

The Internationalization of R&D and its Offshoring Process

Jianlin Li, and Jizhen Li

Abstract—Transnational corporations (TNCs) are playing a major role in global R&D, not only through activities in their home countries but also increasingly abroad. However, the process of R&D offshoring is not yet discussed thoroughly. Based on in-depth case study on Agilent China Communications Operation, this paper presents a stage model for theorizing the R&D offshoring process. This stage model outlines 5 maturity levels of organization and the offshoring process: Subsidiary team, Mirror team, Independent team, Mirror sector and the Independent sector (from software engineering point of view, it is similar to the local team's capability level of maturity model). Moreover, the paper gives a detailed discussion on the relevant characteristics, as well as the ability/responsibility of transfer, priorities and the corresponding organization structure. It also gives the characteristics and key points of different level's R&D offshoring implementation using actual team practice.

Keywords—Internationalization of R&D, R&D offshoring process, Multinational Corporations, Organization Level.

I. INTRODUCTION

MNCs (Multinational Corporations) from developed countries or regions have speeded up the progress to transfer their R&D activities into China since Nortel Networks Corporation and Beijing University of Posts and Telecommunications jointly set up an R&D centre in 1994, the number of TNCs' R&D laboratories in China has been growing steadily. In 1998 Microsoft established its first Asia Research Institute (its second overseas base) in Beijing, China. Ten years later, in 2008, the Microsoft planned to double the number of full-time Microsoft research employees up to 3,000 by 2010, in addition to the current 1,500 project-based researchers in China. For another, the Motorola has invested in China about five hundred million dollars on the R&D up till now.

At the end of the year 2008, the MNCs had established about 1000 various R&D organizations in China, involving many areas such as computer, communication, electronics, chemical, automobile and medicine. There are also lots of MNCs that are coming or will come to China to have their R&D bases.

Following the external trend that MNCs are transferring their R&D activities into China, there has been extensive discussion on the motivation, location determinant of R&D offshoring and its impact to host countries.

Relevant researches show the MNCs' main objective

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investing on R&D in China is to remedy their self strategic defect, to enhance their competition in China, to use China's intellectual resources and to realize the global connection in R&D. The final goal is to adapt the MNCs' global strategy. For these reasons, they treat China's R&D as the conjunction of the global R&D, and use the global R&D resources sufficiently to realize the global R&D integration.

Yet MNCs have not attached much weight to understanding the implementation process of the R&D offshoring. It is hard to estimate the process and the strategic points when they are implementing localization in China. In this paper, we are going to analyze and conduct the pace of the R&D offshoring in accordance with Agilent's case in Beijing, China.

II. LITERATURE REVIEW

The topic of foreign R&D was noted by a few academics in 1970s [1], [2]. By the early 1990s, both growing numbers of academics and national statistical officers showed heated discussions in the internationalization of R&D [3].

There are various forces and developments that have made MNCs to outsource and internationalize their R&D activities. The developments can roughly be divided into pull forces that have made internationalization and outsourcing an attractive alternative for organizing R&D operations and to push forces that have made it necessary for companies to internationalize and outsource R&D

R&D/technology transfer is a dynamic process between the source and recipient units consisting of four stages: initiation, implementation, ramp-up and integration [4]. While the first two stages comprise all events that lead to the decision on transfer and the actual flow of technology from the source to the recipient, the latter two begin when the recipient starts utilizing the transferred technology. Clearly, pure transmission of technology from the source to the recipient has no useful value if the recipient does not use the new technology. The key element in technology transfer is not the essential part of (original) technology, but rather the extent to which the receiver acquires potentially useful technology and utilizes this technology in its own operations. Technology transfer may lead to some change in the recipient's behavior or to the development of some new idea that leads to new behavior [5].

Dunning's (1988) proposed that foreign direct investment (FDI) is a function of ownership advantages, internalization advantages and locational advantages [6]. Whereas the ownership advantages explain which firms will be involved in foreign markets, and the internalization advantages explain whether foreign market involvement will take the form of

direct investment, the locational advantages seek to explain in which country's market such investments will take place. Dunning (1988) further added that the locational advantages would vary depending on the nature of the task that the firm intends to perform in the country and that such advantages derive from the comparative advantage of countries [6].

Although the vast majority of R&D is still performed at home by developed-country MNCs, R&D is increasingly performed globally and collaboratively, driven by market and costs factors. Increased and more dispersed FDI in R&D-intensive industries [7] and emerging global R&D management strategies [8-10] imply the need to complement information on international R&D production, and funding with international transactions statistics.

MNCs are no longer seen as repositories of their national imprint but rather as instruments whereby R&D is transferred across subsidiaries, contributing to technology development [11], [12]. A common theme in this line of research is that MNCs can develop technology in one location but exploit it in other locations, implying the internal transfer of technology by MNCs. Thus, the competitive advantage that MNCs enjoy is contingent upon their ability to facilitate and manage inter-subsidiary transfer of technology.

The MNCs have already set up many R&D organizations in China. Most of them claim they have transferred the important technologies to branches in China. There are also lots of MNCs that are coming or will come to China to choose cooperative partners as their R&D domestic base.

Based on study of the R&D centers or Sino-foreign cooperative enterprises of MNCs in China, especially in-depth face-to-face interview on Agilent China Communications Operation, this paper presented a stage model for the R&D offshore.

III. AGILENT AND ITS R&D IN CHINA

A. Introduction of Agilent

Agilent is a high-tech multinational company separated from HP Company when making strategic reorganization in 1999. Agilent provides clients from 110 countries with the important electronic and bio-chemical analysis and measure tools and plays a leading role in electron, communication, life science research, environment, petroleum and chemical industry. It emerged from a small garage in California and developed into becoming a MNC with 19,000 employees worldwide. With setting up branch organizations in more than 30 countries (regions), Agilent received about 2/3 of its income from outside the United States in 2006.

In Agilent, each business unit has independent R&D department, sales/marketing department and production department which is in charge of the relevant global business interactions without preserving the company-level R&D center. The R&D organizations in each business unit generally contain a series of departments with each being in charge of the development of one series of products. Besides, each department sets the project teams. When a group is in charge of

one or more products (or components) development, there will be some technical experts in charge of the important problems in the technical aspect.

B. Agilent in China

China is Agilent's most important overseas market except its native market in the US. Since 2004, China has replaced Japan to become Agilent's second largest market in the world. The development of Agilent in China dates back to 1977 during which HP's founders, Bill Hewlett and Dave Packard, established relations with China's senior leaders. Now, Agilent has nearly 1300 staff members in China, 3 joint ventures, 2 Sole-source investment enterprises. Its business in China involves software and hardware R&D, manufacture, marketing, sales and service support with administrative agencies set in 8 key cities including Beijing, Shanghai, Guangzhou, Shenzhen, Chengdu, Xi'an, Shenyang and Nanjing.

Agilent China Communication Center was set up at the end of 1999. As a sole incorporated unit, it has turned from Agilent into a sole proprietorship company through continuous investment and development in many years. The number of employees rises from more than 10 to 230. Agilent China Communication Center began as a unitary product R&D and now is in charge of developing and designing a variety of advanced communication software for both China market and the global market.

Agilent China Communication Center is different from other R&D centers of the company. It does not belong to any sole business unit while its R&D departments respectively belong to different business motion units.

IV. AGILENT'S MOTIVATION OF R&D OFFSHORING AND LOCATION OPTION

The motivation of Agilent's R&D offshoring can be concluded into 2 parts basically, i.e. market oriented and resources oriented. Actually, when planning R&D investment, Agilent has to consider a number of factors including the outcome led by multiple factors.

When coming to the background of the establishment of the China Communication Center, president Gail of China Communication Center briefed that the consideration mainly comes from two aspects at that time, one is the need of the market, "the sales income in Asia Pacific then had already taken account above 30% in the company's global income, and more and more customers, including Ericsson, Nokia, MOTO, etc, are all preparing to transfer their production lines and R&D projects to China. The marketing department of the company forecast that the position of especially China in the global market will rise sharply in the coming years." The other aspect is the requisition of low cost as the president explained, "China's large number of cheap scientific research personnel is also an important reason of absorbing companies to invest." Considering the need of the company's long-term development, and the key role China has played in the process, Agilent finally decides it must begin large-scale investment in

China including R&D organization establishment and R&D offshoring.

The advantage of location is often the important component of the motivation behind the R&D offshoring. In the view of Agilent, the huge market potential in China and the low human resource cost is more attractive than those in other countries and regions, which explains Agilent's motivation to transform R&D to China.

V. THE IMPLEMENTATION AND LEVELS OF THE R&D INSIDE AGILENT

Nine years after Agilent China Communication Center was founded, the number of employee has grown from approximate thirty people in the very beginning to more than two hundred people now. Its growing process is the same as the R&D offshoring brought in by each business operation unit to China.

A. Conceptualizing the R&D Offshoring Model

The R&D offshoring can be clearly classified into five levels according to the degree of developments of organizations aiming at promoting research and development interrelations and the diversion of responsibilities of interrelated products. In short, a complete process of R&D offshoring, the interrelated technology ability and the responsibilities of products can be divided into the following respects:

- Business strategy;
- The long-term development strategy of products;
- The releasing plans of product versions;
- Project management capability;
- Product development capability;
- Products support and maintenance.

TABLE I
 THE R&D OFFSHORING LEVELS

R&D offshoring Levels	Responsibility/capability					
	Business Strategy	Product's long-term Developing Strategy	Product Version Release Plan	Project Management	Product Development	Product's Support and Maintenance
5 Independent Sector	○	●	●	●	●	●
4 Mirror sector		○	●	●	●	●
3 Independent team			○	●	●	●
2 Mirror team				○	○	●
1 Subsidiary team						○

B. Subsidiary Team

Subsidiary team is the lowest stage of R&D offshoring. In the first place, local R&D personnel have limited knowledge about the final products. Moreover, they also lack in-depth understanding of the position of the work for the whole products. The work is led and arranged directly by the project manager in the headquarter. The main object of transfer is to reduce cost and to increase more labor input, so as to meet the increasing demand.

The task of this stage consists of some simple coding and unit testing works. Communication mainly occurs between the headquarter's manager and the corresponding local R&D header clarify the needs, to communicate about the process and

to evaluate the performance of each R&D personnel (restructuring the sentence). On the contrary, the local personnel does not communicate among themselves. As the work of this stage is often simple and small-scale, it can usually be done individually (to some extent ensure the lower risk). As there is no interdependent relationship between local staffs, the possibility of the local R&D personnel to communicate with each other for the reason of work is low.

During this stage, the key to success is the technical capacity of local staffs and their accurate understanding of the situation. Since the work is simple and small-scale, there is no control on the process of project development, the headquarter gives no systematic training to the local R&D personnel. So the original personal technical capacity has important effect in the project's successful implementation.

In terms of the organization structure, there is no local project manager, and all works are arranged by the headquarter's manager directly. The figure below shows the reporting relationship during this stage. As there is no team in the real meaning, it uses the dotted line frame to show every team.

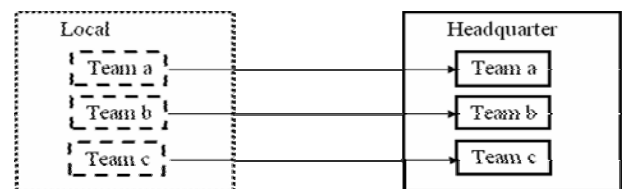


Fig. 1 Organizational linkage between the local task units and the headquarter departments at the subsidiary team stage

Case One

At the beginning of 2002, the ASD of Agilent China Communication Center established testing tools groups. The main function is to imitate the topology producing customer's internet, to define the relevant characters of the chain circuit, to pour flow and to imitate the typical calling model. These kinds of testing tools have already accomplished the main parts' development and tested by North Queensferry's R&D headquarter in England and are used inside the department with a half year on probation before. When it was on probation, the most important problems were that the internet topology structure was formerly defined; and the kind of calling model could not meet the needs of the testing made by each project group; and the entire project groups seriously needed more types of internet topology structure and calling models in testing. The homeland headquarter fell to put enough labors to meet the numerous needs in short time.

After finishing the main parts of the testing tools, the definition of internet topology structure used for testing, the grammar, the structure and the models had already been given a precise definition.

In order to meet the need required by each project team, the ASD, as supplement of R&D headquarter, has set up the testing tools group including 3 engineers without project managers.

The staff of the project begins to work after experiencing 1 month's training. They code according to the need of the word defined accurately and carry out unit testing. Then they hand in the result to the project groups of the headquarter to integrate and release. Each of the project members reports directly to the project manager of the testing tools group in North Queensferry's R&D headquarter in England.

This project team was set at the beginning of year 2002 and was dismissed at the beginning of 2006. During this process, the number of the member had raised from 3 to 5. A position of local project manager was appointed for a short time, but the position was later abandoned. Then the number of the employee was gradually reduced to 1 and at last the only one member was also dismissed. The main reason was that, with the development of the item, varieties of the main internet topology and the typical calling models had already been finished, and all testing engineers affiliated with the project teams had mastered the competence of designing and making the topology and models with special needs on their own. The dependence on the testing tools groups was gradually reduced and eventually disappeared.

From the experience of this group, a typical supplementary group, it showed that even though the group tried to grow, it fell to develop into the mirror group at last. In the view of the R&D offshoring, assessing the supplementary group alone, the process of R&D offshoring was finished successfully. The characters of the R&D offshoring are mainly following:

1. The needs occur suddenly. They emerge and grow quickly so that more human resources are needed to accomplish the missions;
2. The mission, which can be clearly defined, checked and accepted;
3. The low level of difficulty of finishing the mission, and the need of large labor power investment;
4. Clear circuit. That the subsidiary group accept the arrangement of their work directly, needn't to be in charge of the estimate on the mission;
5. The mission accomplishment mainly relay on the subsidiary group members' technical capability with small need on the control of the circuit and communication.

C. Mirror Team

With technical accumulation and expansion, the local team now has a better capacity of conducting R&D programs and is given more R&D tasks in order to release the need of technical staff in the headquarter. In the headquarter, when a product is completed and delivered to its users, or when a product enters its final stage of R&D, issues such as customer support and development of new features are gradually transferred to the local team, allowing the headquarter to release its related technical staff to join in R&D of new products. During this phase, the local team needs to receive systematic training to obtain in-depth understanding of the product and to acquire necessary technical knowledge (such as C++, NET, etc). It is also allowed to access the source code library of the headquarter to visit relevant codes. A complete software

development environment (including fault reporting and tracking system, version control systems, etc) will be gradually established.

A local Project Manager is required in this phase because local assignments will be managed by him, not by the Project Manager from the headquarter any longer. The assignment is set in a clear demand from the Project Manager of the headquarter. Then the local Project Manager organizes the personnel to elaborate and estimate it, and confers with the headquarter on the requirements of time, personnel and the quality of the work. The local team also needs to develop a work plan and to arrange the personnel to carry out their plan. After the testing, the product will be transferred to the headquarter for further testing. In addition, sometimes the local Project Manager is required to build up the local team, including recruitment, training and performance evaluation. (The specific quota and type of the recruit are decided by the headquarter.)

The process implementation becomes the focus in this phase, and there is a clear process definition of each work. Generally the local team does not take the work of setting the process, while it will be done by the Project Manager of headquarter who monitors the progress of the local team and ultimately takes the responsibility for the entire project.

The communication between the local team and the headquarter on various matters including clarifying the requirements and reporting the progress is mainly done between the two Project Managers. Due to the interdependence among the local staff's work, there is a substantial increase in the communication between the local teams.

The key to achieving success of the project in this phase includes whether the local team can conclude an effective process and make a timely adjustment based on the specific implementation. To guarantee the successful implementation of the process they should train their personnel with gradual practices and promote them with rewards or punishment. Furthermore, because of the increasing channels of communication, how to guarantee the timely and effective communication turns out to be an important factor that may affect the result of the project.

From the organizational relationships of view, the local personnel form a team and a local Project Manager has been set, but he is required to report to the Project Manager of the headquarter who ultimately takes the responsibility for the project budget, the arrangement of the funds as well as the results of the project plans. Since the headquarter does not understand the ability of the local team very well in this phase, the headquarter keeps a close control of the latter including managing the microcosmic affairs. As the important posts are set both in the headquarter and the local in this phase, this phase is called as "mirror team".

The difference between this stage and the former one is that the local team has relevant technical capability and can engage in the preservation maintenance of product, the development of new features, the procedure of items adaption and the development of contract word kind. Project manager in the general headquarter allocate assignments to the local

development staff by contract. The local workers finish the designated assignments according to the development contract and hand in the tenders specified in contract which are generally code documents, illustration word, text result, and so on.

In the organization structure, the MNCs don't set up project manager in the local generally. All the work is assigned by the headquarter manager through contract. The crux in this stage is the use during the software development process and the transition from workshop-kind produce to scientific management. The Fig. 2 below shows the report relationship in this stage. Because local teams aren't set up in the truly sense, each local team is showed by dotted line frame.

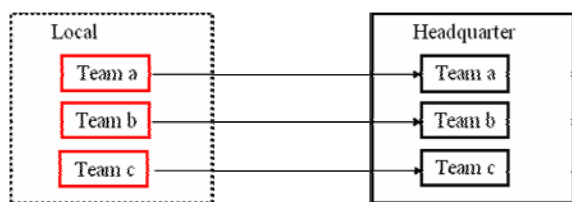


Fig. 2 Organizational linkage between the local task units and the headquarter departments at the mirror team stage

Case Two:

Taking the above ASD as an example, it set up the Core-Access7 software preserve project group at the end of the year 2004. At the beginning there is only one project manager, one edition manager, three technical directors (one of which is also the edition manager), six software development engineers, one testing engineer --- totally 11 persons.

Meanwhile, the R&D headquarter in England still retain the Core-Access7 software preserve project team, including project managers, edition managers, technical directors, software development engineers and testing engineers for 9 in total. This project team is functionally equal with the Beijing project team, but any serious customer problem and the release of the Core-Access7 upgrade package are wholly within the jurisdiction of the headquarter project teams.

The Core-Access7 product is ASD's traditional products, whose development process began at the year 1994 and is jointly developed by the headquarter in England and IPL Company. The product series include three main products called Troubleshooting, Surveillance and Platform7. Their main functions are providing monitor to the traditional telecommunication and moving7 signal command internet, the whole internet status controlled, the methods of fast discriminating and settling the internet fault. It provides the tools and means of monitoring any calling and communication in the internet in which proper operation of internet is not affected. The products series are the most important product in this series of ASD and are the main profit products at present.

After the accomplishment of the R&D of the series of the Core-Access7 product, customers have covered all the main telecommunication operators in the globe, including AT&T, Sprint, Verizon Wireless, Rogers, Vodafone Group, NTT

DoCoMo, T-Mobile, Orange, Telstra, and so on. The following preservation of Core-Access7 product and Core-Access7 upgrade packages are important income in ASD.

After the software preservation group of Core-Access7 product was set up in Beijing, each member's role and the relevant role in the headquarter R&D in England is peer to peer. The work is tentatively divided by the project manager of headquarter and coordinates with the project managers to make arrangement. Bilateral members in project groups need to communicate fully on the technology and products with the corresponding role. Meanwhile, they also need to finish the relevant assignment inside the project team including communicating and interacting with the marketing staff and the customers service staff.

With the increasing work complexity, the demands of the project team rise obviously and the acquisition of the capability on the technology of the staff in project team is high. As for the whole project team, clearance, integration and implementation of the circuit mechanism are needed to ensure the smooth development of the work and the effectiveness of the communication.

In order to ensure the right order for the development work together with timely and smooth communication, the main process of the software preservation group includes weekly funnel review process, defects prioritization process, hot binaries process, hot fixes process, enhancements development process, maintenance pack test process, maintenance pack release process, and so on.

Analyzing the experience of the Core-Access7 software, the project team of the R&D headquarter made meticulous guide, arrangement and monitor, to make sure to accomplish the mission successfully in this project; the characters of the R&D offshoring are mainly following:

1. The technical relief is complicated, requiring formal and relatively long-time training and practice;
2. The amount of information of the communication and the frequency of communication increase dramatically. The communication changed from former simplex carrying out the order into some complicated communication net among each member of the group inside the native and the relevant joggle men of the headquarter, the relevant general manager and other project teams;
3. The circuit increases in order to make sure the work goes on smoothly, varieties of processes are used. Meanwhile, in order to make sure the communication goes on smoothly, the communication channel, the method and the time and so on are arranged though the circuit;
4. The headquarter intervene in the local work varying between scale and degree. The project teams in the headquarter go on guidance and requirement in accordance with the aspects of situation, the work arrangement, the process, the method and the technology on the local circuit;
5. Correctly handling the relationship between the two teams is needed in order to avoid the problem of competing resources that may impact team cooperation.

D. Independent Team

When the headquarter begins to fully trust in the local staff's capability and competence, and hope the local team can make more contributions and bear more liabilities simultaneously, it will ask the local teams to join and undertake the development of the core product independently, and they may include all the stage work of developing the life cycle in order to release more technical staff to engage in the following product R&D and cut down the product R&D cost. At this moment, the local teams are similar to the component factories, which independently provide the end-to-end product or settling plans. But from relation with the headquarter, the difference now is that the local teams are no longer in touch with the relevant R&D teams of cooperative development in this stage but are closely cooperating with other functional departments (marketing departments, sales departments and so on) in the headquarter.

In this stage, the staff in headquarter do not take part in the specific works any longer and each stage of the development of life cycle is completely accomplished by the local staff. The staff in the headquarter need to discuss with the marketing department and even the final user, to understand the customers needs. They need to discuss with the sales staff to make sure that the sales and announce dates. They need to discuss with the full experienced design teams about the need of design and text and to make definite systematic framework and text plans. They also need to discuss with the customer service department, to make clear about the problems and influences on customers site.

Communication in this stage still plays an important role. In the mirror team stage, the communication often happens inside the R&D team, the headquarter project managers take on the mission of communicate with other departments. All problems and information are transferred to other departments of the headquarter and are dealt with by the headquarter's project managers. Then the results will be transferred the feedback to the locality. During this stage, all communication needs the local staff to contact with the staff of different functions from the headquarter directly. Therefore how to enhance the inter-communications and avoid language misunderstanding becomes the key in this stage.

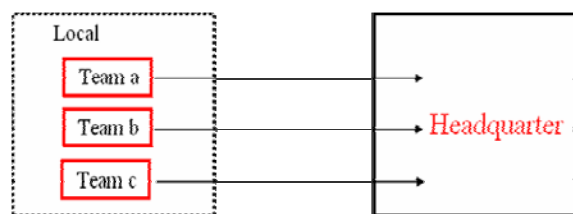


Fig.3 Organizational linkage between the local task units and the headquarter departments at the independent team stage

On the organizational relation, the independent local teams begin to report to the department managers of the headquarter. The headquarter no longer makes top-down control of the local affairs. Instead, they mainly use the macro aim management. The following Fig. 3 shows the report relationship in this stage.

Case Three:

This case is about the Core-Access7 software preservation project team of ASD.

According to the adjustment in the business of the departments of telecommunication at the beginning of 2006, more investment is needed by those new businesses; and the cost of those traditional businesses needs to be reduced. So the executive leaders plan to make the Core-Access7 software preservation project team an independent team.

The process of making the team a separated one includes giving the members of the Core-Access7 software preservation project team newly explored projects gradually. The final goal is to replace the former headquarter and to facilitate the access of the local Core-Access7 team to the marketing staff and customer servicing staff. Each of the team members is authorized to be in charge of making, revising and implementing the working process individually. Also, they will have the ability to apply for allocating hardware resources, and deal with staff recruitment and training by themselves.

From the start of the plan at early 2006 till early 2007, all the transitional work has nearly been done successfully. The number of member in the local program team had increased from 11 to 16. And only a few members now are staying in the headquarter. So the goal of transition has nearly been reached.

In the process of forming an individual team, the features of the technical transition are as follows:

1. The key point is not simply the transition of technique itself, but is whether the technique and relative knowledge can be acquired and put into practical use properly.
2. The independent team formed during the process of the technical transition must be put into action from the top level to the basic level. Due to the lack of essential motivation, it's hard to run the process through the project itself.
3. Some of the invisible techniques are hard to shift. It includes market, the access of customer service, and building a reliable cooperative relationship, etc.
4. The pressure on the team members increase and the former firewall and shelter harbor has gone. So it is necessary to face the pressure of connecting with other teams and clients.
5. Core members of the team are very important. In the past processes of concluding the program, some core members of the team has accumulated many related skills and experiences. These members' status has an enormous influence on the process and outcome of the program.
6. Coordinating with other projects and teams is crucial. And it's always the important factor which devotes to the result of the work.

E. Mirror Sector

At the beginning of the R&D offshoring, the connection with the headquarter is often directly made between each R&D team and each functional department relatively independent.

With quite a few part of the local teams going into the independent team stage, the coordination and communication cost gradually rise, the repeating communication and work become more and more, and the R&D efficiency decrease. Also

relevant team will have similar local needs, such as the localization of R&D support system, organizations trained locally, unified management, coordination, and so on. Therefore, the organization of local teams to form department is needed for the purpose of resource sharing and management integration. In this stage, the relevant strong local teams are organized to form the local departments and to establish the relevant management position and R&D support function.

In this stage the main context of the work has no difference on the R&D aspect, and still implements the product development independently. But the department manager position is set locally. The local department managers are in charge of the assessments on local project managers through gathering the rate of accomplishment of the process, and then report them to the headquarter, establishing the local R&D sustain system and helping to manage and support the local R&D (the sentence structure needs to be restructured).

On the organization structure, each of the local project group directly reports to the local headquarter, no longer to the headquarter. But the local departments still need to report to the departments of the headquarter. The following Fig. 3 shows the report relationship during this stage.

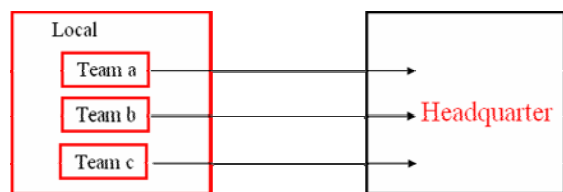


Fig. 4 Organizational linkage between the local task units and the headquarter departments at the mirror sector stage

Case Four

Company China Communications Center's ASD has 4 project groups in the stage of independent teams, with 1 project team staying in mirror status. It disposes the R&D sustain group, provides 15 sets of labor equipments at the price of more than 3 million dollars, sets up the functional positions such as department manager, training manager, human resource staff and has already exercised the progress design independently. It has the right and capability to allocate the resources among the project teams including asking the project teams inside the departments to coordinate and then make sure the superior missions of the departments implemented preferentially.

The main duties of the division manager are multiple: 1) to set up relevant project teams according to the policy made by the headquarter; 2) to allocate human resources and equipments to each team; 3) to control and master each team's rate of process; 4) to report to the headquarter about the process situation at key checkpoints; 5) to make decisions in the department business range; 6) to be in charge of each project manager's assessment and examination, to manage the R&D support group and the mission of training the managers.

The formation of the mirror status department is the inevitable result of the development of the team scope. When

each project gradually completes R&D offshoring and change to higher levels, it is needed to integrate coordinate, to manage the project groups and then to produce the need of set up departments. The features of the R&D offshoring formed in mirror status departments are mainly as follows:

1. The installation and allocation of relevant staff become the key points.
2. Each report relation among the project managers changes directly
3. The mirror departments need to report to the headquarter on their work, whereas the headquarter still take in charge of the finance and personnel.
4. Inner department has the right to allocate resources to ensure to implement the preferential mission priority.
5. The resource line and product line may cause the superior conflict, which impacts efficiency.

F. Independent Sector

When the long-run evolution tactics of products and relevant framework design of products also transfer to the China, the local departments have had all technological and business responsibilities of the products. The local department then can do business as an independent sector/department. If equipped with local market and salesman, this department may get a further step to grow into a business unit, it may keep separate accounts of the products' profits in globe, and it may become business center. Such a unit is no longer the outcome of the R&D offshoring.

As the local department take in charge of the whole course of the total product life cycle in this stage, there is no need to report to headquarter's relevant R&D department. Instead, it turns to report to the headquarter's R&D center. Owing all the decision rights of the products including technology and business, the local department can decide the personnel fit locally, the allocation of human resources to do the next generation's development of this kind of product, and so on.

At the present stage the Agilent China Communication Center still hasn't reached to the level of the independent department grade. It needs to continue to develop, with he help of rapid growing China market.

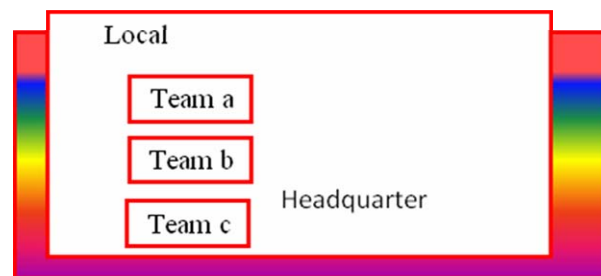


Fig. 5 Independent Sector stage

G. Conclusion

Now it is time to conclude the above Agilent R&D offshoring level model from the R&D offshoring of Agilent

China Communications Center. There are 5 levels in a complete R&D offshoring based on product, namely, Subsidiary team, Mirror team, Independent team, Mirror sector and the Independent sector. The R&D offshoring often begin with low level, and then with the increasing capability of the local staff, the work with higher levels is transferred after assessment and decision made by the headquarter. But not all of the R&D offshoring are bound to develop to the highest level, because different business departments have different strategies, the degree of the importance of Chinese markets are also different in their business strategies, leading to the different expectations of the role played by the Chinese R&D organizations. In some cases, the headquarter lack the motive power to continue doing technical transfer. The local R&D centers may stay at a certain level and will not go on the development. In the case of Agilent China Communication Center, some parts of the teams' R&D offshoring have reached the third or fourth level, some other parts remain at the second level or are transiting to the third level.

VI. SUMMARY

This paper makes conclusions by interviewing the staff in Agilent China Communication Center and research on the R&D offshoring route since its establishment, and by inducting and analyzing the growth process of typical team as well as its R&D offshoring levels. The major conclusions are as follows:

1. The main motivation of many MNCs' R&D offshoring to China is the growth of China market and ample and cheap technical talents. Given the difference between MNCs' business and the level of importance of China market to them, different business departments probably adopt varying R&D offshoring strategies.

2. For deep-level R&D offshoring, it is not only localization of technical capacity, but usually the localization of the responsibility of research and development, including specific business, strategy, the long-term strategy of product, the product release plans, the management and monitoring of projects, the development support and maintenance of products.

3. Based on the strategies of Agilent's different departments and China's position in the strategy, the extent of R&D offshoring is also varied. It can be divided into five levels. Each level relates to different technical capability and different degree of the transfer of products' liability. This paper brings forth a model of compartmentalizing the degree of the implementation of R&D offshoring, which is divided into five levels. Moreover, it gives a detailed discussion on the relevant characteristics of the level that the Agilent China Communication Center reached, as well as the ability/responsibility of transfer, priorities and the corresponding organization structure. It also gives the characteristics and key points of different levels of R&D offshoring implementation by means of actual team practice.

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