

AC 2010-44: 25 YEARS OF TECHNOLOGY ENTREPRENEURSHIP

David Barbe, University of Maryland

Dr. Barbe received B.S.E.E. and M.S.E.E. degrees in Electrical Engineering from West Virginia University in 1962 and 1964, respectively and the Ph.D. degree from The Johns Hopkins University in Electrical Engineering in 1969. After positions at Westinghouse and the Naval Research Laboratory, and the Office of the Secretary of the Navy, he joined the University of Maryland in 1985 as Executive Director of the Maryland Technology Enterprise Institute and Professor of Electrical and Computer Engineering. Dr. Barbe was awarded the rank of Fellow of the IEEE in 1978 for his pioneering work on charge coupled device imagers, now used in digital cameras, camcorders, fax machines and numerous defense and medical applications. The Hinman CEOs Program, for which he is the Faculty Director, received the Stanford University Innovative Entrepreneurship Educators Award in 2002, and Dr. Barbe received the American Society of Engineering Education Outstanding Entrepreneurship Educators Award in 2003 and the Olympus Lifetime of Education Innovation Award in 2008.

James Green, University of Maryland

James V. Green is Mtech's Director of Entrepreneurship Education with responsibilities for the Hinman CEOs Program, the Hillman Entrepreneurs Program, and the Entrepreneurship and Innovation Program. As a Senior Lecturer and Associate Director with Mtech, Dr. Green designs and teaches undergraduate and graduate courses in entrepreneurship and technology commercialization. Dr. Green earned a Doctor of Management and an MS in Technology Management from the University of Maryland University College, an MBA from the University of Michigan, and a BS in Industrial Engineering from the Georgia Institute of Technology.

Dean Chang, University of Maryland

Dean Chang is the director of Mtech's award-winning venture creation programs and a strong advocate of preparing students to compete in the 21st century by weaving technology, business, and entrepreneurship together. Dean previously was CTO and VP Gaming at Immersion (NASDAQ: IMMR). Dean holds over 30 patents and received his B.S. from MIT and an M.S. and PhD in mechanical engineering from Stanford University. He also holds an MBA with honors from the Wharton School.

25 Years of Technology Entrepreneurship and Innovation

Abstract

Over the past 25 years technology entrepreneurship programs of the Maryland Technology Enterprise Institute (Mtech), a unit of the Clark School of Engineering at the University of Maryland (UM), have evolved from an on-campus incubator for technology-oriented startup companies to a dozen innovative programs in entrepreneurship education, venture creation and industry partnerships, three of which are national models. These programs form an innovation ecosystem, a continuum that provides a full range of supportive activities for entrepreneurial endeavors. This continuum can be thought of as a system whose inputs are ideas, concepts and intellectual property (IP), and whose outputs are seasoned entrepreneurs and sustainable companies. Over 600 students enroll in Mtech's entrepreneurship courses annually. Each year, the most promising research results are selected for company formation and enter into the Venture Accelerator Program for 1-2 years of intense mentoring. Mtech's technology transfer program enables Maryland companies to access UM faculty and graduate students who develop new and improved products and services for the companies. Since 1987, these programs have contributed \$22 billion to the economy of Maryland.

1.0 Introduction

Before 2000, most entrepreneurship programs were in business schools; however, since then, many, if not most, engineering and science schools have instituted various entrepreneurship activities, either alone or in cooperation with business schools. These entrepreneurship activities of engineering and science schools tend to concentrate on "technology" entrepreneurship.

2.0 Overview of Mtech's Entrepreneurship Programs and Activities

Mtech began in 1984 as a result of an initiative of the Board of Visitors to encourage closer collaboration between the College of Engineering and industry in the State of Maryland. Initial programs included:

- On-campus incubator opened in temporary buildings and moved to a permanent building in 1998
- Program to establish industrially oriented laboratories
- Manufacturing extension

In 1987, a new program was added to facilitate R&D projects for Maryland companies, carried out on campus by faculty and graduate students – Maryland Industrial Partnerships (MIPS).

Since 1999, Mtech's entrepreneurship programs have evolved significantly with the following timeline:

- 1999 Hinman CEOs residential program for juniors and seniors
- 2001 Technology Startup Boot Camp
- University of Maryland Business Plan Competition

- 2002 First technology entrepreneurship course in engineering
- 2005 Entrepreneurship course for high school students
- 2006 Venture Accelerator Program
Second Stage Incubator
- 2007 Hillman Entrepreneurs scholarship program for community college transfer students
Entrepreneurship course for freshman students
Entrepreneur Office Hours
Faculty Venture Fairs
Entrepreneurship course for technical graduate students
Executive Education – Certificate in Innovation Management with Business School
- 2008 4-Course Graduate Certificate in Technology Ventures and Innovation
Corporate Ventures online course for Petroleum Institute in Abu Dhabi
Annual \$50K Seed Fund Grant
\$750K Chesapeake Bay Seed Capital Fund
- 2009 International Incubator
Product Development Course for High School Students
TERP Startup Lab
Maryland Intellectual Property Legal Resource Center (MIPLRC)
- 2010 Entrepreneurship and Innovation residential program for freshmen and sophomores
Summer program for 8th grade students interested in entrepreneurship
Entrepreneurship and Innovation course for international high school students
Creativity and Innovation course for high school students

Major Mtech Programs are listed in three categories in Table 1. The activities listed below the three categories indicate that they apply to all three. The italicized program listing indicates that it will start after the date of this paper – fall 2010.

<u>Education</u>	<u>Ventures</u>	<u>Partnerships</u>
- Hinman CEOs	- TERP Startup Lab	- Product R&D (MIPS)
- Hillman Entrepreneurs	- VentureAccelerator (VA)	- Maryland International Incubator (MI ²)
- Entrepreneurship courses	- On-campus Incubator (TAP)	- Biotech Scale-Up and Education (BREP)
- <i>Entrepreneurship and Innovation Program</i>	- 2 nd Stage Incubator (TVB)	- Manufacturing (UMMAP)
- Tech Startup Boot Camp		
- Business Plan Competition		

E- Office Hours, MIPLRC, Mentoring, Seed & Venture Funds, Venture Fairs

Table 1. Major Entrepreneurship and Innovation Programs and Supporting Activities

Figure 1 indicates the way these programs combine to form a robust entrepreneurship and innovation continuum. The arrow in Figure 1 can be thought of a system having innovative companies and entrepreneurs as the desired outputs. The system inputs are the extensive \$518 million research base of the University of Maryland, as well as concepts and ideas of faculty, students and entrepreneurs. As noted in Figure 1, there are multiple entry points into the

continuum, and it is believed that by providing a continuum of resources to entrepreneurs and startup companies, the probability of success is significantly increased. Details of each of the programs listed in the figure will be discussed below.

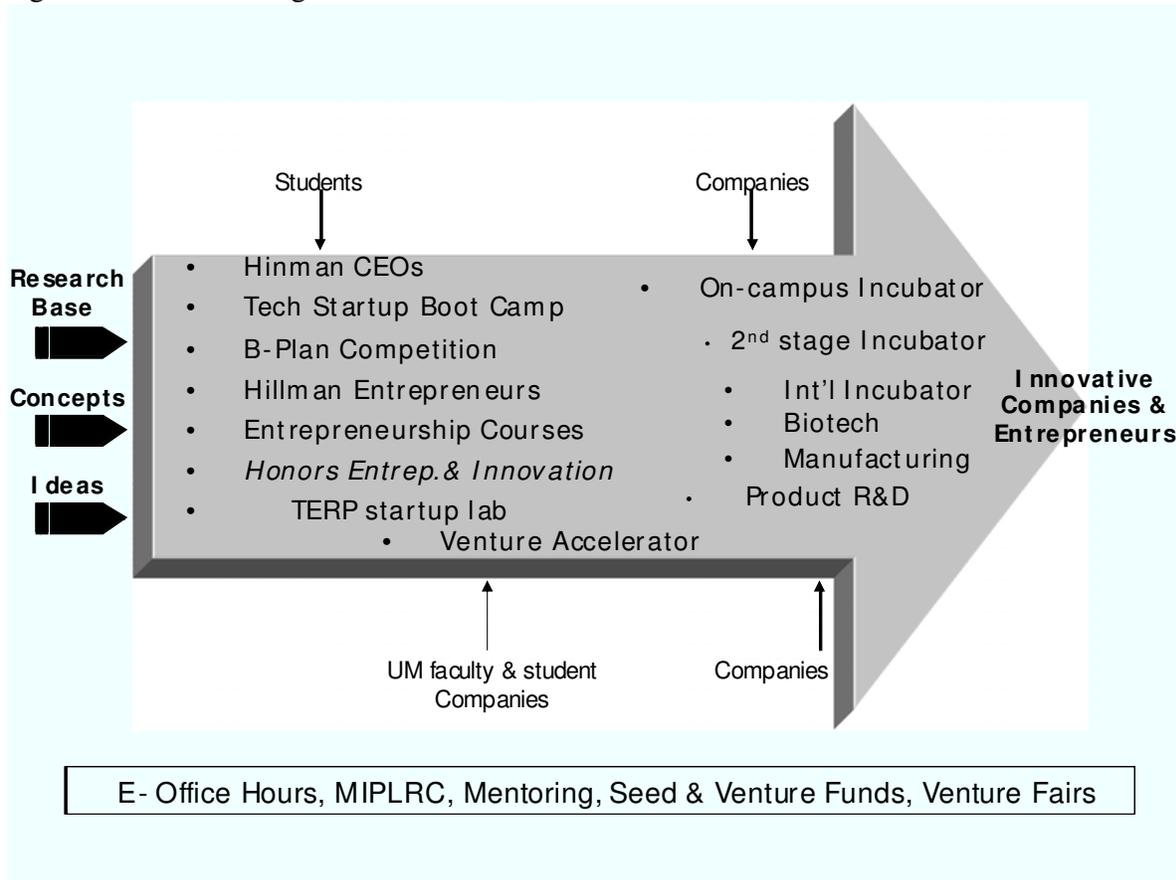


Figure 1. Mtech's Entrepreneurship and Innovation Continuum

3.0 Education Programs and Activities

The University of Maryland is a recognized leader in entrepreneurship and innovation education through the dynamic entrepreneurship courses and offerings of Mtech^{1,2}. At Mtech, we believe that a firm grasp of the entrepreneurial process and mindset benefits every person engaged in developing technology. Our goal is to infuse technology-creating students, faculty members and professionals with that knowledge and its accompanying skills. Armed with an entrepreneurial mindset, technology creators drive economic growth by launching successful ventures and bringing life-changing products and services to market.

Through live companies, courses, seminars, workshops, competitions, and volunteerism, Mtech's students are part of a special experiential learning model. While providing entrepreneurship and innovation education and helping teams to start and operate ventures are important, a continuum of hands-on mentoring helps students not yet engaged in founding and managing start-ups to develop their entrepreneurial skills. Over the course of students' careers in Mtech programs, they can develop innovative ideas and write business plans. Students may also compete in the

University's \$75K Business Plan Competition, attend the Technology Start-up Boot Camp each fall, and volunteer through program-managed activities.

In contrast to many entrepreneurship programs across the country that are aimed at graduate students or upperclassmen, Mtech invests significant attention to undergraduate students. When entrepreneurship and innovation are introduced early, the knowledge gained significantly impacts direction towards more entrepreneurial and innovative careers. This knowledge combines with the community to create a dynamic hub for entrepreneurial skills building and innovative venturing.

3.1 Courses

Table 2 provides a summary of the entrepreneurship education programs and activities organized by the students being served. Mtech's entrepreneurship courses are experiential and practical, and almost all of them culminate in student groups developing plans for their own businesses. As noted in the table, the interest in entrepreneurship extends all of the way to middle school students, and Mtech's education programs serve interests from that level to working professionals.

Summer courses for rising senior high school students have been offered for the past four years, and the number of students has steadily increased to about 100 for summer 2009. The trend of students interested in entrepreneurship in earlier grades has been noted, and next summer, a course will be offered to 8th-grade students. In addition to the two summer courses offered on campus, an entrepreneurship course is provided at two of the top high schools in the region during the school year and a third summer course on creativity and innovation will be offered during the summer.

Based on the outstanding success of the Hinman CEOs Program, the University requested Mtech to develop a similar residential entrepreneurship program for freshmen and sophomore students, and this program will begin in the fall of 2010. The course "Entrepreneurial Opportunity Analysis" has been provided to a special group of incoming freshman students for some years.

3.2 Hinman CEOs Program

Mtech's anchor undergraduate entrepreneurship program is the Hinman CEOs Program, which was started in 1999. Each fall, approximately 45 incoming juniors are selected to enter the two-year program. Key selection criteria include evidence of an entrepreneurial spirit and a desire to pursue an entrepreneurial career path. The application process occurs during the second semester of the sophomore year and culminates with personal interviews. The acceptance rate is typically 30%. Students of all majors are eligible for the program, with accepted students evenly representing engineering majors, business majors, and arts and humanities majors. The diversity of the students in the program is considered to be very important. As noted in Table 2, the students take a course on entrepreneurship each of the four semesters that they are in the program.

<i>Middle School Students</i>	<ul style="list-style-type: none"> • Entrepreneurship 101 - Summer course for 8th grade students interested in entrepreneurship (New 2010) 	<p><u>General</u></p> <ul style="list-style-type: none"> • Technology Startup Boot Camp • \$75K Business Plan Competition • Seed Funds
<i>High School Juniors & Seniors</i>	<ul style="list-style-type: none"> • Summer courses on campus <ul style="list-style-type: none"> – Discovering New Ventures – Technology Marketing and Product Development – Creativity and Innovation (New 2010) • Spring course on-site at a local high school <ul style="list-style-type: none"> – Entrepreneurial Opportunity Analysis 	
<i>UM Freshmen & Sophomores</i>	<ul style="list-style-type: none"> • Entrepreneurship & Innovation Program (EIP) (New 2010) <ul style="list-style-type: none"> – First course: Fundamentals of Entrepreneurship and Innovation – Three more courses to be added • Course: Entrepreneurial Opportunity Analysis and Decision-Making in 21st Century Technology Ventures 	
<i>UM Juniors & Seniors</i>	<ul style="list-style-type: none"> • Courses: <ul style="list-style-type: none"> – Fundamentals of Technology Startup Ventures – Special Topics in Entrepreneurship – Corporate Ventures (for the Petroleum Institute in Abu Dhabi) • Hinman CEOs Program – 4 courses • Hillman Entrepreneurs Program – 4 courses 	
<i>Graduate Students</i>	<ul style="list-style-type: none"> • Course <ul style="list-style-type: none"> – Advanced Engineering Startup Ventures • Graduate Certificate in Technology Ventures & Innovation: Professional Masters courses managed by Mtech – 4 courses: <ul style="list-style-type: none"> – Technology Startup Ventures – Strategies for Managing Innovation – Innovative Thinking – Corporate Technology Venturing 	
<i>Professionals</i>	<ul style="list-style-type: none"> • Certificate in Innovation Management Program 	

Table 2 Listing of Mtech’s Entrepreneurship Courses Organized by Student Level

The Hinman CEOs living-learning environment is housed in an exclusive, apartment-style residence hall designed to encourage the exchange of ideas. The incubator setting enables the free flow of ideas among the CEOs as well as easy interaction with experts outside of the university. Seminars by experts in company formation and by successful entrepreneurs are held to educate and inspire the CEOs. Mentoring is provided by on-site staff with experience advising young entrepreneurs and by other volunteers from inside and outside the university who have expertise in business, legal, technology, and other fields important to entrepreneurs.

All of the students are involved in entrepreneurial endeavors, with 25% of these endeavors generating revenues. In 2009, student companies generated \$1.6 million in revenues, while in

2008, four student teams generated \$1.5 million in revenues. Two companies founded by Hinman CEOs' students while they were in the program were recognized in the 2009 *Inc. 500* list of the fastest growing companies in the U.S., SquareSpace and Lurn (formerly Affiliate Classroom).

3.3 Hillman Entrepreneurs Program

For the Hillman Entrepreneurs Program, selected entrepreneurial-minded students begin their education at a nearby community college and matriculate to the University of Maryland for the junior and senior years³. Students selected for the program receive four-year scholarships. Without the scholarships, these students may not have the financial capacity to pursue a college degree or compete well for financial aid. The Hillman scholarships enable students to attend college full time and take a rich set of four specially designed entrepreneurship and leadership courses. The program includes out-of-the-classroom activities and mentoring to help them develop as entrepreneurs within a community of entrepreneurs. A full-time mentor is supported at each educational institution and each is charged with guiding student classroom education, ventures and activities. In contrast to the Hinman CEOs Program, the Hillman Program is non-residential.

In addition to being non-residential, the Hillman Program crosses two campuses. It faces the unique challenges of building a community for the students and a collaborative environment between the institutions. Also, the profile of the community college students admitted to the Hillman Entrepreneurs Program includes those who have faced economic and social challenges and many are non-traditional students. The community college campus serves people from a wide age range, including students with families and children, and the Hillman Program reflects this. It is indeed inspirational to see these students succeed in their academic and entrepreneurial endeavors. One Hillman student who grew up in Sierra Leone and who now drives a taxi in Washington 40 hours per week started a company and won two categories of the most recent University of Maryland Business Plan Competition for a product to generate electricity from organic material and biodegradable waste⁴.

3.4 Entrepreneurship and Innovation Program

Launching fall 2010, the Entrepreneurship and Innovation Program is a cornerstone initiative to further elevate the university's profile and competitiveness internationally, particularly in the entrepreneurship and innovation arenas. This new Honors College program, launched by Mtech, provides 150 entrepreneurially-minded freshmen and sophomores from all majors the opportunity to learn and live entrepreneurship and innovation. In this living-learning program students develop the entrepreneurial mindsets, skill sets, and relationships to launch successful concepts with startup companies and corporate ventures.

The Honors academic program combines small classes taught by exceptional faculty with the wide range of additional education opportunities offered by a large research institution. The Entrepreneurship and Innovation Program track starts with "Discovering New Ventures", a one-credit seminar focused on building the entrepreneurial mindset and introducing basic entrepreneurship principles and terminology. In the second semester, "Contemporary Issues in Entrepreneurship & Innovation" inspires innovation and creativity through interactive lectures,

workshops, and case studies in contemporary issues to include energy, life sciences, healthcare, and technology. The third semester includes "International Entrepreneurship & Innovation", an introduction to the opportunities and challenges of entrepreneurship and innovation from an international perspective through lectures and guest speakers with international experiences. The fourth semester is the capstone course, with the "Social Entrepreneurship Practicum" enhancing strategic capabilities and leadership skills through the development of an innovative for-profit product or service concept with social benefits. The academic program also consists of Honors 100 and two Honors Seminars approved by the Entrepreneurship and Innovation Program. Honors seminars and courses are an excellent way to satisfy graduation requirements as many of these classes totaling 16 credits may count towards general education requirements and the student's major.

The valuable academic experiences are complemented with the central offices of program staff. In this way, students can easily visit staff offices to discuss their latest new venture idea or to tackle a tough legal, financial or ethical question. The program directors are seasoned in the entrepreneurial community, pairing practical experience with a top-tier education to coach teams and individually mentor students.

3.5 Seed Fund and Internships

A \$50,000 seed fund is available each year for students of the Hinman CEOs Program, the Hillman Entrepreneurs Program, and the Entrepreneurship & Innovation Program. These funds are exclusively dedicated to new ventures making a positive social impact, typically in education, healthcare, environment, and related areas. Funds are provided as grants to students with no payback or equity requirement. Funds are to be used for R&D or working capital for student ventures.

Internships play an important role in the entrepreneurship and innovation experience. Students can learn hands-on with area startups, in the offices of venture capitalists, and in faculty laboratories. Applying their experience in these environments amplifies their learning, in turn, bringing energy and expertise back to their fellow Mtech students. On a competitive application basis, select students will be placed in these entrepreneurial internships each summer.

3.6 Impacts

The impacts of Mtech's undergraduate education programs may be measured alongside those of *Entrepreneur Magazine* and *The Princeton Review's* "Top 25 Undergraduate Colleges for 2009" (*Entrepreneur Magazine*, 2010). It should be noted that the impacts listed in Table 3 are measured solely for Mtech's programs and courses and not for the entire University of Maryland.⁵

The dramatic impact of Mtech on the University of Maryland and the region is also demonstrated through a dynamic set of non-classroom activities and programs. Since the spring of 2001, the Mtech has developed and managed a university-wide business plan competition. The University of Maryland \$75K Business Plan Competition. Over 400 entrepreneurs have vied for annual

prizes of up to \$75,000. The competition serves as a catalyst to encourage students and eligible alumni to strategize and present their best ideas and to write business plans.

Category	Mtech Impacts	Mtech Ranking vs. U.S. Universities
Enrolled students	655	#7
Scholarships	\$360,000	#4
Business plan competitions	\$125,000	#5
Faculty who are entrepreneurs	100%	#1 (Tie)
Number of entrepreneurship clubs	3	#11 (Tie)
Mentorship programs	4	#13 (Tie)

Table 3. Mtech’s Undergraduate Education Programs’ Impacts

The Technology Start-Up Boot Camp, started in fall 2001, is an annual one-day program serving over 600 students and faculty from throughout the region. The day is devoted to exploring technology venture formation. Topics include evaluating your business idea, managing intellectual property, building a team, and obtaining financing. The Mtech-managed Boot Camp is the model for the NCIIA Invention to Venture Workshops that have had national reach in impacting communities.

4.0 Mtech Ventures

The primary programs that are aimed at company generation and growth are listed below, and each will be discussed briefly. These programs are managed by a staff comprised of seasoned veterans of startups and venture capital firms.

- TERP Startup Lab
- VentureAccelerator
- On-campus Incubator
- 2nd Stage Incubator

4.1 TERP Startup Lab

This program is aimed at two types of faculty and student companies: ventures that are too embryonic for the VentureAccelerator, but have promise of getting to that stage and “lifestyle” companies that are worthy of support but are not expected to become large. The TERP Startup Lab provides a place in the on-campus incubator building where these companies can quickly develop their technology prototypes and get some help in moving their ventures forward. The program strengthens the entrepreneurial community and provides shared networking/learning experiences with VentureAccelerator and on-campus incubator companies. Winners of the University of Maryland \$75K Business Plan Competition and the Faculty Venture Fair are eligible for one free year at the TERP Startup Lab. Special accommodations are made for students in the Hinman CEOs and Hillman Entrepreneurs programs. SAIC provided \$35K in funding for software and equipment for the lab.

4.2 VentureAccelerator

The Bayh-Dole Act provides for intellectual property (IP) resulting from federally-sponsored research to be owned by the university and licensed for commercial purposes. Since the large majority of university research is federally funded, the university owns most of the IP research carried out by faculty and graduate students. If the university decides not to pursue protection of invention disclosures, it may assign its rights to the inventors. Faculty, staff and students may acquire ownership and use rights in inventions and patents that the university will generally own when the inventions have been created using resources beyond those usually and customarily provided or are not created as part of their university research and academic activities. At many universities, IP generated by undergraduate students is owned by the students. Thus, IP can be either owned by the university or by faculty, staff and students.

Most major universities have substantial research bases that result in invention disclosures and subsequent protected IP. Traditionally, universities seek to license this IP. VentureAccelerator (VA) provides faculty and students with opportunities to start companies based on IP with promising commercial potential. As discussed above, the IP can either belong to the faculty and students or the university.

The basic concept for VA is to select the most promising opportunities for commercialization, to form companies and develop the companies through intensive processes to the point that they can move forward on their own. As discussed above, in the case for which the university owns the IP on which the companies are based, the companies license the IP from the university. In cases for which the inventors and not the university own the IP, the inventors assign the IP to the companies.

The VA processes are shown in Figure 2. The first process is the selection of companies to enter VA. This is accomplished very carefully and involves four steps: identification of candidate opportunities, due diligence regarding IP, market analysis, and feasibility of assembling human resources. If these steps provide positive results, a panel of experts in the field of the company is assembled, and after a presentation by the inventor(s) and extensive Q&A, the panel advises VA regarding the viability of the venture. After the company is admitted to VA, the second process begins and involves extensive planning. The steps included in this process culminate in a well-developed, fundable business plan. The last process includes steps to raise initial funding, prepare to launch the product or service and recruit the management team. At this point, the company is ready to “graduate” from VA.



- | <u>Selection</u> | <u>Planning</u> | <u>Execution</u> |
|---|--|---|
| <ul style="list-style-type: none"> ▪ Scalable market opportunity ▪ Unique IP ▪ Feasible to assemble human & financial resources ▪ Extensive due diligence ▪ Advisory Panel | <ul style="list-style-type: none"> ▪ Product planning ▪ Customer research ▪ Competitive analyses ▪ Organizational chart ▪ Significant hurdles & risks mitigated ▪ Financial model & funding requirements ▪ Completed business plan and presentation | <ul style="list-style-type: none"> ▪ CEO recruiting; team build-out ▪ Advisors and experts ▪ Angel & grant fundraising ▪ Product launch; alphas and betas ▪ Graduation (possibly to on-campus incubator) |

Figure 2. VentureAccelerator Processes

Table 3 provides a description of the VA services provided to VA companies for business planning, customers and markets, skills and talents and funding. Table 4 provides a listing of current and graduate VA companies and their product areas.

	Business Planning	Customers & Markets	Skills & Talents	Raising Capital
Plan Development	X			
Financial Modeling	X			
Market Validation		X		
Market Assistance		X		
Service Providers			X	
Recruiting Help			X	
Grant ID and Advice				X
Angel/VC Fundraising				X
Facility after Graduation				X

Table 3. Services Provided to VentureAccelerator Companies

Company	Product Description	Milestones reached	Start Date	Graduation Date
OmniSpeech	Single microphone speech enhancement	SAIC Grant	2/10	Pending
Video Semantics	Video search, retrieval and summary	N/A	8/09	Pending
Remedium Technologies	Modified chitosan hemostatic agent	N/A	5/09	Pending
-----	-----	-----	-----	-----
Flexel	Thin film rechargeable batteries	\$200 equity raised	2/09	8/09
Resensys	Wireless structural health monitoring systems for critical infrastructures	\$400 in grants	8/08	7/09
Traffax	Vehicle traffic monitoring and management systems	\$250 equity raised	7/08	11/18
Zymetis	Cellulosic ethanol and bio-refining	\$2M equity raised	10/06	12/17
Lurn	Online affiliate marketing training	\$10M sales in '09	12/15	4/07
Applied Media Analysis	Mobile Visual solutions	9 employees	9/15	10/06

Table 4. Current VentureAccelerator Companies (above dashed line) and Graduated Companies

4.3 On-Campus Incubator

The first company was admitted in May, 1985, and since then, over 80 companies have graduated and populated the region. Candidate companies are admitted into the incubator only after passing rigorous technical and business reviews. About one in six applicant companies are admitted. Once admitted, companies that are making reasonable progress can remain in the incubator for up to four years. All types of technology companies are acceptable. Biotech companies tend to stay the full four years, and IT companies tend to stay for a much shorter time. Once admitted, companies enjoy increased credibility due to the rigorous admittance process and the dynamic atmosphere that creates an environment where entrepreneurs flourish. The incubator is outfitted with flexible, furnished office and laboratory space, modern IT and biotechnology infrastructures, in-house business support, and convenient office facilities.

Companies pay a license fee that is based on the space occupied plus they grant the University 1% equity per year of incubator occupancy. Of the over 80 companies that have graduated from the incubator, 70% are operating five years after graduation. Companies that graduate from VA tend to become candidates for the incubator. Two of the companies have reached \$1B valuations and one company developed the technology on which some hybrid-electric drives for automobiles are based.

Table 5 provides a comparison of VA and the on-campus incubator. Note that VA is only for University of Maryland affiliated faculty, staff and students whereas the incubator is for entrepreneurs in general.

	VentureAccelerator	On-campus Incubator
Eligibility	Current UMD affiliation	All entrepreneurs
Mtech Role	Active: part-time interim CEO	Advisory, mentor
Location	Anywhere	On-campus incubator building
Duration	6-24 months	24-48 months
Terms	1-3% equity per quarter Deferred service fees	1% equity per year Space fees below market rates Deferred service fees

Table 5. Comparison of VentureAccelerator and On-Campus Incubator

4.4 Second Stage Incubator

Mtech operates a second-stage incubator located about a mile from campus. There is no special mentoring unless occupying companies request assistance. Space is leased at market rates, and the University does not receive equity. Currently, five companies occupy space, one of which is a graduate of the on-campus incubator, another is a VA graduate and one is a spinout of a nearby defense laboratory.

4.5 Venture Supporting Activities

The following activities broadly support technology ventures and will be discussed briefly.

- Maryland IP Legal Resource Center (MIPLRC)
- Entrepreneur Office Hours
- Faculty Venture Fairs
- Seed Fund
- Venture Fund

4.5.1 Maryland IP Legal Resource Center (MIPLRC)

The MIPLRC is a program of the University of Maryland’s Law School and its offices are located in Mtech’s on-campus incubator building. It is led by a member of the law school faculty and involves law students specializing in intellectual property. It is both a training ground for the law students and provides free services to the entire university community. Under the supervision of the faculty member, the students provide free legal services for entrepreneurs and emerging technology companies, including:

- patent applications,
- prior art searches,
- license agreements,
- non-disclosure agreements,
- company formation.

These students provide considerable preliminary work for the startup companies associated with all of Mtech's programs. For example, they can develop drafts of patent applications which then are finalized by professional patent attorneys, thus saving the companies substantial costs.

4.5.2 Entrepreneur Office Hours

Entrepreneur office hours are held the second Tuesday of each month for free mentoring and advisory sessions for students, faculty and regional entrepreneurs. Advisors include individuals from Mtech, the business school's Dingman Center for Entrepreneurship, the licensing office, the MIPLRC, experienced entrepreneurs, venture capitalists, state economic development and grant agencies, small business development center and various outside entities. These sessions provide help and advice with how to:

- build and finance a startup company
- develop and protect intellectual property
- navigate the technology transfer process
- refine your business strategy for rapid growth
- tap into other entrepreneurial resources

Typically there are 15-20 appointments/walk-ins each month with 50% from campus and 50% from outside the University.

4.5.3 Faculty Venture Fairs

Each year, the University hosts two open houses – one in the Fall with a life science focus and one in the Spring with an information technology focus. Embedded in each of these open houses is a venture fair in which faculty present their inventions to a panel of regional VCs and entrepreneurs. The winners typically form startup companies, and this process identifies candidates for the TERPS Lab or the VentureAccelerator.

4.5.4 Seed Fund

Begun in 2008 and renewable on an annual basis, SAIC provides VentureAccelerator with \$50K in seed capital to invest in VA companies with innovative technology addressing technology areas of interest to SAIC. To date, investments have been made in three VA companies. Even though the investment amounts are \$50K or less, they are important to very early stage startups.

4.5.5 Venture Fund

This is an evergreen fund supported by the Maryland Department of Natural Resources (DNR). It is managed by Mtech and provides seed capital for Maryland-based startups with innovative technology addressing Chesapeake Bay Non-Point Source (NPS) pollution (water pollution conveyed to waterways through natural processes, such as rainfall, storm runoff, or groundwater seepage). The DNR input to the fund is \$250k/year over 3 years. Mtech receives a management fee and 20% of upside on return on investments. The first two investments were in companies in the VentureAccelerator and the on-campus incubator: \$50K in Traffax, a vehicle traffic

monitoring company and VA graduate, and \$100K in Zymetis, an enzymes for cellulosic ethanol company that is currently in the on-campus incubator.

5.0 Mtech Partnerships

The major Mtech Partnerships programs are:

- Product R&D (MIPS)
- Maryland International Incubator (MI²)
- Biotech Scale-Up and Education (BREP)
- Manufacturing Assistance (UMMAP).

5.1 Product R&D - Maryland Industrial Partnerships (MIPS) Program

When one considers the extensive technical expertise, facilities and equipment that reside in major research universities and couple these via a program to help companies to develop new and improved products, extraordinary benefits can accrue to the university, companies and economic development. This is the case for the Maryland Industrial Partnerships (MIPS) program, one of the most successful programs of Mtech. This program is referred to in Figure 1 as “Product R&D.”

MIPS helps Maryland companies create new and improved products via on-campus projects co-funded by companies and MIPS funds and carried out on campus by faculty and graduate students. MIPS co-funding is provided by the State of Maryland via the University budget, and the co-funding shares are provided in Figure 3. Note that the MIPS share is larger for smaller companies. There are many successful MIPS projects including:

- HughesNet – satellite technology for Internet
- MedImmune – Synagis, the 10th best selling biotech drug in the used to prevent respiratory syncytial virus (RSV) disease in infants.
- Martek Biosciences – Formulaid - aids in the development of the eyes and central nervous system in newborns
- Quantum Sail Design Group - created the first U.S.-based wind tunnel testing facilities for downwind sails; became the No. 2 sail maker in the world
- Black and Decker - Bullet Speed Tip Masonry Drill Bits – enables hand tool batteries to last 6 times longer between charges.
- CSA Medical - CryoSpray Ablation™ System; revolutionary new device and treatment for Barrett’s esophagus (a pre-cancerous condition)

MIPS projects must be technology-based in the following areas: engineering, computer sciences, life sciences, physical sciences and environmental sciences. The recent trend is for more projects in biotechnology, nanotechnology, energy technologies and homeland security. Proposals are accepted twice per year in May and October, and they must be co-authored by a representative of a Maryland company and a faculty member of the University. Each proposal is evaluated based on technical merit and business/economic potential.

Benefits to companies include: leveraging assets/outsourcing R&D, access to university facilities and faculty & student expertise. Often companies establish lasting relationships with faculty

experts and hire students who have worked on projects. Benefits to faculty and students include: funding for commercially applicable research, relevant real world experience for students, potential lasting relationships with technology companies and potential future sponsored research. Companies are offered rights to an exclusive license to IP created by the university research team during the course of a project with generally accepted terms within the technology area. Since 1987, there have been 644 projects for 448 companies involving 348 faculty.

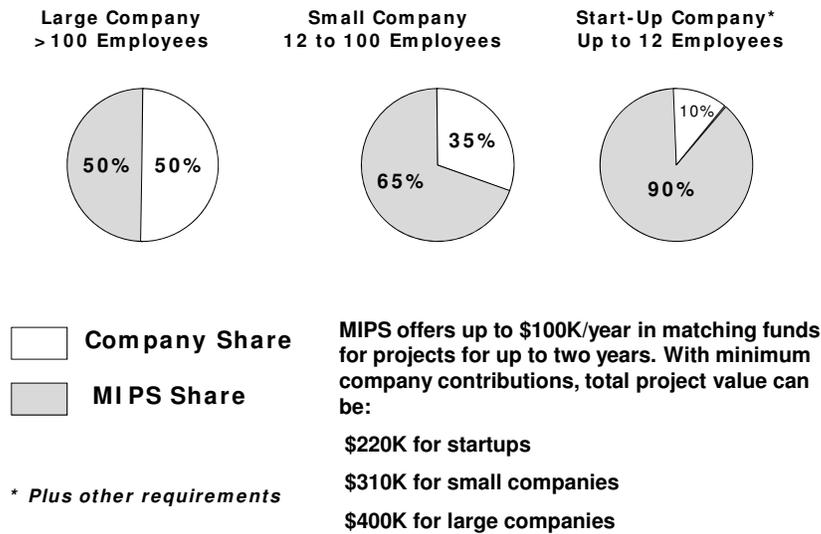


Figure 3. Cost Sharing for MIPS Projects

Table 6 provides revenues from sales of the three top-selling products that were developed via MIPS projects.

Company	Product	Revenue/Sales
Hughes Communications	HughesNet	\$8.4B
MedImmune	Synagis	\$9.1B
Martek Biosciences	Infant formula supplements	\$2B
Total		\$19.5B

Table 6. The Top Selling Products developed via MIPS Projects

5.2 International Incubator

The Maryland International Incubator (MI²) was an outgrowth of the University of Maryland – China Research Park and was dedicated in October, 2009. It provides:

- Physical space for companies to reside in the Incubator
- Networking opportunities with potential partners, or investors
- Hands-on mentoring and training
- Access to world-class faculty, students and research facilities.

Expected benefits include:

- Assistance to international companies help in entering US marketplace
- Contribution to the Maryland economy through commercial activity attracted to the incubator
- Successful partnering of international and U.S. companies
- Research participation and cultural exchanges for University faculty and students.

Currently nine companies reside in the MI². Also, an agreement has been signed with the Warsaw University of Technology regarding identification of potential Polish companies that could benefit from joining the incubator.

5.3 Biotechnology Research and Education Program

The Biotechnology Research and Education Program (BREP) includes an on-campus scale-up facility and staff to operate the equipment as well as provide training for biotechnology company personnel and courses for students.

5.3.1 Biotechnology Scale-up Facility

The Biotechnology Scale-up Facility (BSF) allows biotechnology companies to scale up their processes very cost effectively so that the process details have been worked out before entering the very costly Good Manufacturing Practice (GMP) stage that is regulated by the US Food and Drug Administration. Fermentation and cell culture equipment in the facility ranges from shake flasks to 250 liter fermenters. Cell separation and product purification equipment can handle a wide range of needs. In 2008, 38 bioprocessing projects were conducted for 38 companies. In addition to the professional staff, typically 3-5 undergraduate students work in the BSF, and when these students graduate, they are in great demand by biotech companies.

Training was provided for 61 people from 14 different companies via:

- Custom programs for two companies
- Fermentation Workshop
- Purification and Downstream Workshop
- Undergraduate classes
- Biotechnology and bioproduction.

Undergraduate classes in 2008 included:

- Introduction to Fermentation technology (online)
- The Science and Practice of Fermentation (workshop with lab)
- Downstream Processing & Protein Purification Workshop
- Biomanufacturing, an Overview
- Biomanufacturing: the Science, Methodology & Industry
- Customized Workforce Training.

5.4 University of Maryland Manufacturing Assistance Program

With manufacturing in the US on the decline, it is important to help existing manufacturing companies remain competitive. For over 25 years, the University of Maryland has operated a program of this nature. This program, the University of Maryland Manufacturing Assistance Program (UMMAP) is funded by the University, the National Institute of Standards and Technology Manufacturing Extension Partnerships (MEP) Program and acts as the State of Maryland's primary resource for Maryland manufacturers. The mission is twofold: to apply Clark School of Engineering resources to benefit Maryland manufacturers and to strengthen the competitiveness of Maryland manufacturers by providing information, decision support, and implementation assistance.

UMMAP concentrates on providing services to small and medium size manufacturing companies in five areas:

- Lean manufacturing/productivity
 - Lean training
 - Process and Plant layout
- Sustainability/Environmental:
 - Pollution prevention assessments
 - ISO 14000
- Energy Services
 - Energy assessments
 - Education
- Strategic growth services
 - Top line growth services
 - ISO 9000
 - Export assistance
- Engineering and R&D: Technical Solutions
 - Product/process improvement
 - Design for manufacturability
 - Automation
 - Failure analysis
 - Design reviews
 - Environmental regulation compliance.

6.0 Summary

The mission of Mtech is four fold:

- To provide entrepreneurship education for students including middle school, high school, undergraduate and graduate students and for working professionals
- To create and assist in the development of new companies
- To create mutually beneficial partnerships with existing companies
- To contribute to the economic development in the State of Maryland.

Over the 25 years of Mtech's existence, it has made major contributions to the University of Maryland, the State of Maryland, technology-oriented startup companies and students through its

entrepreneurship education, technology ventures and partnerships programs. Table 7 provides a numerical summary of Mtech’s economic development impact.

Program	Amount	Description
Hinman CEOS	\$26,000,000	Revenues of Hinman CEOs student companies – founded while in the program (2000 – 2009)
On-campus incubator	\$2,431,282,630	Venture investments, federal, state and MIPS awards; public stock offerings; private sales of incubator companies (1984-2007)
MIPS	\$19,538,169,000	Combined revenues/sales of products resulting from MIPS projects (1987 – 2009)
MIPS	\$164,361,377	Total combined MIPS and company funding for MIPS projects at the University (1987 – 2009)
UMMAP	\$323,300,000	Increased and retained sales, costs saved, investments saved, unnecessary investments avoided, increased investment, plants and equipment by Maryland manufacturers (2000 - 2009)
Total	\$22,483,113,007	

Table 7. Summary of Mtech’s Economic Development Impact

Especially, within the past ten years, Mtech has contributed significantly to the entrepreneurship culture at the University and in the region. Some of its programs have been replicated widely across the United States, and many universities in the US and abroad visit Mtech to learn about Mtech programs and processes. The activities of Mtech continue to evolve and are becoming more international. Taken together, the program offerings are very comprehensive and provide a continuum of assistance and resources for students, startup companies and existing companies.

8.0 References

1. Barbe, D.F., Thornton, K. S., “Components of a Comprehensive Engineering Entrepreneurship Program,” Proceedings of the American Society for Engineering Education Annual Conference and Exposition, June 2002
2. Barbe, D.F., Thornton, K.S, “The Development of a Technology Entrepreneurship Culture And Lessons Learned,” Proceedings of the American Society for Engineering Education Annual Conference and Exposition, June 2004
3. Dowd, A.C, Gabbard, G. (2006). The Study of Economic, Informational, and Cultural Barriers to Community College Student Transfer Access to Selective Institutions
4. <http://www.washingtonpost.com/wp-dyn/content/article/2009/10/23/AR2009102302137.html#young>
5. Entrepreneur Magazine and The Princeton Review. (2010). Top 25 Undergraduate Colleges for 2009. Retrieved from <http://www.entrepreneur.com/topcolleges/undergrad/0.html>