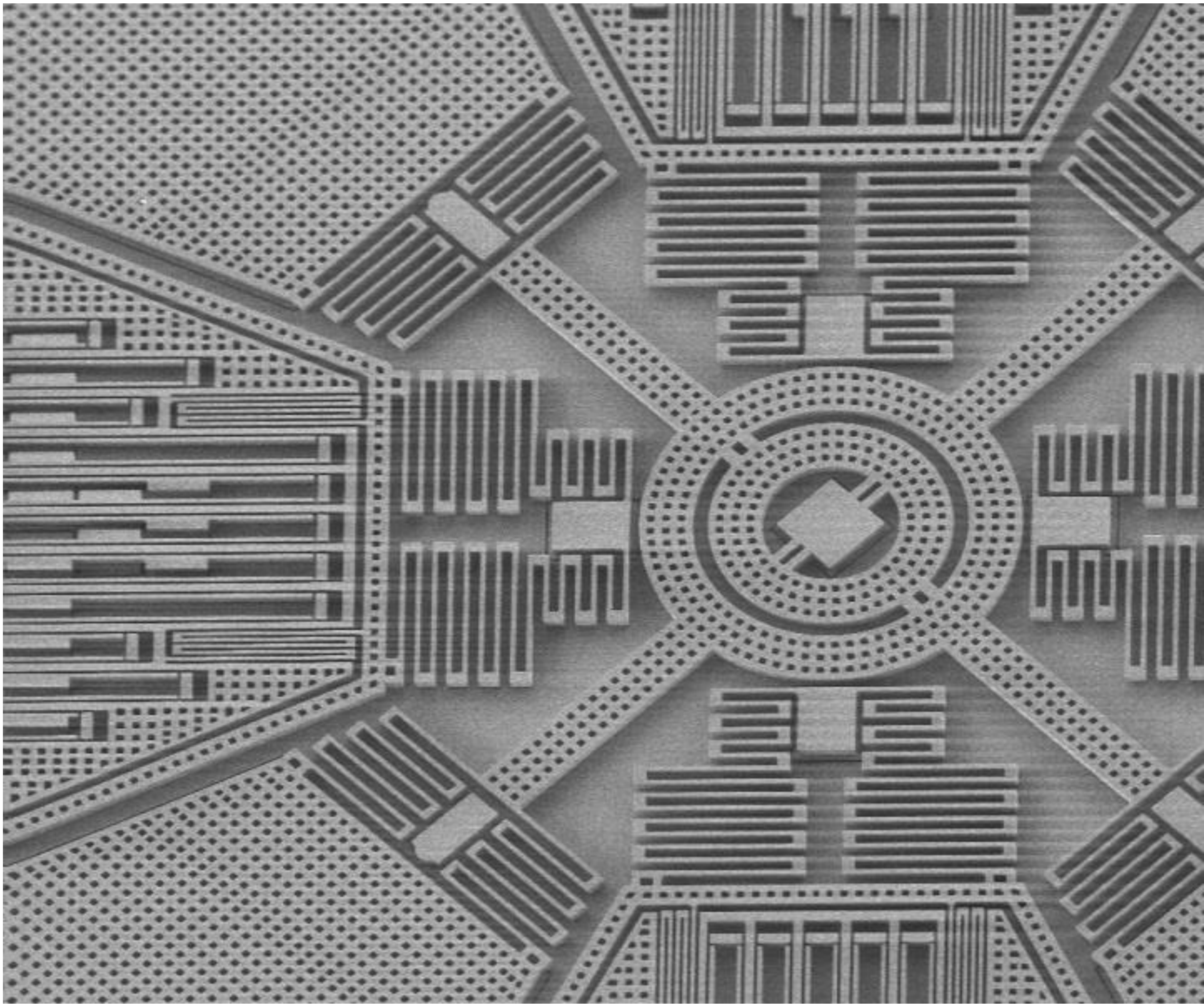


Expert Contributors

MEMS Commercialization Report Card – Part 2: Clusters

By Roger H. Grace

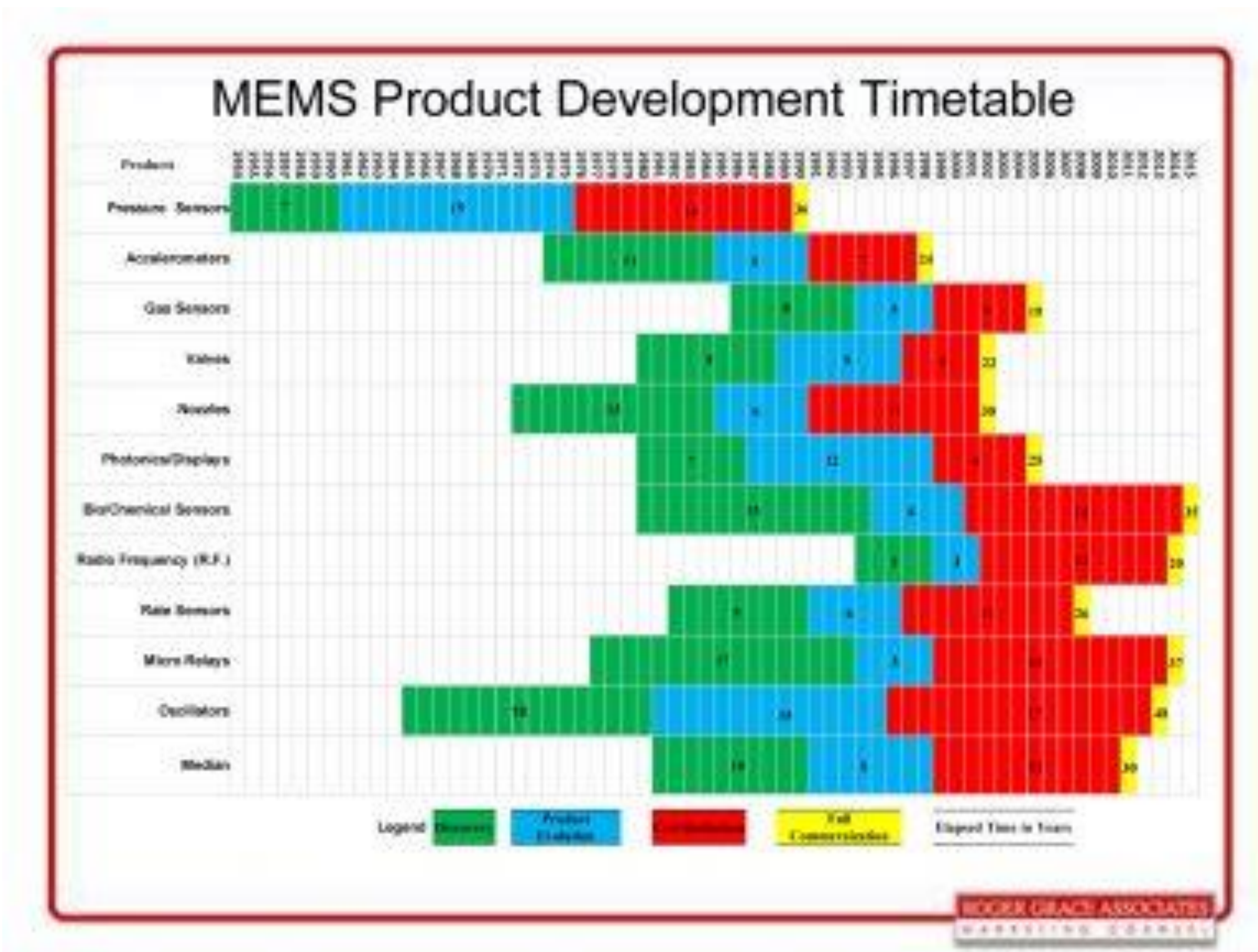
Introduction

This is the second in a multi-episode series addressing the 2018 MEMS Industry Commercialization Report Card. Episode 1[1], which appeared in the December 3, 2019 issue of this publication included an introduction to the Report Card, its evolution, the market research process from which its grades were derived and the summary of the annual grades from its inception in 1998 to 2018.

This article will address the topic of “Clusters”. Subsequent episodes will also take a deep dive into several of the remaining 13 topics a.k.a. critical success factors, including Design for Manufacturing and Test, Industry Infrastructure, VC attraction, Creation of Wealth and Industry Associations which I opine are the basis of the successful commercialization of MEMS, as well as other technologies.

Results

After careful review of the provided grade data and the specific verbatims of the 35 respondents, it is my opinion that the resulting final grade of the 2018 Report Card remaining at B- for the past several years could be greatly attributed to the ongoing maturation of the MEMS Industry.   Please keep in mind that MEMS began their long road to commercialization, figure 1, beginning with the discovery of the piezoelectric effect in Silicon in 1956[2]. The Report Card has tracked its progress over the past 20 years.



Source: R. Grace / S. Walsh, MANCEF Roadmap

Fig. 1: The MEMS Commercialization Timetable demonstrates the extended duration of each part of the commercialization process for several types of MEMS sensors starting with pressure

sensors in the mid 1950's. The median duration of the process was approximately 35 years. (Courtesy: Roger Grace Associates/Prof. Steven Walsh, University of New Mexico – Copyright 2019 Roger Grace Associates)

As can be seen in figure 2, I believe that MEMS /Silicon has replaced the discrete mechanical approach as the platform of choice for sensors. My research has indicated that MEMS is apparently reaching the full maturity stage of its evolution. No longer is MEMS "revolutionary" but rather an "evolutionary" technology. The time has come for astute design engineers to judiciously consider alternative platforms including printed and fabric-based sensor technologies to optimize their product design [3].

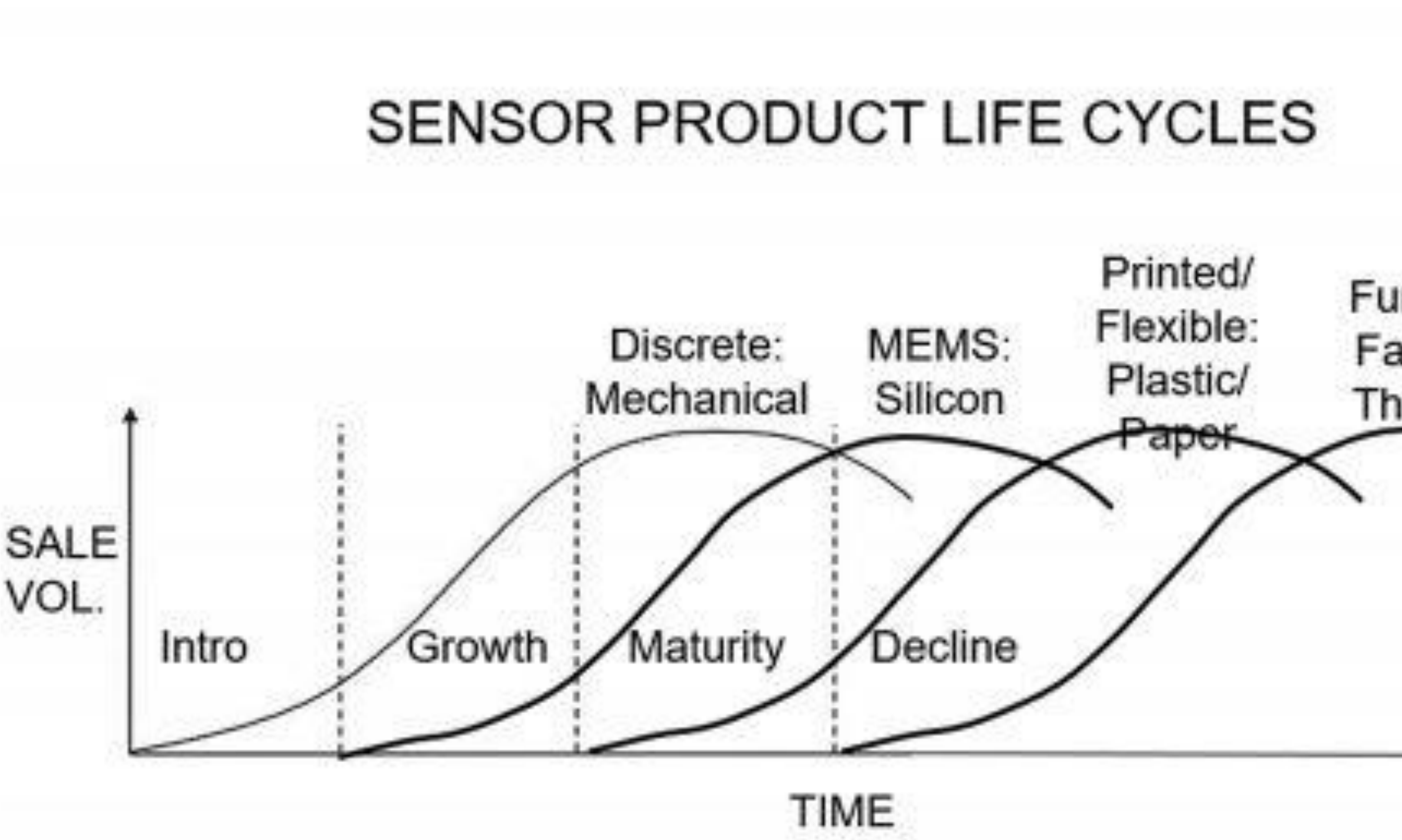


Fig. 2: Product life cycles of various sensor platforms demonstrate that MEMS/Silicon has reached a high level of maturity since its early development stage in the mid-1960. New sensor platforms including printed, now in rapid commercialization, and fabric show major opportunities for high volume applications. (Copyright 2019 Roger Grace Associates – Courtesy: Roger Grace Associates)

The 2018 grade for Clusters remained at C+. Cluster grades have historically hovered in the C+ to B- region with B+ grades achieved in the 2004/2005 (see figure 3). Clusters were added to the existing list of nine topics in addition to four other topics in 2003. In my review of the worldwide cluster development activity, it appears that existing clusters continue to deliver their value to the industry. However, new clusters have not appeared in the industry for the past several years. Additionally, and to my dismay, several of the respondents declined to

provide a grade to the cluster topic and/or provide verbatims leading me to believe that the topic is not fully understood and valued by this highly experienced audience.

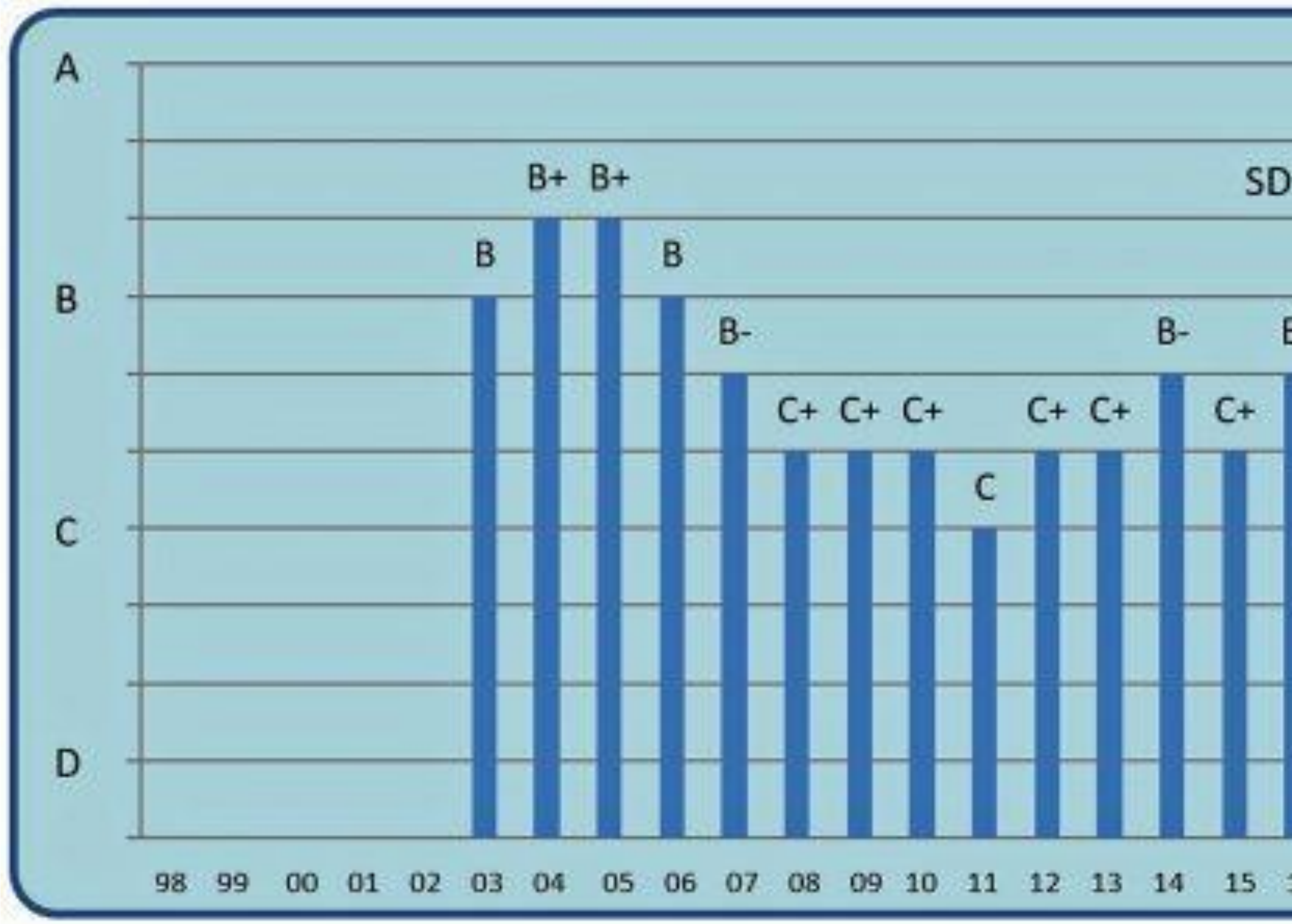


Fig. 3: The MEMS Industry Commercialization Report Card grade for Clusters remained at B- for the fourth year running. Grades for the Clusters have remained in the C+ to B- range consistently during the addition of this topic to the Report Card in 2003. (Copyright 2019 Roger Grace Associates – Courtesy: Roger Grace Associates)

Clusters Defined

Clusters are defined as…" geographical concentrations of firms, supplies and related industries and specialized institutions that occur in a particular field in a nation, state, city or region" [5]. It was reported that the first "cluster" was established in 500 B.C.E. in the Greek City-Sate of Miletus for the production of wool products [6]. The primary raison d'etre for clusters is that they provide competitive advantage for their constituents vis-à-vis more efficient manufacturing. Additionally, they create economic development opportunities for the region especially in the creation of highly paid new jobs…both directly and indirectly. It has been reported that a new technology job has the ability to create approximately 5.2 additional support jobs in a region [7].

For a cluster to be viable, it should possess the following attributes:

- **Availability/concentration of human capital/intellectual property/patents**
- **Existing physical infrastructure including R&D facilities, equipment, materials and suppliers**
- **Convenient access to investment especially venture capital**

Examples of Classic Clusters

I had the distinct pleasure of visiting Puebla Mexico several years ago to give a weekend seminar on MEMS at the local technical university. Puebla is the home of the famous colorful Talevera pottery. There are currently over 150 producers of this unique decorative pottery art in Puebla. One would ask…why Puebla? Upon deeper investigation, I uncovered that Puebla is blessed with having two unique types of clay that are critical to the manufacture of these delicate pieces in addition to the minerals that provide the rich blue and brown paint color to be created and applied to the pottery. Also, there was an abundance of workers to undertake the design and manufacture process. Intellectual property was brought to the region in the mid-16th century by Dominican priests from Spain. Investment was done by the Roman Catholic Church through the influence of the many local Dominican priests. Thus…a perfect storm.

Fast forward two centuries to Lowell, Massachusetts and to the creation of the US textile industry in the early 1800's. A wealthy Boston Brahmin, Mr. Francis Cabot Lowell, the man for whom the town was named, during a trip to Northern England and Scotland during 1810-1812, observed weaving factories and decided to replicate the same in Lowell. Lowell conveniently sits at the confluence of the Concord and Merrimac Rivers in Northeast Massachusetts which served as the abundant and low-cost power source to the weaving looms. It attracted investors from nearby Boston and drew on the local farming community and nearby French-Canadian immigrants to fuel this bustling business. In just a short period of time, scores of mills were established and prospered in this region.

Early on, weaving machines were bought from English manufacturers and transported by ship to nearly Boston ports. Over a period of time, local manufacturers of these machines began producing and providing them to the mills. Local wool and cotton the South was in plentiful supply and reached Lowell by ship and later by rail. By 1840, over 950 women and 120 men were employed. They created over 155,000 yards of fabric weekly using 3,500 looms. The rest is history with Lowell becoming one of the first successful industrial clusters in the US. Again, a "perfect storm". However, time has taken its toll on the region which fell into gradual recession after WWII with the ever-increasing cost of labor which resulted in the displacement of the textile business to the Carolinas.

Modern Day Clusters

There are many examples of modern-day microelectronic clusters for technology worldwide. Two of the most famous are Silicon Valley and Rt. 128 Boston. Both of these thrive to this day with many successful MEMS organizations resident in each [8]. The primary raison d'etre for their success emanated from the abundant availability of human capital…i.e.

science and engineering graduates from local universities…MIT in Boston and Stanford and UC Berkeley in Silicon Valley California. A new microelectronics cluster has emerged in the Albany, New York region with major financial support from the State of New York and human capital from SUNY. Many MEMS/microsystems technology clusters currently exist worldwide with the first being established in Dortmund, Germany in 1989. We will briefly address two here… BRIDG in Kissimmee, Florida and CEA-Leti in Grenoble, France.

The most recent addition to the portfolio of clusters is the recently completed BRIDG (formerly ICAMR) in Kissimmee (Orlando) Florida. I had the pleasure of attending its ribbon cutting ceremony in April 2017. As part of a 500-acre NeoCity Campus, it has a 109,654 sq. ft. building with a 26,527 sq. ft. class 100 cleanroom compatible with 200-mm. wafers. Although it has no spin-offs to date, it employs 45 full-time technologists. Its technology focus are microelectronics production, advanced heterogeneous systems integration and packaging and III-V materials growth for sensors. Its purpose is to act as a commercialization bridge from R&D to high-volume manufacturing. Recent awards from the DOD includes $7.5 million for the Air Force Research Lab and $20 million from the DOD/Industrial Base Analysis and Sustainment Agency. NeoCity also boasts a recently completed STEM high School, office buildings and a Kissimmee Utilities Authority substation. Collective funding to NeoCity has amounted to over $300 million. It enjoys close collaboration with its nearby neighbor, the University of Central Florida.

Fig. 4: BRIDG, located in Kissimmee (Orlando) Florida is the most recent of MEMS/ microsystems clusters.   It is located in the 500-acre NeoCity campus in close proximity to the University of Central Florida's main campus. Startup funding was obtained from the State of Florida, Osceola County and the I-4 Corridor organization. Its 26,257 sq. ft. Class 100 cleanroom is equipped with the most up-to-date semiconductor manufacturing tools. (Courtesy: Skanska/Seamus Payne)

I first visited CEA-Leti in 2001. Since then, it has emerged as a major international player in research and development in a wide spectrum of technologies including 3-D package integration, sensor networks and smart devices, digital microfluidics, nano biotechnology and photonics.   It is the anchor of the 50- acre MINATEC cluster campus with also includes the University of Grenoble-Alpes PHELMA(Physics/Electronics/Materials) Engineering School.   Spinning off 64 companies, it has garnered over 148.5 million Euros in Series A to Series D financing in the last five years.   1,900 people are employed, creating 2,763 patents and establishing 350 industrial partners. The 8,500 sq. meter clean-room facilities are compatible with 200- and 300-mm. Silicon wafers. Initial funding was provided by city, department and federal government. It had a 315 Million Euro budget in 2019.

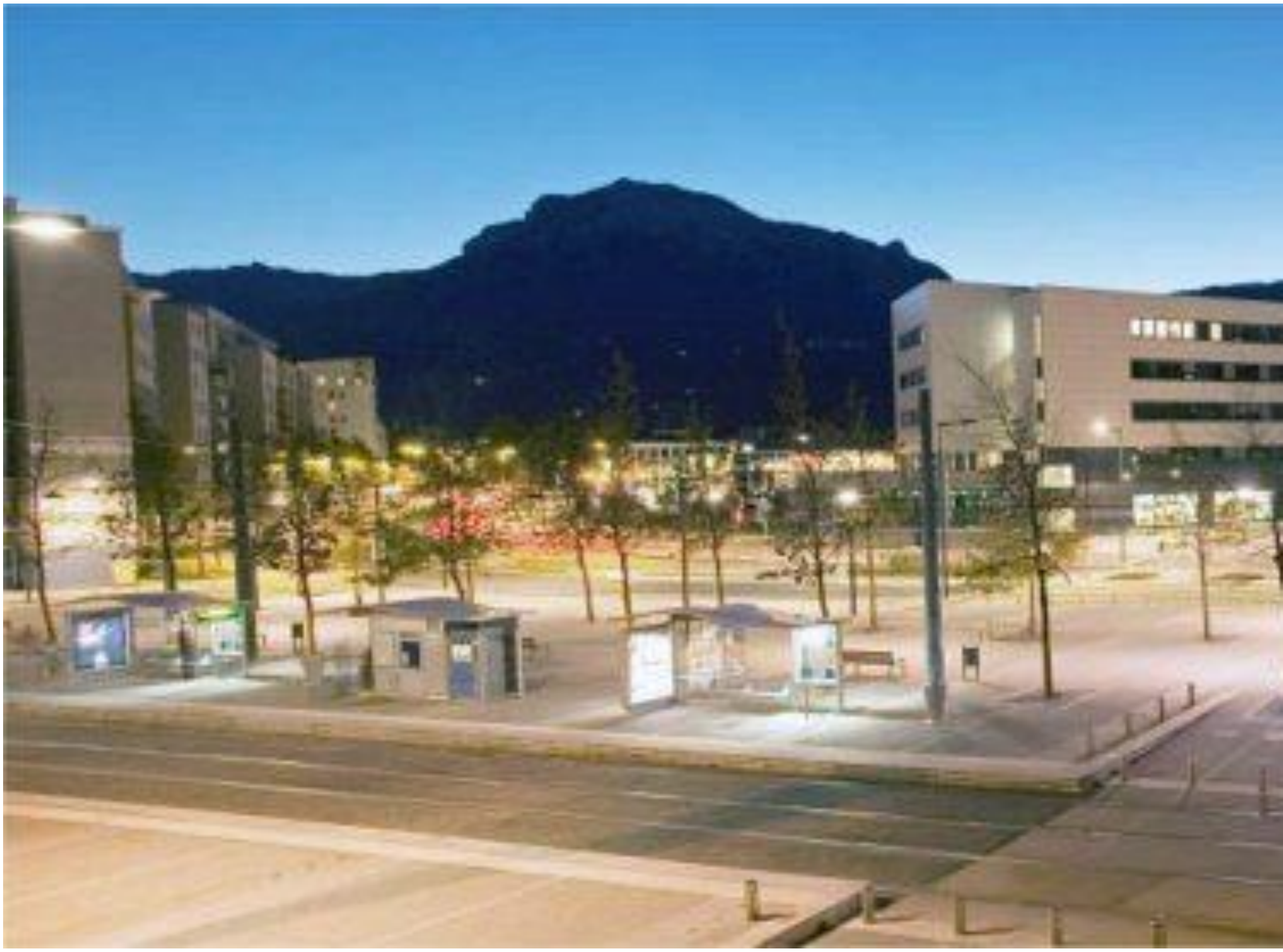


Fig. 5: The CEA-Leti research center anchors the MINATEC cluster campus in Grenoble, France. Founded in 2006, the 50-acre MINATEC cluster campus also includes Minalogic and the University of Grenoble-Alpes PHELMA Engineering School. (Courtesy: CEA-Leti)

Summary

Clusters remain to be an important component to the successful commercialization of MEMS. While the grade for clusters has remained constant over the two several years at C+, I believe that this was due to the lack of knowledge and understanding that many of the respondents, although quite experienced, have as to the existence and progress of the clusters in CEA-Leti, BRIDG and several others.

It is my intention that informational vehicles such as this article will help alleviate this problem and demonstrate the value of the need for continuing support of existing and creation of new clusters worldwide to continue to facilitate MEMS commercialization. I expect the continued support and success of organizations within clusters will continue to play a major role in the successful commercialization of the MEMS industry.

References

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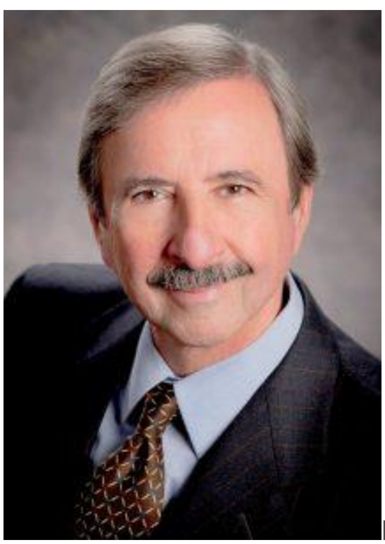
About the Author



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Roger H. Grace is president of Roger Grace Associates, a Naples Florida based strategic marketing consulting firm specializing in high technology. Founded in 1982, it provides custom market research, integrated strategic marketing communications, M&A due diligence and distribution channel advisory services. His clients include the international "Who's Who" of corporations, federal laboratories and government agencies. His background includes over 40 years in high frequency analog design engineering, application engineering, project management, product marketing, and technology consulting.

Roger's educational background includes a BSEE and MSEE (as a Raytheon Company fellow) from Northeastern University, and the MBA program at Haas Graduate School of Business at U.C. Berkeley. He has specialized in sensors and ICs for over 35 years with a focus on micro electromechanical systems (MEMS). He has authored over 75 technical papers and articles, organized, chaired, and spoken at over 50 international technical conferences.

Roger is frequently quoted as an industry expert in major international technical and business publications on the topic of technology commercialization. He was the co-founder, past president, and currently is the Vice President of the Americas of the Micro, Nano and Emerging Technologies Commercialization Education Foundation (MANCEF), and has served on the Board of Directors of the Florida Manufacturing Extension Partnership from 2008 to 2014.

Mr. Grace has also served on the advisory boards of Northeastern University's School of Engineering, National Council, and Nanomanufacturing Research Institute as well as on the University of Michigan's Wireless Integrated Microsystems and Sensors Center (WIMSS) Strategic Advisory Board. He was selected as a recipient of the Outstanding Engineering Alumni of the Year in 2004 by Northeastern University. He was bestowed the inaugural Sensors Industry Impact Award in 2014 by Sensors Magazine. Mr. Grace held the position of visiting lecturer at the University of California at Berkeley School of Engineering from 1990 to 2003.

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