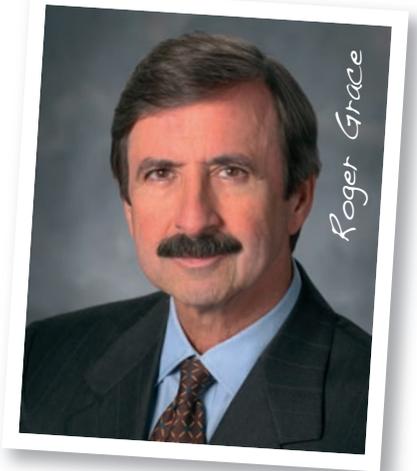


# BARRIERS TO THE SUCCESSFUL COMMERCIALISATION OF MEMS:

## The 2012 MEMS Industry Commercialization Report Card

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### Introduction

*This article provides the results of the recently completed 2012 MEMS Industry Commercialization Report Card Study (Report Card). The 2011 Industry Report Card was previously presented in the August 2012 edition of this publication [1].*

**The Report Card has been published annually beginning in 1998. For the establishment of the specific topics of the report card, market research was conducted on the general topic of technology commercialisation and resulted in the selection of a number of critical success factors (a.k.a. topics) that were considered necessary for successful commercialisation specific to MEMS and to the MEMS industry. The report started with nine topics in 1998 and by 2003 it had expanded to 14 based on continuous reassessment of the ever-changing dynamics of the MEMS industry. The purpose of the report card is to provide MEMS industry participants with an objective assessment of these critical success factors over time and to act as a tool to help them better understand, respond to and exploit the ever changing dynamics of the MEMS industry. The MEMS Industry Commercialization Report Card has been developed not only to help assess the progress of the commercialisation of this technology but more importantly to serve as a vehicle to help guide industry participants overcome the barriers to the successful commercialisation of MEMS.**

The Report Card is unique in the technology commercialisation strategy sector and also to the MEMS industry. It has been widely published and presented worldwide since its introduction in 1998 and is widely accepted as a valuable tool for MEMS industry participants to create winning business strategies for their organisations.

### The Problem

It is interesting to note that MEMS technology established vis-à-vis the discovery of the piezoresistive effect at Bell Laboratories in 1955 by Charles Smith is approximately the same 'age' as Integrated Circuit (IC) technology established vis-à-vis the semiconductor effect that was discovered at the same laboratory by Bardeen et al. only a few years earlier. More importantly however, the total sales of MEMS as reported by numerous groups at the time was approximately 1/25th of the sales of ICs in 1998 at the time of the first Report Card. The MEMS market has been reported by several organisations to be approximately \$10 Billion (US) in 2012 whereas Gartner Research has reported that that total IC market was \$299.9 Billion (US) in 2012 (approximately a 30:1 ratio). Some positive news here is that the MEMS market has been reported to be growing over the past several years at a compounded annual growth rate (CAGR) in the 15-20% range where the IC market has remained relatively stagnant over the similar period. However, the question still remains: why is there still such a disparity in the market sizes?

### Barriers to Commercialisation / Situational Analysis

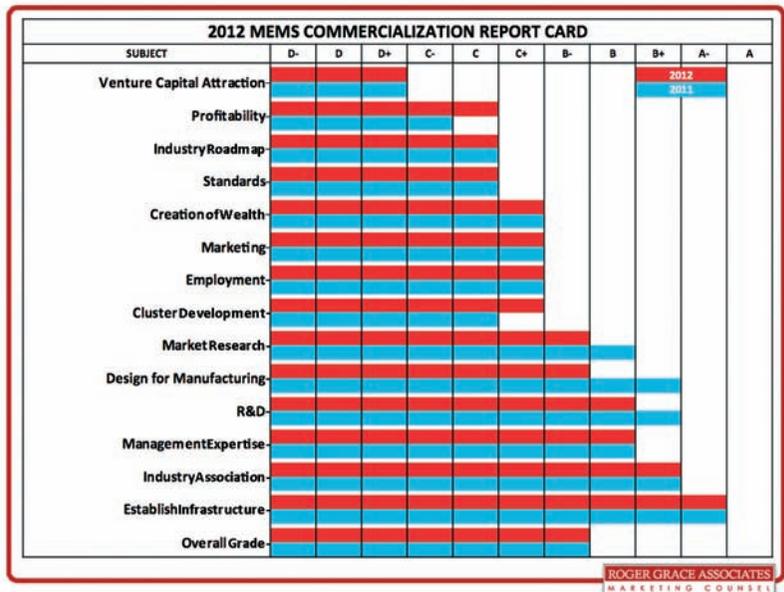
The following are considered to have been or currently are some of the more significant barriers to the successful commercialization of MEMS:

- *The extremely long period of time to commercialise a MEMS product is approximately 30 years [2].*
- *Only until recently MEMS has been plagued by the lack of high-volume applications*
- *There exists a lack of well-defined direction from roadmaps, industry standards and industry associations*
- *Multidisciplinary technology knowledge is required*
- *Packaging and testing costs typically are at 70% of total value, however, the focus has been (and continues to be) on devices not systems solutions [3]*
- *There has been a significant lack of focus on customer needs*
- *MEMS device suppliers are technology-centric and exhibit a technology push versus market/applications pull strategy*
- *Marketing programmes are either non-existent or are under-funded and/or ill-planned*
- *A lack of capital formation opportunities exist, investors are risk adverse; low IPO opportunity because of small sales volume levels*

2012 MEMS COMMERCIALIZATION REPORT CARD																	
SUBJECT	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	Δ	
R&D	A	A	A	A	A	A-	A-	A-	A-	A-	B+	B	B	B+	B	-1	
Marketing	C-	C	C+	C+	C+	C	C	C+	C+	C+	C+	C	C	C+	C+	0	
Market Research	C	B-	B-	B-	B	B	B	B+	B-	B	B	B	B+	A-	B	B-	-1
Design For Manufacturing	C+	B-	B	B	B	B	B	C+	B-	B	B+	A-	A-	B+	B-	-2	
Established Infrastructure	C+	B	B+	A	A	A	A	A-	A-	A-	B+	B+	A-	A-	A-	0	
Management Expertise	C	C	C+	C+	C+	C+	C+	B-	B-	B	B	B	B	B	B	0	
Venture Capital Attraction	C	B-	B+	A	C	C-	C	C+	C+	C	C-	D	D+	D+	D+	0	
Creation Of Wealth	C	B-	B+	A	C	C-	C-	C-	C-	C	C-	D+	C-	C+	C+	0	
Profitability	C-	C-	C-	C-	C-	C-	C-	C	C+	C	C-	D+	D	C-	C	+1	
Industry Roadmap	INC	B-	B	B+	A-	A	A	B	B-	C+	C-	C-	C	C	C	0	
Industry Association	INC	INC	INC	B	B+	B+	B+	B	B	B+	B	B	A-	B+	B+	0	
Standards	INC	INC	INC	INC	C	B-	B-	B-	C+	C	C	C	C+	C	C	0	
Employment	INC	INC	INC	INC	INC	C	C	C+	C+	C+	C	C-	C	C+	C+	0	
Cluster Development	INC	INC	INC	INC	INC	B	B+	B+	B	B-	C+	C+	C+	C	C+	1	
Overall Grade	C+	B-	B	B	B-	B	B	B	B-	B-	C+	C+	B-	B-	B-	0	

<< Figure 1: The MEMS Industry Commercialization Report Card was created in 1998 and annually provides an objective measurement using a market research approach of the MEMS industry's performance against 14 critical success factors. Source: Roger Grace Associates. >>

<< Figure 2: The 2012 Report Card established the continued under-performance of Venture Capital Attraction, Creation of Wealth and Marketing. Nine of the 14 critical success factors remained at their 2011 level. Source: Roger Grace Associates. >>



of companies with the exception of those addressing the mobile phone and other high-volume consumer markets

- Successive 'bubble busts' have occurred e.g. biomems, optical telecom, the results have created wary investors
- Markets are highly fragmented and diverse, many small companies, few large players
- Limited 'success stories' of MEMS companies; only a couple of MEMS companies have had IPOs.

However to offset this new market opportunities for large volume applications have recently emerged in the following industries: automotive, e.g. gyros, pressure; consumer e.g. oscillators, magnetometers, microphones, gyros, accelerometers and displays; point-of-care diagnostics; analytical instruments; infrastructure monitoring. The challenge is how to successfully overcome the existing barriers to the successful commercialisation of MEMS and to exploit these application opportunities.

### Research Methodology

Questionnaires were emailed to the audience of 378 names in the Roger Grace Associates database who have and continue to play major roles in the MEMS commercialisation process. These 'expert' participants represented a broad range of MEMS manufacturers, users of MEMS as well as individuals who represent companies engaged in MEMS infrastructure e.g. foundries, design software and equipment providers. Academics were not included in the research universe. The participants represented a worldwide universe with the majority of the respondents coming from the US and Europe. The members of the research universe were asked to rate the 14 critical success factors/topics using grades 'A' to 'D' using pluses and minuses where applicable. Additionally, they were asked to provide

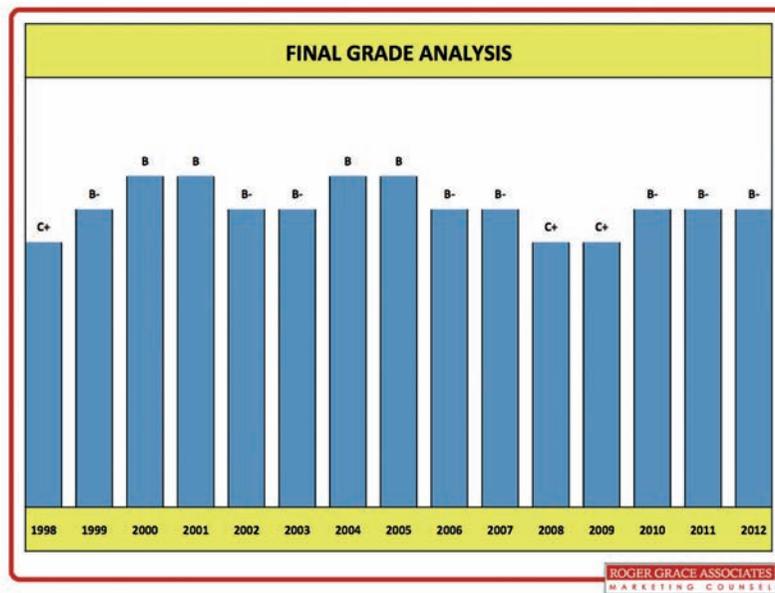
specific comments as to the rationale of their assigned grades. The 67 respondents constituted an 18% return rate versus the market research industry average of approximately 2% for a similar study. The collective experience of these 67 respondents was over 1300 years averaging out to approximately 20 years per respondent. Certainly this was an exceptionally well-experienced and well-qualified group of participants also known as 'experts'.

This research approach, known as 'Delphi', is based on having 'experts' in their respective fields as the research universe. It provides the best possible insight into a research topic where a statistically significant/projectable approach is not feasible. In comparison, statistically significant studies require a large number of respondents: 1067 to be able to establish results at a 95% certainty with errors in the plus or minus 3% range and 384 for errors in the plus and minus 5% range. As such, it was not considered a feasible approach for the conducting of this study.

### Results

Figure 1 provides the results of the 2012 MEMS Commercialization Report Card. A direct comparison between the 2011 grades and the 2012 grades is given in Figure 2.

<< **Figure 3: Final grades of the Report Card have gone from a low of C+ in 1998 and in 2008/2009 to highs of B+ achieved in 2000/2001 and 2004/2005. The level has remained at B- for 2010 to 2012. Thus it has followed the trend of the health of the general economy. Source: Roger Grace Associates. >>**



### Summary

The 2012 MEMS Commercialization Report Card provided an overall grade of B- to the 14 critical success factors for MEMS commercialization. The overall grade did not change from the grades of 2011 and 2010 (Figure 3). Increasing one grade level from 2011 were Cluster Development (C+) and Profitability (C). Reduced grades of one grade level were R&D (B) and Market Research (B-). A two letter grade decrease was given to Design for Manufacturing and Test (B-). Nine grades remained constant from their 2011 levels, which was a rather new outcome from previous years where results demonstrated a larger number of letter grade changes. The only subject to receive an 'A' was Established Infrastructure. VC Funding was the only subject to receive a 'D'. The grades established that marketing and capital formation continue to need major improvement and may be critical items in restraining the industry from realising its true potential. Capital formation for MEMS continued to be a major problem and has been significantly exacerbated by the slow emergence of the economy by the worldwide financial crisis of 2008. Additionally, most angel and VC investors continue their attitude of being 'infatuated' with social media funding opportunities at this time rather than those which are hardware-based.

I believe that the objective of the 2012 annual MEMS Industry Commercialization Report Card of providing a valuable tool for MEMS industry participants to objectively monitor the 'health' of the MEMS industry has been realised once again. I strongly recommend that MEMS industry participants should embrace the famous George Santayana quotation from his book "The Age of Reason" (1919): "Those who forget the past are condemned to relive it." The results of the 2012 Report Card should provide industry participants with valuable information to effectively help craft their business strategies moving forward.

For a more comprehensive look at the 2012 MEMS Industry Report Card, I recommend that you visit my website to see much more information including the extensive verbatim responses of the participants on each of the 14 topics.

### References

- [1] R. Grace, Barriers to the Successful Commercialization of MEMS: The 2011 MEMS Industry Report Card, Commercial Micro Manufacturing International, July/August 2012, [www.rgrace.com](http://www.rgrace.com)
- [2] R. Grace, S. Walsh; MEMS Industry Roadmap, Micro and Nanotechnology Commercialization Education Foundation Roadmap, Chapter 2, 1990, [www.mancef.org](http://www.mancef.org)
- [3] R. Grace, MEMS Commercialization: From the Lab...to the Fab...to the Market, Commercial Micro Manufacturing, January/February 2012, [www.rgrace.com](http://www.rgrace.com)

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**Part 2 of the MEMS Sensors article will be published in the July/August issue of Commercial Micro Manufacturing magazine.**