efficacy of the SBIR programme, it is likely to have been important to certain firms in the region.

State and local policies

While the University and WARF are central to the creation of the cluster, local and state government have provided the infrastructure and support necessary to maintain its growth. One way this is pursued is through groups such as the Wisconsin Technology Council and the Wisconsin Biotechnology and Medical Devices Association, who lobby the federal and state governments in the interest of local firms. These organisations also help with regulatory issues. The state responds well to such lobbying efforts. In 2004, Governor Doyle announced that Wisconsin would invest up to USD 750 million in biomedical research over the next few years. One such programme included in that pledge is the planned Wisconsin Institutes for Discovery. Construction began in 2008 for the public-private partnership that includes a large private donation well as matching gifts from WARF and the state of Wisconsin. The Institutes will be housed on the UWM campus and have as their goal the fostering of interdisciplinary collaboration and innovation.

Outside of Madison, many of the cities in Wisconsin have faced economic difficulties in recent years. State wide, the Grow Wisconsin Initiative looks to reverse this trend by creating an environment that encourages business

development. The plan laid out by the governor in September 2003 focuses on four key areas: 1. the creation of competitive business climate; 2. investment in the people of Wisconsin; 3. investment in Wisconsin businesses, and; 4. the reform of regulations and increased government responsiveness.[10] It is too early to gauge the results of this initiative that plans to invest over one billion dollars to achieve its goals, including USD 300 million in seed and venture capital funds and another USD 10 million for a free training fund for companies looking to invest in new high-tech jobs. Regardless of this, the support of the government is impressive.

Unlike many other regions with high rates of start-up creation, there are limited venture capital funds available in Madison. In 1998, there were 40 states that recorded venture capital activity. Only eight of these had lower levels of activity than Wisconsin. Rates of VC funding have increased since that time, but they remain well behind those typical of regions with high levels of technology-based entrepreneurship. Supported by local and state policies, angel financing has been able to fill this void. The first angel investing group in the state of Wisconsin was founded in 2000. Today, there are 15 networks (Table 7.8).

Table 7.8. **Angel investment groups in Wisconsin**

Firm name	Location(s) in Wisconsin
Badger AgVest, LLC	Wausau
Badger Alumni Capital Network (BACN)	
Central Wisconsin Business Angels	Wisconsin Rapids
Chippewa Valley Angel Investors Network	Eau Claire
IQ Corridor Angel Network	Pewaukee
Marshfield Investment Partners, LLC	Wausau
New Capital Fund, LP	Appleton
Origin Investment Group	LaCrosse
Pennies from Heaven	Racine Country, Kenosha County
Phenomenelle Angels Fund I, LP	Madison
Silicon Pastures	Milwaukee
St. Croix Valley Angel Network	River Falls
The Golden Angels Network	Milwaukee
Wisconsin Investment Partners, LLC	Madison
Women Angels	Milwaukee

Source: NorthStar Economics, Inc. 2007.

Indicative of the willingness of state and local government to support the biotech cluster and angel financing is the recent adoption of the Wisconsin Angel Tax Credit (Act 255). Beginning in January 2005, the state of Wisconsin made USD 3 million available annually in angel tax credits. The full amount

was expended in 2005 and just over USD 900 000 remain from 2006 (Commerce Department, 2007). While analysis on the effects of the tax credit is still incomplete, initial findings are optimistic. According to a report filed by NorthStar Economics, Inc., investing by angel groups in 2005 increased by 65 per cent over the previous year. Of course, the ultimate test is whether high-quality firms were created, thereby justifying the state investment.

On a local level, ordinance amendments have been passed to alter zoning restrictions for companies looking to set up biotechnology research facilities. In addition the city provides tax incremental financing for businesses locating in specific districts as well as revolving loans. Together with three other counties in Wisconsin, Dane county is involved in a programme that offers tax credits for new and expanding high-technology businesses (Office of Business Resources, 2007).

While the policies and programmes mentioned above have played an important role in the cluster, it is important to realise that these influences can only do so much. Pam Christenson from the Wisconsin Department of Commerce points out that "we see clusters as a private sector driven initiative, not a programme the public sector can impose on an industry" (Christenson, 2007). Her office produced a white paper in 2003 entitled *Fostering Cluster Development in Wisconsin*. The publication reads, "the private sector must lead successful clusters. Business and other key stakeholders should examine the changes and improvements that need to occur *within* the cluster and not focus solely on what government should do *for* the cluster" (Wisc. Dept. of Commerce 2003: 2).

Future policy challenges

For a state like Wisconsin, which has felt the full brunt of deindustrialisation, research-based entrepreneurship has been seen as an important boon to the state. The success has been so great that recently the state has been asking UWM and WARF to assist other cities in Wisconsin to develop technology clusters. From the political perspective, this makes perfect sense. However, there is a possibility that the institutions at UWM and in Madison will lose their focus on growing the cluster in Madison, thereby inhibiting its growth, while it is unlikely that the other regions have the technological bases to establish viable clusters and, perhaps, even viable firms. Thus its very success might lead local and state politicians to extend UWM's mission in directions that divert it from doing what it does best, which is grow its local cluster.

Tom Still of the Wisconsin Technology Council is quoted in a recent newspaper article on the future challenges facing high-technology start-up business in Wisconsin."The bottom line is Wisconsin is seeing more activity –

that doesn't mean we're where we need to be; we're well behind the curve, but at least we're laying a strong foundation for stronger investment activity years ahead".

The Madison biotechnology cluster is significant. However, government and industry leaders believe that growth, especially outside of the supply and services fields, will depend on increased venture investment – both in quantity and value of deals. Whether this belief is justified or not is beyond this chapter's scope. Unfortunately, the prospects for more local venture capital do not look particularly promising because the UWM start-ups do not offer the promise of the enormous returns of a blockbuster drug. In addition, the region does not have many IT-related start-ups that provide extremely the rapid returns that ensure high internal rates of return for the venture capitalists.

Taxation is often mentioned in Wisconsin as an issue for the health of the cluster. A recent study for the Small Business Administration found that Wisconsin has above-average tax levels. While the Commerce Department notes that business taxes are lower in Wisconsin than those in 35 other states, an anti-tax group, the Wisconsin Taxpayers Alliance, reports that state and federal taxes claimed 33.4 per cent of personal income in the state on 2006 (Still, 2007). Some believe that if the state wants to encourage the continuing development of the high-tech cluster, these supposedly high rates of state taxation should be lowered. It should be noted that the most successful state in the US in terms of high-technology entrepreneurship, California, has a roughly similar tax burden. Also, given that Wisconsin's start-ups are so university-linked, it is unlikely that these entrepreneurs would relocate to a state with very low tax burdens such as Mississippi. Tax cuts that weakened UWM would almost by definition in such a public university-centric cluster have a negative effect on the cluster. Those arguing that tax cuts would strengthen the development of the Madison cluster likely are more interested in tax cuts than in the furtherance of cluster growth.

The greatest policy challenges for the cluster centre upon any changes in the levels of Federal funding for research. The current federal deficit spending, particularly on the invasion of Iraq and the military, could lead to a situation within which federal research funding decreased. Because of the centrality of UWM research to overall cluster health, such an event would almost certainly weaken the cluster. The impact would be magnified if biological research were particularly singled out for cutbacks. The dependence of the cluster on federal funding of biological research, both for continuing growth both in existing firms, many of which produce biologicals for research, and the flow of new start-ups cannot be underestimated.

Lessons for other clusters

It is hazardous to draw too strong conclusions from a single case study. However, Madison's experience does suggest the following observations:

1. High-technology entrepreneurship has been important for the growth of the Madison economy, and has made it the fastest growing part of the state of Wisconsin.
2. The development of the Madison cluster has been underway for approximately 25 years, and it has developed a regional recipe that does not require large amounts of venture capital. A number of firms have received venture capital. The exact chronology of this co-evolution between technology fields and financing strategies is not clear, but in 2007 it is now conventional wisdom among entrepreneurs.
3. UWM has a unique institutional relationship with the fully independent WARF, which is responsible for all licensing and technology transfer. This contrasts with dominant model in US and increasingly universities around the world where the technology transfer organisation is a part of the university. The success of university entrepreneurship and WARF in returning funds to the university suggests that the dominant model may not be best for all universities, and that experimentation with other models might be valuable.
4. For university-based clusters, national-level decisions on research funding may be as important as any local or state decisions particularly in smaller less wealthy states such as Wisconsin.
5. As Klepper and Sleeper (2005) and others have discovered, one firm such as Promega in Madison or Fairchild in Silicon Valley may be very important as a source of still further entrepreneurial firms.
6. UWM's research excellence particularly in biology has translated into local economic development.
7. The state government has invested in a large variety of initiatives to encourage the growth of the cluster. However, there have been few evaluations of the efficacy of this funding. The most successful UWM firms such as Promega received little direct assistance from these new state programmes as WARF has historically been the locus of university-based spin-off activity.
8. The living conditions retain Madison entrepreneurs. Unfortunately, Madison has been less successful in attracting either top-flight executives to the region or entrepreneurs that established their firms elsewhere. Thus it falls in between regions such as Pittsburgh with universities like Carnegie Mellon that often lose their entrepreneurs to other regions such as Silicon Valley or Boston, and universities and regions such as Stanford/UC Berkeley and regions such as Silicon Valley that attract entrepreneurs from around the world.

As was the case in Silicon Valley and many other high-technology clusters, Madison suggests that it was not far-sighted policy makers that were responsible for the creation of the cluster, but rather pioneering entrepreneurs. Moreover, the Madison entrepreneurs did not compete in human therapeutics, which required large tranches of venture capital and were extremely risky, but rather found niches that could be bootstrapped into profitable small businesses. In the overall scheme of things, the Madison cluster is relatively small, however for the medium sized city of Madison it is an important component of the city's overall success.

Ultimately, the inception of every cluster is based upon entrepreneurship and, rarely, is this an outcome of government policy. Usually, policy follows the emergence of a cluster, and hopefully it does not retard the cluster's growth. One of the greatest mistakes by practitioners, policy makers, and academics is to examine an established cluster and the extant policies at that time and assume that the policies were responsible for the birth and growth of the cluster. It is only through longitudinal analysis that we can surely identify the reasons for the birth of the cluster and evaluate the reasons for its growth.

Notes

1. This detailed information was provided by Allen Dines, Assistant Director, Office of Corporate Relations, UWM.
2. On entrepreneurial support networks, see Kenney and Patton 2005.
3. On the dynamics of venture capital investment see Florida and Kenney (1988) or Gompers and Lerner (1999).
4. *www.wisgov.state.wi.us/docview.asp?docid=707&locid=%2019*.
5. Kenney and Patton 2005, Powell *et al*. 2002.
6. Our research has strict definitions of high-technology. For example, while some lists of technology firms in Madison include personal computer assembly shops or routine blood testing firms, we exclude these. For this reason our list is shorter than the one produced by Madison Gas and Electric.
7. This may be politically correct, but may also be a waste of UWM-affiliated persons' time even if the resources are provided by the state.
8. The belief by the supporters of incubators is that they can shepherd small firms over the initial difficulties typical of firms. Another school of thought, frequently held by successful entrepreneurs, argues that locating firms to an incubator merely prolongs the lives of unworthy firms and might harm good firms by not exposing them to market rigors immediately.
9. Initially, UWM attempted to charge royalties to any researchers wishing to do stem cell research. This policy created enormous criticism and in late January 2007 it modified the policy to allow researchers to use the materials and techniques royalty free.
10. *www.wisgov.state.wi.us/docview.asp?docid=707andlocid=%2019*.

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