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“INTELLIGENT MANUFACTURING SYSTEMS” A CASE STUDY OF GLOBAL COLLABORATING INITIATIVE FOR RESEARCH AND DEVELOPMENT

by

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Abstract

"Intelligent Manufacturing Systems" is a consortium initiative to research and develop the next generation of manufacturing and processing technologies capable to tackle the new challenges that cannot be addressed individually because of the high cost incurred and the vast expertise needed. The main task of this initiative is to launch cooperative projects that help improve manufacturing operations, enhance international competitiveness, and lead to technology breakthroughs via market-driven R&D. The aim of this case study is to introduce collaborative research as a new approach to scientific capacity building that involves multiple organizations of different origins and diversified backgrounds from the industry, research centers and the government. It also exposes the distinguishing dimensions of this new type of initiatives and highlights the benefits expected for ESCWA regions.

Introduction

Major industrialists in the developed countries have been facing serious challenges over the last decade pertaining to the new developments in environmental consciousness, telecommunication technologies, globalization obligations, as well as other concerns. This has persuaded most of them to rethink the validity of traditional methods used so long in manufacturing, and forced them to adapt with the new trends through a global strategy of collaboration with partners from different parts of the world. Their aim is to genuinely resolve shared problems and to collectively benefit from the solutions obtained.

This paper presents a case of a currently established program for research collaboration called "Intelligent Manufacturing Systems" (IMS). This program was established by major manufacturers from Australia, Canada, the European Community and EFTA, Japan and the USA. It is an international initiative for scientific research and technological development that aims at gathering advanced manufacturers from different parts of the world around agreed projects of common interest to all participants. These projects address new issues that result from the above trends and attempt to develop new solutions.

It happens that this initiative has established a good example for collaborative scientific research and technological development that can be a benchmark for similar activities to follow interests. It can also be considered as a guiding case for regional coordination towards global integration. Lessons can be drawn from this initiative concerning new ways and means for international collaboration, where common themes are identified for regional prospective partnerships among research institutions, private businesses and local governments within the ESCWA region.

The Case

The program of "Intelligent Manufacturing Systems" is one of the initiatives that have been established by major manufactures in several developed countries as a collaborative consortium for research and development. As defined by the consortium: *"IMS is an industry-led Research & Development Program established in 1995 to develop next generation of manufacturing and processing technologies."* Major manufacturers and research institutions from different developed countries recognized that the new intended technologies could not be developed by individual entities because of the high cost they entitle on one hand. While on the other hand, it has been acknowledged that merging the expertise of all member firms will yield to commendable solutions through international coordination and local acceptance, since no single entity may have all the expertise needed to develop such solutions.

The aim of IMS is to reach excellence in manufacturing and processing operations, where *"properly managed informational co-operation in advanced manufacturing R&D, through IMS, can help improve manufacturing operations, enhance international competitiveness, and lead to technology breakthroughs via market-driven R&D."* The results of collaborative projects are shared within the community of IMS while being carried up, as well as the public upon the completion of each project. Special arrangements for protecting intellectual rights are also drafted by the consortium to facilitate the diffusion of information on an equitable and balanced basis for all project participants.

The IMS initiative was conceived early last decade in a feasibility study that was conducted by participants from five regions: namely Australia, Canada, the European Community, EFTA, Japan and the USA, and was

completed under the "Terms of Reference for the Feasibility Study on International Collaboration in Advanced Manufacturing. The study concluded that an international cooperative program in research and development in advanced manufacturing can be created that is "equitable and beneficially structured, and provides equitable and beneficial outcomes." Afterwards, the IMS Program was established in 1995 according to a pre-proposed management structure, technical themes and intellectual property rights provisions for it. The program was made open to new regions (such as the recently accepted Korea zone) where any company or research institution in the particular region is eligible to participate in IMS projects.

Research projects endorsed by IMS must abide to the following principles:

- *Industry Led and Market Driven*, where five themes are highlighted with industrial relevance to form the framework of scope for such projects. Those themes will be described later;
- *International Cooperation and Effort* to ensure international participation from at least three of the regions participating in the IMS program. Therefore, collaborative projects are carried out by inter-regional, geographically distributed consortia. Avoiding at the same time competing projects held under individual governmental sponsorship or other resources;
- *Equitable and Balanced Benefits to All Participants*, where contribution is equally shared by the participants, and results are shared through controlled information diffusion among the partners that ensures the intellectual property right provisions set during the cooperation;
- *Added Value* assuring economic and socio-economic improvement to the quality of life through innovative means in manufacturing operations.

The objectives for IMS as stated by the program are:

- 1- To enable greater sophistication in manufacturing operations;
- 2- To improve the global environment;
- 3- To improve the efficiency with which renewable and nonrenewable resources are used;
- 4- To create new products and conditions which significantly improve the quality of life for users;
- 5- To improve the quality of the manufacturing environment;
- 6- To develop a recognized and respected discipline of manufacturing which will encourage the transfer of knowledge to future generations;
- 7- To respond effectively to the globalization of manufacturing;
- 8- To enlarge and open markets around the world; and
- 9- The advancement of manufacturing professionalism worldwide by providing global recognition and establishing an educational discipline for manufacturing.

To achieve those objectives, IMS identifies its role as a catalyst agent for global manufacturing cooperation that involve large and small producers, suppliers, research centers and governments in the search for significant improvements and the dissemination of their results worldwide. This cooperation also attempts to establish standards, develop priorities and institute guidelines through collaborative research and development.

On the other hand, since most of the enrolled organizations are large size manufacturers and institutions, partnership with small businesses has been given particular attention and special measures are under development to enlist SMEs into the program. Such measures like electronic search facilities and a register intended to SMEs who would like to join in the activities and projects of IMS and to benefit from the experiences and donations from various project teams.

Five technical themes have been determined by IMS to be adopted by project applicants in their proposals with proven necessity of global cooperation. Those themes are:

- 1- Total product life cycle issues, where it is expected to incorporate research on a new generation of manufacturing systems that advance agility, flexibility and integration of the production enterprise in a

global context. This theme also endorses research on intelligent manufacturing and the use of information and telecommunication networks as means to improve productivity of global supply chains for manufacturing. It encourages as well proposals concerning the environment concerns, the minimum use of energy and economic justification of new methods that requires more sophistication in the production processes and addresses at the same time new ways for recycling and refurbishing the products and correct measures for disposal treatments.

- 2- Process issues that facilitate proper response to changing requirements of the products, efficient use of material resources, and improving working conditions for employees. These themes include developing new processes that encourage clean manufacturing with minimum environmental negative effects, efficient use of energy, technological innovation, agility and reconfiguration ability.
- 3- Strategy/Planning/Design issues that incorporate making proper decisions in a global economy and developing proper organizations towards the global formation of the extended and virtual enterprise.
- 4- Human/Organization/Social issues where the aim is to improve the image of manufacturing in the service of global societies and helping out in increasing the workforce knowledge-based skills. Other proposals may shed light on introducing new methods for better corporate technical memory that is transformed into organizational knowledge.
- 5- Virtual/Extended enterprise issues that promote collaborative manufacturing between legally independent partners with different competencies for the achievement of higher degrees in customization and re-configurable processes and the incorporation of smaller producers into the manufacturing system.

A project to be supported by IMS should satisfy general guidelines and undergo an endorsement process. Project selection criteria consists of the industrial relevance, compliance with the Intellectual Property Rights provisions set by the IMS Steering Committee. Participants in the project consortium must originate from at least three different regions, prove their capability to contribute and to benefit from the project on an equitable and balanced basis, provide leadership and be committed to disseminate project results to all participants and to the public.

The evaluation process of a project has to pass through three phases and to be reviewed and approved at three structural levels of evaluators: A project Abstract must be submitted to the Regional Secretariat for initial regional review. If recommended, participants are sought from all IMS regions and a standardized Full Proposal is submitted to the Inter-regional Secretariat, should participants from at least three regions adopt the project. The partners should sign a cooperation agreement that includes formal commitment of each participant to the Principles and the Intellectual Property Rights provisions. Final endorsement is granted from the International Steering Committee of IMS in the last stage based on the recommendations and the submitted proposal.

When a project is endorsed, the IMS Steering Committee regularly reviews its progress and the project team submits a summary report once every year in a standard form until it is completed. Participants are expected to provide the necessary funds to the project where each will chose the method of contribution on equitable basis for funding and benefits. Delegates of the participating partners are also supported from their original firms. During its progress, more interested companies can be admitted into the project and thus augment participation for more benefits to be achieved.

Up to date, there are 48 projects at various stages at IMS. Three of them are already completed and their final reports are available to the public. Eighteen projects have their proposals endorsed and related research is under way. The total value for all the endorsed projects is about \$250 million US and membership to their consortia is still open. There is one project proposal that has its endorsement still pending where it consortium is in the final stage of formation and research will begin shortly. The remaining projects are at the abstract stage where 18 of them are already endorsed and detailed proposals and work plans are in progress, and 8 abstracts are in their evaluation process.

The breakdown of all IMS projects by their inception year shows a significant growth in the years 1997 and 1998 where 13 projects have been initiated in each year. The number of projects that have started in 1995 was 4 and grew to 7 in 1996. However; there were only 6 projects that initiated in 1999 and the number of

projects submitted in 2000 rose to 5 to the current date. Should those number be compared to the average time it takes a project to be fully endorsed, most of the projects that were initiated two years ago are still in their early stages of research.

The themes of those projects were investigated and it was found that 24 of them could be listed under Process Issues and 9 under Total Product Life Cycle research. There are 6 projects that can be classified as Human/Organization/Social related, 5 of them have Virtual/Extended research interests, and 4 aim to Strategy/Planning/Design development.

The future of IMS has been outlined by the IMS Vision 2020 Forum in a new concept of "new manufacturing" operating as service provider industry with new systems of corporate architecture and highly integrated enterprise functions. The main characteristics of the new era emerge from the requirements of rapid innovation, shared knowledge and global and flexible collaboration among multi-national partners to exploit new market opportunities and needs. Influenced by increasingly educated consumers, manufactured products will increasingly be developed to be easily constructed, reliable and recyclable. The main drivers for the "new manufacturing" era are identified to be the consumer demand, ecological sustainability, revolutionary communication systems and emerging enabling technologies mainly information and communication technologies, biotechnology and nanotechnology.

The Forum also discussed several key issues pertaining to global manufacturing that ranged from environmental concerns to sustainable manufacturing and from process enhancement to "life-long 'manufacturing learning'". It was also concluded with a future role and vision of the IMS program within the following outlines:

- *A focus on the nature and challenges of 'new manufacturing'.*
- *Greater emphasis on the challenges of sustainable development and global equity.*
- *Continuing emphasis on the strength of the IMS Intellectual Property Requirements framework for collaboration.*
- *A review of the most appropriate structure and organization.*
- *A move from a reactive, project-driven to a proactive ideals-driven operation.*
- *A broader membership beyond OECD-like countries and streamlined entry procedures.*

Lessons to Emulate

From the above case, a new approach for scientific research and technological development can be outlined for successful collaboration in scientific capacity building and technological development through several dimensions highlighted in the following.

Collaboration:

Clearly, collaboration in research and development has become essential in the new economy. This has resulted from the fact that most of the recent challenges are global rather than local or regional, where solutions are possible to attain using the resources of many organizations. In fact, such collaboration is already observed in activities other than research such as business and social cooperation, where alliances and mergers are continuously occurring in the business world and where international conferences are organized to resolve social problems commonly shared worldwide.

Collaboration in scientific research and technical development is more devoted than other types of scientific capacity building means, because of the fundamental need for the widest scope of knowledge and expertise on one hand, and because of the high cost it usually incurs which can only be tackled by cooperative sharing. Most importantly, however, is the common interest that is shared among partners in a particular project and which could arise from globally prevalent conditions and challenges, and the joint benefits that each member will tap from.

Moreover, such collaboration has become easily facilitated more than ever through the use of new technologies of telecommunication and computing. The Internet has become the major catalyst for this collaboration in conducting research and knowledge proliferation through the exchange of data and

expertise. The power of computing on the other hand, has also enhanced problem solving and real time simulation, where the participants can easily test the solutions obtained for effectiveness and conformity.

Other than the above advantages for the collaborative research approach, flexibility is guaranteed in scope extension and partnership expansion where the door remains open for more partners to get involved under the general proposal been defined for the particular project. This allows wider participation and expertise enrichment that should enhance the results of the research and widen the range of the beneficiaries in different parts of the globe and on equitable basis.

Mechanism:

Another lesson can be drawn from the IMS case is the project endorsement process and its mechanism. An important objective of the IMS program is to include all types of research organizations and beneficiaries from the industry, governments and academia. All members from the three types should develop and agree on the main themes into which research projects must fit in order to be endorsed. The endorsement process being used asserts the involvement of multinational partners for a project and ensures sustainability in project activities until it achieves its objectives.

The main requirements for a project to be endorsed are, first, to prove valuable outcomes for all partners and to the community, and second, to affirm intellectual property right provisions concerning the contributors. Such process undergoes several stages before full endorsement in order to enforce those requirements, and to assure the potentiality for research extension at the end of the project. The process is supervised by a steering committee that oversees all project activities and which consists of members from all regions of the IMS consortium.

Although the mechanism of project endorsement looks slow in its progress, structuring an expediting process can be obtained through further devotion and more frequent committee operation.

Globalization:

The importance of the projects endorsed by IMS stems from their global nature where partners from different parts of the world join efforts to resolve common problems of global context and concern. This fact is the result from the contemporary globalization trends enticed by the new technologies and a wide variety of social, economical and political factors.

The global dimension of scientific research has become eventuality at all endeavors for sustainable development and better quality in living standards. For this reason, research must ensure its global scope and not to be limited to just local or even regional extent. However, new research can focus at means and methods that allow local organizations gain an edge to endure in a global environment.

Equality and Balance:

As it was just mentioned, benefiting from the results of research must be equitable for all participants. This is also supported by balanced contribution from all parties involved. The basis of the balance is that each project member, to become a participant, should develop a suitable areas related to the project, and which will be pursued and solely financed by the members themselves. This indeed should take into consideration how contributive and important is the work to be taken on its part, and how much it contemplate to the overall objective of the project.

The importance of equitable and balanced participation in such projects is that it allows members to join their effort to solve common problems which means that even competitors would initiate collaborative research in particular areas and at equal basis. This is important when common challenges arise and competing organizations have to find common means to be tackled. Such a challenge, for example, is the rapid proliferation of information technologies and the emergence of electronic commerce that have mounted to be very critical in the immediate future to all organizations all over the world.

Themes Development:

To emphasize further the importance of collaborative initiative in scientific research and technological development such as IMS, sharing among participants in the effort to advance knowledge assimilation plays

a crucial role to identify common problems and exchange information and expertise in order to provide solutions.

Therefore, and to facilitate sharing among prospective partnerships, specific themes must be agreed upon by a supervisory board that have the capability to direct research to common interests and to make proper decisions at both strategic and operational level.

In what is concerning the ESCWA region, such themes must also be relevant to the endeavors that organizations in those countries are expecting to achieve. Some of such themes are suggested in the following:

- The adoption of Information and Telecommunication Technologies and using electronic commerce for enterprise integration of local businesses in all sectors with regional and global partners both vertically through supply chains, and horizontally with partners across the region.
- Strengthening the role of Small and Medium Enterprise in the economies of the member countries since SMEs form the backbone of all economies in the world. Such support should be in all forms, financial, legal and technical, and throughout all phases of their life cycles from inception till full operation or clean exit.
- Human resource skill development to match the new requirements of the era of knowledge economies. This is highly essential for all ESCWA societies to hold their skilled forces from migrating and allow them invest in their gifted capabilities in beneficial projects.
- Oil related research in issues of common concern to the oil producing communities.
- Agriculture industries related to crop growing or food manufacturing and related industrial production such as the textile industry and dairy production, since many countries have already existing factories with common problems and similar global challenges to face.

As well as other themes that can be considered equally important to increase the scientific capacity of the region and improve the quality of life of its societies.

Conclusion and Recommendation

The above case presented a new form of research initiatives that focuses on collaborative efforts of many organizations from the industry, academic research centers and the government. The undergoing projects under such initiative address international concerns that have arisen from the continuing trends of globalization. A defined mechanism is established for the endorsement process of such projects where funding is shared among the project partners. This type of initiatives facilitates expertise sharing and scope expansion that will eventually achieve valuable solutions for technological advancement and value adding. The ultimate beneficiary is identified to be the global community that is expected to have its life quality improved.

We would recommend adapting the collaborative research approach such as the IMS's and establish a similar consortium between the different interested organizations in the ESCWA region in order to facilitate cooperative projects to be carried out. However, such projects must always have their scope defined in a global context, so integration with global initiatives must be set upfront at all times. A similar program can be initiated through the assistance of ESCWA that should qualify the various institutions to be enrolled into the program. The admission mechanism to the program must ensure equal contribution and balanced benefits for all members and should therefore be realized on the basis of a predefined project to participate with. The progress of the project is continuously monitored and its results are secured by agreed provisions for copyright.

To enable communication between the participants in the initiative, a Web site can be created on the Internet where the initiative is introduced and described and invites organizations to join the program with expressed interests that match the predefined themes of the consortium, or to enroll in an ongoing or proposed project. A structure of committees must be established then supported by ESCWA, and a fixed set of principals and dedicated objectives are also to be set commonly by the initiative supervisory committee.