

Title	Coordination Method between Specialist of Nano-Materials and Non-Specialist in Nano-Industry
Author(s)	Inami, Nobuhito; Iwasaki, Hideo; Koyano, Mikio; Hori, Shinzoh Hide
Citation	
Issue Date	2007-11
Type	Conference Paper
Text version	publisher
URL	<a href="http://hdl.handle.net/10119/4132">http://hdl.handle.net/10119/4132</a>
Rights	
Description	The original publication is available at JAIST Press <a href="http://www.jaist.ac.jp/library/jaist-press/index.html">http://www.jaist.ac.jp/library/jaist-press/index.html</a> , Proceedings of KSS'2007 : The Eighth International Symposium on Knowledge and Systems Sciences : November 5-7, 2007, [Ishikawa High-Tech Conference Center, Nomi, Ishikawa, JAPAN], Organized by: Japan Advanced Institute of Science and Technology



# Coordination Method between Specialist of Nano-Materials and Non-Specialist in Nano-Industry

Nobuhito Inami, Hideo Iwasaki, Mikio Koyano and Shinzoh Hide Hori

School of Materials Science,  
Japan Advanced Institute of Science and Technology,  
1-1 Asahidai, Nomi, Ishikawa, 923-1292, Japan  
n-inami@jaist.ac.jp

## Abstract

Making a roadmap to a new business plan in nano-industry proposed here is one of the suitable examples of coordination method in current business. The roadmap is discussed here on the standpoint of a specialist of magnetism for the example. Most difficult but quite important points in the example are found in exact prediction to the timing of the technical developments and exact evaluation of the appraisal value as the business. The most possible method against these difficulties will be given by the cooperative discussion with the selected key persons including some excellent specialists in the enterprise. The two points in the method of collaboration to success the business are emphasized as the review.

**Keywords:** coordination, nano-industry, specialist, non-specialist, roadmap

## 1 Introduction

Business promotion of nano-industry has been considered to be quite important in developed countries. Especially, corporatization related to the ideas on science and techniques on nano-materials has been expected as a new hopeful direction of industry. The market size of the field is considered to be quite big. It has been estimated to be over several ten-trillionths yen in 2010 in Japan and the size in the world is considered to be several trillionths dollar. [1]. The activity of nano-industry now, in 2007, seems to be not so high except the researches supported by public funds and apparatus

industry related to nano-technology. In spite of studious effort, others are not so active, so far. Such slow development in corporatization makes us infer that there exist some obstacles to the research in key technologies to apply and the key technologies still have not been developed well, so far. Nevertheless, some developed countries wish to lead the industrialization of nano-materials and they are still investing big budget continuously.

One of the typical examples in nano-techniques is seen in the problems on Magnetoresistive Random Access Memory (MRAM). The most characteristic property of MRAM is in voltage driven magnetic memory action. The characteristics mean possibility of memory system without mechanical read/write-head system in magnetic recording. The techniques of MRAM have been expected to realize both nonvolatile recording and quick switching action by the electric signal. The high density memory which is larger than 1 terabit/mm<sup>2</sup> requires nano-meter techniques in lithography process. The technique of MRAM, however, seems not to be established well until now, 2007, because press release for the new basic techniques is still continued [2]. Considering such present conditions and situation, we can recognize it is good timing to discuss the coordination to make corporatization of MRAM problem. Thus, we will discuss about the detailed coordination method between specialist and non-specialist in nano-industry for the subject of "voltage driven magnetic memory system".

## **2 Background, outline of project and roadmap**

In order to start a new business, the most basic and important procedure is the preparation of flowchart along the time schedule of the business actions to the personnel program of industrialization and investment plan to support the business action. Here, we define such a flowchart along the time schedule as a roadmap. All business actions are tried to perform along the roadmap and some change will be also made under the basic spirits in the roadmap, when some unexpected conditions are appeared. Procedure of making roadmap is basic design to make a new business and we can see the most typical example of coordination procedures in the business action. However, it is quite tough to evaluate vendibility of the business seeds and moreover, exact estimation of the timing for various research and developments (R&D) in techniques is also quite hard. Such works are also difficult for usual specialist, because the works are belong to non-linear phenomena in complex system and only some limited specialists can perform the evaluation or estimation with high accuracy based on the rich experience in R&D. The degree of the accuracy of the evaluation is the point to success in the new business. The most possible method to clear against these problems is collaborative work joining with the limited specialists of technique, management and investment. Because the limited specialists. Hereafter, we discuss the method in detail by using a typical example of industrialization of MRAM.

### **2.1 Background and outline proposed on the standpoint of the specialist**

At first, we estimate the market size and evaluate the value of the techniques of MRAM. If the MRAM system produced by lithography techniques can realize the enormous capacity of nonvolatile memory with high-speed response in read/write actions, we can expect enough high needs in the field of IT-industry. The reason is easy to understand, if we remember the experience on merit and demerit in use of USB-memory. In fact, after USB-memory was introduced to the market, almost all floppy disk was replaced by the USB-memory within

several years. For the flash memory in USB-memory, however, the speed in read/write actions is not so high. Moreover, the flash memory is gradually destroyed in just proportion of the read/write actions. What is worse, the method of flash memory in USB-memory has severe limitation in the fabrication technique because of the electric brake down of the memory element. On the other hand, method of MRAM does not have such a difficulty. Thus, these objections make us encourage the making business plan of MRAM.

The key techniques in this plan are 1) establishment of the method supported by clear physical principle, 2) new techniques of nano-size fabrication. The development of first one is fairly proceeding now and is to be accomplished within two or three years. For second ones of nano-size fabrication, we also can draw the positive outlook. The lithography techniques are realized by using the combination of EB-lithography and imprinting method. Though the method is now confirmed only in laboratory stage, the method of production will be also realized within three or four years. Thus, we can consider that the business plan of MRAM should be the project for four years. The limitation of the size on the method is about several ten terabit/cm<sup>3</sup>.

Such enormous high-density memory can sufficiently answer to the requirement for the method of big capacity to the work like a 3Dimension-Computer Graphics (3D-CG). If these techniques realized, we also have highly efficient memory having nonvolatile high speed switching action. Such characteristics make us prepare new relation between CPU action and memory system. For example, physical position of CPU action need not fix in the special position in Si-substrate. For example, a different CPU action may be newly generated after some CPU-actions. If we hope to realize such exotic CPU action, the new computer architecture might be completely different from the architecture realized before. Because such a development makes us expect to generate new hopeful scope in computer science and techniques, we can expect the wide possibility of application to the related field. Thus, it is considered that the MRAM project is worth carrying out as a new project. The importance of these technical discussions is easy to

understand if he is technician, but non-specialists may not have enough understand.

## **2.2 Estimation of market size by the marketing section**

After the business leaders understand the big possibility of MRAM-project and its time relation along developing speed of the research on MRAM and the related techniques, the first work by marketing directors must estimate the market size which is the most basic knowledge to make the plan of personnel allocation along the time elapse and to decide the target of the investment. We can estimate the size of the market from the population of the computer user. We may consider the population of computer user is proportional to the working population and the mean ratio of the working person is about 1/3 to the population. If MRAM comes out to the market, all people will replace the memory by MRAM, as seen in the relation between floppy disk and USB-memory. Thus we can estimate the size of the market and the size is approximately several trillions dollars in world, if the price of the MRAM is about one hundred dollar per one MRAM memory system. If the required market size is realized for five years, the mean market size in one year is about 1 trillion dollars. After elapse of the initial stage of the market, amount of required size is to be reduced and the size is proportional to the number of the replacements. The stationary demand of the memory system may be considered to be about 10% to the initial market size, when we assume that the period to replace the computer is ten years. Thus, stationary size of the market after five years from the initial release is approximately to be 0.1 trillion, if no other development is not appeared.

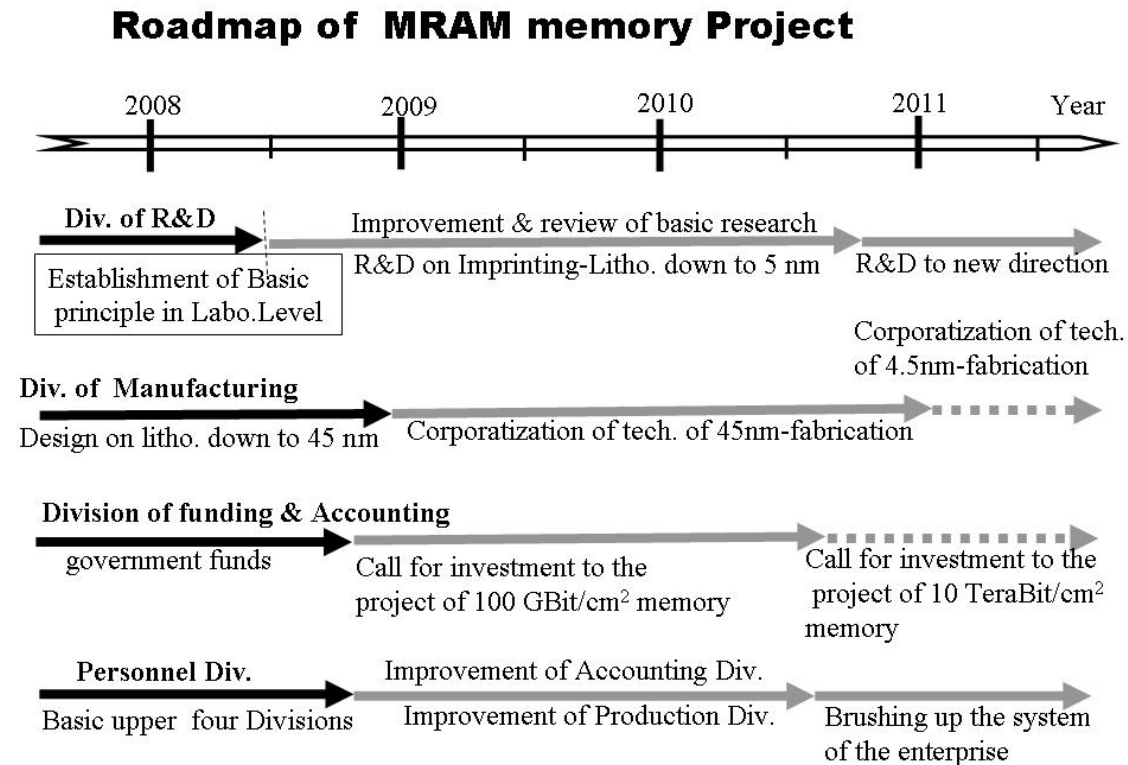
The estimation method of market size shown above is quite general one. Provably director and capable members in marketing section may have more detailed characteristics of the market. For example, knowledge of time elapse and regional characteristics for the market are the expected ones to the marketing section. They

are absolutely necessary and important information to make business plan or financial plan. Such knowledge can be obtained only by watching market with high sense and rich experience.

## **2.3 Making a roadmap and business plan: An example on MRAM memory system**

To realize the business plan, making a suitable roadmap is the first important procedure. Considering basic techniques of MRAM are incomplete and moreover, some periphery techniques should be developed, multiple capable specialists should join to make the business planning. Especially, technician of lithography is necessary to design and establish the high efficient facility and has adequate discretion to the developing direction of the related research. Assuming the leaders of entrepreneurial team can already have such excellent technician team, we try to draw the roadmap of the new MRAM-project in Fig. 1.

There exist two important turning points to decide the direction of the business plan. The first one is the timing at the beginning of 2009. The important thing in the timing is more exact prospect to the method in practical application for 45 nm fabrication. Probably the result of the research will give them positive conclusion, because the research on the basic techniques in the fabrication has been already successful in laboratory level now in 2007. The second one is just the timing before 2011. The final decision done in the second turning point will include really important original direction in nano-fabrication, because the clear direction of the basic method has not been obtained now in 2007 except imprinting method. Because the imprinting techniques are completely different from photolithography techniques, there exist many problems to be solved. However, big profit will be promised, if such difficult but original work will be successfully accomplished and monopoly on the original technology is retained and if the business operation is performed under the suitable corporate strategy.



**Figure 1:** Roadmap to make business promotion to the project of high density MRAM memory. This roadmap is made from the discussions in 2.1 and 2.2. Broken arrows after half year in 2010 means that the business actions will be performed after confirmation of the success in research on basic techniques of nano-fabrication, because the techniques has not been established now, 2007. If the techniques of the fabrication do not success until the year, reviewing or change of the overall plan should be reappraised in the board meeting in the enterprise.

### 3. Points of coordination and conclusion

The roadmap in Fig. 1 of MRAM project can be made on the discussions in the sections of 2.1 and 2.2. The roadmap represents relation between investment and other key conditions along the time schedule to realize the new business. If the estimation of the commercial value of the techniques and the timing of the completion of techniques are more exactly performed, much more profit can be obtained in the business action. The time schedule in the roadmap in Fig. 1 was given by one of the present authors (Hori) who is a specialist of magnetism. But he is not specialist of magnetic recording and accuracy of the decided timing is

not so exact. Especially, it is quite difficult for usual R&D members to evaluate more exact timing of completion on the key technology. Only some limited specialists have such a talent of prediction. However, such a excellent specialist is usually indistinctive. If the leader has enough power of discerning to the specialist, such difficult procedure is not so hard to carry out. One of the hints to find the excellent specialist is seen in the facts that almost all researchers around him is usually esteemed as a researcher and they are usually quite faithful to science and techniques. It is the point of the coordination method that we want to present here.

Especially, it is quite desirable that the board

meeting by the members with well-balanced sense will make the most possible decision. Such collaboration also gives the broader perspective to the members in board meeting. The knowledge in each division is usually dogmatic and does not lead to flexible decision. The flexible and broader perspective is mainly obtained from the collaborative work in the discussion site of "Ba" in Japanese. The sense obtained from the collaborative work also leads to adequate strategy of investment against the fluctuating economic conditions. Once evaluation to the current commercial value of the relevant product and the value of the developing techniques, the personnel plan and amount of investment can be calculated straightforwardly following the standard method. The work of the estimation referring the usual data is not so hard. For the collaboration, what is decisively important is that divisions are not only excellent in their own work, but also flexible in interdivisional cooperative discussions.

When the leader in an enterprise is required to decide a big investment at some important timings, collaborative discussions by the excellent specialists in R&D division and non-specialists of the marketing and funding divisions are necessary in order to obtain more exact solutions. To make such cooperative work effectively, directors, managers and leaders in the enterprise should have enough capability to accept other professional opinions. Especially, the business leaders should have special ability to recognize the deference between authentic and usual specialists apart from their position title. The capability is usually cultivated by the attitude to upgrade the quality of daily life including knowledge of science and technology. Recent developments of e-learning and other

education software are quite helpful to cultivate the capability. Their attitudes in the daily life are also required change in life stile to enjoy scientific news and events. Thus, the second point of the successful collaboration is the method of upgrade the discerning eyes to fined out the excellent specialist. Especially how to look for the excellent specialists in the own R&D system is quite big points in the procedure. The suitability of the selection depends only on discerning of the business leaders. Once the leader chose the board meeting members, the fate of the enterprise is completely depends on their decisions. But who choose such an important leader in the enterprise? Provably, some democratic selection by investors, all working staff and managers with some suitable weight of right is the most appropriate method to the successful business.

### **Acknowledgment**

This work is partly supported by a 21st century COE program called "Scientific Knowledge Creation Based on Knowledge Science" by Japan Advanced Institute of Science and Technology.

### **References**

- [1]. The report in 2001 by Nippon Keidanren, <http://www.keidanren.or.jp/japanese/policy/2001/0.14.html>
- [2]. Press release by National Institute of Advanced Industrial Science and Technology, [http://www.aist.go.jp/aist\\_j/press-release/pr20040302.html](http://www.aist.go.jp/aist_j/press-release/pr20040302.html)