

Management of Engineering and All Dimension of Technology Development in 21st Century

Dr. Morteza Sadegh Amalnik

Faculty of engineering, University of Qom, Qom, I.R. Iran
Email: sadeghamalnik@yahoo.com

Abstract – The international competitive economy, the rapid face of market and technological and industrial change and diversification, decentralization, integration of all function in manufacturing organization, and also integration of enterprise with all suppliers and customers place grater pressure on higher education and industries to train and provide such expertise specially on management of technology. There is also some confusion between industries and higher education perspectives on technological activities. Technology management is design and use of the means needed within and outside of organizations to achieve economic and social activities. It is a human skill, combining elements of engineering, science, and management techniques. This paper addresses the concept of technology and various domain of technology management in higher education and industries. We discuss about the basic premise of technological activities such as strategic and organizational context of technology, technology project, managing of professional team of technology, management of technology for developing new product and process and system, management of technological change and innovation, management of technological assessment law and ethics, internet based technological development. We will discuss each domain of technology in detail.

Keywords – Technology, Engineering, Management, Development, Innovation.

I. INTRODUCTION

Technology is a world with Greek roots that is free translation means the logic or method of an art, implying that it is what allows one to engage in a certain activity, initially considered as part of the state of the art, with consistent quality of results. This term currently has a multitude of definitions, but we prefer the one by Rogers; “A technology is a design for instrumental action that reduces the certainty in the cause- effect relationships involved in achieving a desired outcome[1]. His definition allows us to perceive the strategic management of technology as an information- seeking and information processing activity that tries to build advantage on the basis of technology [2] or bring the potential opportunities that technology creates to bear on the formulation of corporate strategy. This emphasis on the informational theoretical dimension of technology and thus the importance of information in the technology-driven strategic decision making process. Burgelman and Rosenbloom’s , 1989) definition of technology is focused more on the content that on the process of technology is focused more on the context that on the process of technology: “the ensemble of theoretical and practical knowledge, know-how, skills, and artifacts that one used

by the firm to develop, produce and deliver its products and services[3].

Technology management can be defined as: The design and use of the means needed within organizations to achieve economic and social activities. It is a human skill, combining elements of engineering, science, and management techniques. Over the past decade it has become obvious that Japanese, American, and European industry faces increasingly fierce competition from Chinese, Korean, and other sought eastern industries and has to become more effective in the way that it manage the exploitation of technology and the way it introduces new products and processes. The field of technology and technology management continues to advance rapidly, transcending disciplines and driving economic growth. The challenging and broad topic has continued to incorporate new concepts and increasing rate, making business and manufacturing a dynamic and exciting field of study. In this paper element of technology management is discussed.

II. ELEMENTS OF MANAGEMENT

The international competitive economy, the rapid face of technological and industrial change and diversification, decentralization and integration of all function in manufacturing business, place grater pressure on companies special on management of technology. To days the various activities and key elements of management of technology in design and manufacturing in industrial organization are: 1) integrating technology strategy into all aspect of manufacturing such as design, process planning, production, finance, marketing and so on. 2) Using technology as strategic weapon in order to respond to competitive market environment and competitors. 3) Investing and directing research and development in order to reduce product development cycle time and cost simultaneously and improving quality and productivity.4) Realizing and evaluating various options of technology and factors relating to success and failure of each technology. 5) Integrating technology into all aspects of manufacturing activities. 6) using new technologies in development of product, processes and systems. 7) using communication and information technologies and integrating all aspect of manufacturing organization in order to monitoring, controlling, planning and implementing. In order to use all aspects of technology and all elements of technology management in our corporations and companies what should we do? And how we can manage it? Technology management is a complex

task and problematic involving human activity, money, markets, machine, material, tool, technology, etc. The problems of highest complexity are those of human decision and activity systems. These tend not to be of a kind uniquely identifiable, but rather problematic situations involving organizational issues, social and environmental systems, problem situations containing different perception, uncertainty about the outcome of some aspects in the design or implementation of a technology management in a system, bounding a problem where the answer lies outside the context of the problem definition, or an effective means of bringing about change. The above problem types are classified as "soft system". It is perceived that the framework for a methodology to cater for such technology management systems be capable of accommodating a composite view in order to solve problems involving more than one person or department. It must be able to reduce a particular situation to a model uniquely suitable to that particular situation[4].

A conceptual model of technology management system can thus be developed by identifying the main subsystem

and their structural and processing characteristics required in order to achieve the stated corporate objectives of the technology management in organization. The production of subsystem will be a part of such conceptual models linked to other subsystems in a logical manner that suits the organization's requirements best. One such general technology management system model is shown in Fig.1. A soft system methodology developed by Checkland for tackling such unstructured problems can be applied to high technology management in organizations and forms the foundation and framework for the manufacturing systems design at the highest level of complexity and abstraction that is "the human activity systems" with all other systems being a sub-set of this system. This methodology is used to develop root definitions for several levels of resolutions. This is a top-down hierarchical structure for effective integration of technology management's activities. For limitation of space we do not show the input, output, constraints and mechanisms of each activities and interrelation between them.

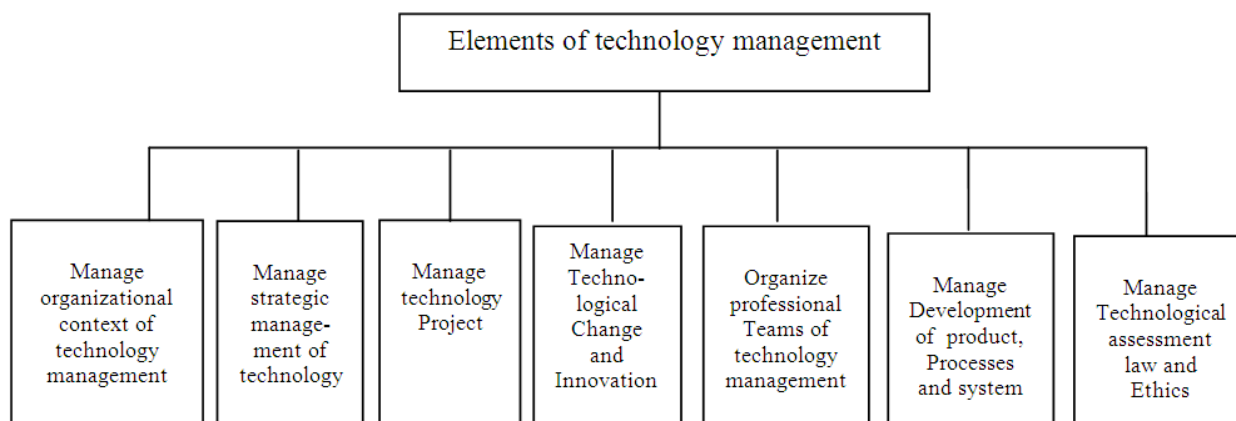


Fig.1. Technology management system model

III. MANAGE ORGANIZATIONAL CONTEXT OF TECHNOLOGY

Manage Organizational context of technology management: including elements such as integration of technology management, organization of hardware and software systems, determination of technological competences, design of system control, information technologies, managing organizational effectiveness and concurrent engineering environment and climate. A formal definition of organizational environment and climate or cultures is as follows: culture is a "pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and therefore to be taught to new members as the correct way to perceive, think and feel in relation to these problems" [5].

Culture is perceived as a system with three interacting layers of increasing visibility and decreasing decipherability [6]. These layers are:

- 1- Basic assumptions that reflect the relationship of the members of the organization to the environment and the nature of humans and the contingencies surrounding them, and are invisible or taken for granted.
- 2- Values that reflect the prevailing organizational culture and are driven by the underlying basic assumptions, and are more visible than the basic assumptions themselves.
- 3- Artifacts and creations that reflect technological and artistic organizational endowments as well as visible audible behavior patterns, and are visible but often hard to decipher.

In Fig. 2 detail information and activities of organizational context of technology management is demonstrated.

Integration of technology management: including historical perspective, technology economic growth and development, system approaches to the manufacturing organization and technology management, and advanced manufacturing, information technology, new material and nano and biotechnology.

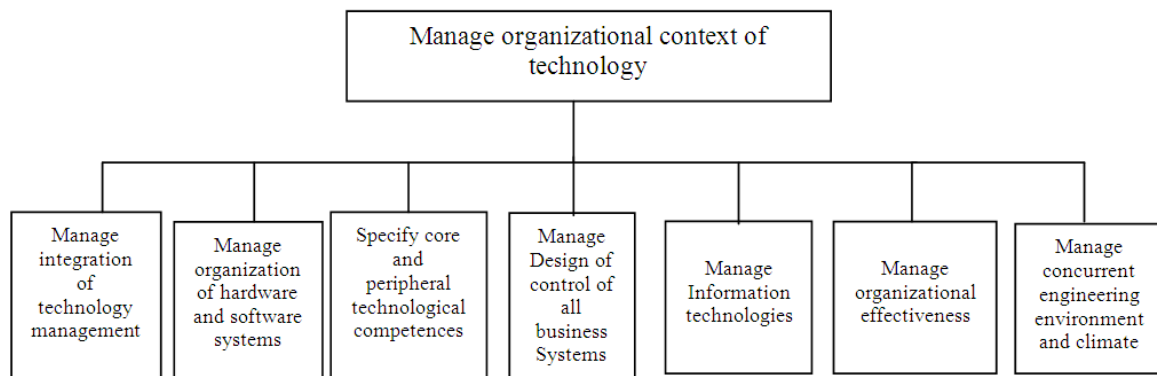


Fig.2. Organizational context of technology management model

Organization of hardware and software systems: including dynamic and internal dimensions, images of organizations, using software systems analysis, problem solving and complex open-ended problems.

Specify core and peripheral technological competences: including the definition of core and peripheral technological competences, in-house versus supplier-based skill, joint ventures, cost management of increasing core and peripheral skill needs, competitor profile and degree of vertical integration.

Design of control of all business systems: including organization by product line or scientific discipline, portfolio planning, project selection, risks and rewards and using manufacturing and financial discounting techniques and their applicability.

Information technologies: including risk vs lean reporting systems, targets, performance and adaptation, technical and market requirements, milestones and

schedules, time vs cost vs performance and company wide vs local project cost accounting.

Organizational effectiveness: including adapting to change, efficient use of assets and resources.

Manage concurrent engineering environment and climate: including creating a suitable environment and climate that implementing effective concurrent engineering is possible.

IV. MANAGE STRATEGIC TECHNOLOGY

In Fig.3 we present detail information and activities of strategic technology management and show how one can manage it. Manage strategic technology management including many elements such as specification of importance of technology management, Review of strategy in competitive companies, Specification strategy and global competitive, corporate management of technology, Specify National and International policy, Manage marketing plans and strategies, Manage manpower skills planning and education and training

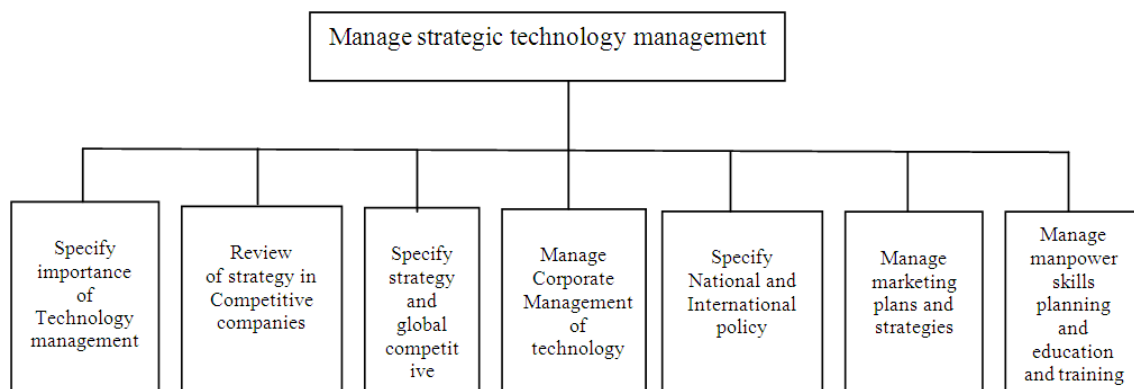


Fig.3. Strategic technology management model

Manage Specification of importance of technology management: including past product and market strategies as purely financial strategies, the recent emergence of technology management as a strategic weapon for 2005, integrated technology strategies for products, manufacturing process and corporate systems.

Review of strategy in competitive companies: including the old colonial strategic of companies, low price and low sophistication strategies for export product, high price and high sophistication product strategies by foreign important

competitors and high short term profit maximization strategies.

Specification strategy and global competition: including world markets, markets segmentation and different price/quality balance, the rise of sought east countries and other competitors, the entry of foreign competitors and effect of local content laws and the new markets.

Corporate management of technology: including developing and manufacturing of product, the new integration of product and all manufacturing functions,

using flexible manufacturing system and just in time, total quality programs and material requirement planning.

Specification of national and international policy: using technology transfer between different companies, collaborate R&D support, national product champion support and small, medium or large firm support policies.

Managing marketing plans and strategies: including overall corporate strategies, integration of product and all manufacturing functions strategies, product portfolios, market segmentation and market shares, pricing, sales, volumes and profits, distribution and servicing policies and regular reassessment.

Managing manpower skills planning and education and training: including integrating manpower skills profiles with all manufacturing function and technology strategies, acquisition of suppliers or new manufacturing units, manage commitment and policies, in house or externally supplied, deciding make or buy sophisticated components and policy frameworks for education and training. More information in references [7] [8] and [9].

V. MANAGE TECHNOLOGY PROJECTS

Technology project management including many activities. In Fig.4 we present detail information and activities of technology project management and show how is possible to manage it.

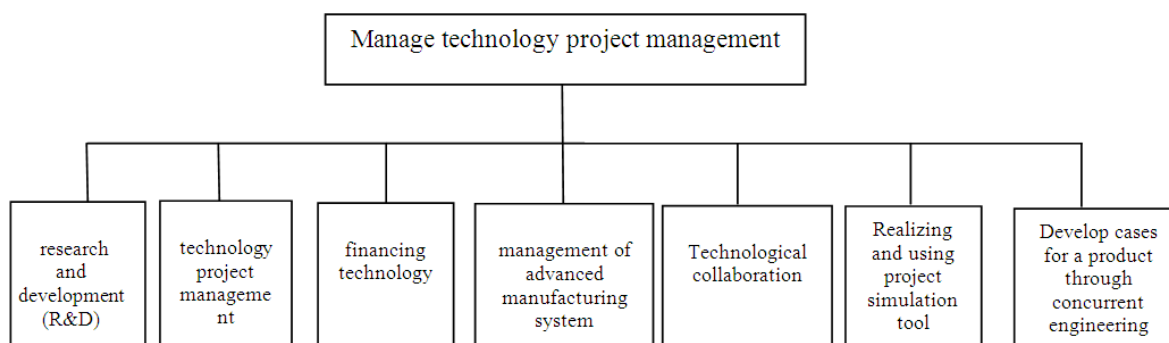


Fig.4. Technology project management model

Realizing and using project simulation tool: including using CAD, CAM, CIM, internet, supplier and user based systems, progress chasing, real time training simulator for complex system users.

Develop cases for product through concurrent engineering: including studying existing product situation, new product development, product market entry and termination considerations, probability of business success, cash flows and break even points, and product profile and factor weightings.

VI. MANAGE TECHNOLOGICAL CHANGES AND INNOVATION

Technological changes and innovation including many activities. In Fig.5 we present detail information and activities and show how is possible to manage it.

Manage and direct research and development (R&D): including portfolio planning versus single market or break company projects, new product definition, programs and priorities, progressing research toward development projects, creativity and new opportunities and technology selection.

Direct technology project management: including project control and resource management, competitor analysis, project approval or cancellation, creating of team building, competing projecting and back ups, building project ownership, project compromising and design disciplines and interactive project reviews.

Manage financing technology: specify rates of return as an investment and cost, specifying risk vs pay off, short term product fix vs long term program support, market exit or market entry costs and standardized accounting versus creative accounting.

Direct management of advanced manufacturing system: including product design for manufacturing, integrate all manufacturing functions using just in time, total quality management, manufacturing required planning and so on.

Manage technological collaboration: including using joint ventures, deciding make or buy and supplier policies, licensing and parent trading, contraction and subcontract ion, consultancies and government labs and research associations.

Forecast technological change: including activities such as predicting change (technical forecasting), review different strategic views and time horizons at the corporate, business and product levels, assumptions, inputs and outputs to forecasting, using techniques (trend extrapolation, curve fitting, regressions, scenarios, matrixes, substitutions and etc.), evaluation and use forecasting experts.

Guide technology management of change: including activities such as forecasting of product life-cycle, manufacturing capital replacement cycles, system replacement, the S-curve for performance or cost versus time, technical substitution (e.g. systems, processes, products and intermediate inputs).

Manage creativity in technology management: including activities such as making organizational environment and climate that every one is creative, using non-analytical techniques (inspiration, brainstorming and lateral

thinking), structural or attribute examination, matrix building, analogies, initial feasibility or simulation, innovation cultures and how to maintain them and managing innovation and innovative people.

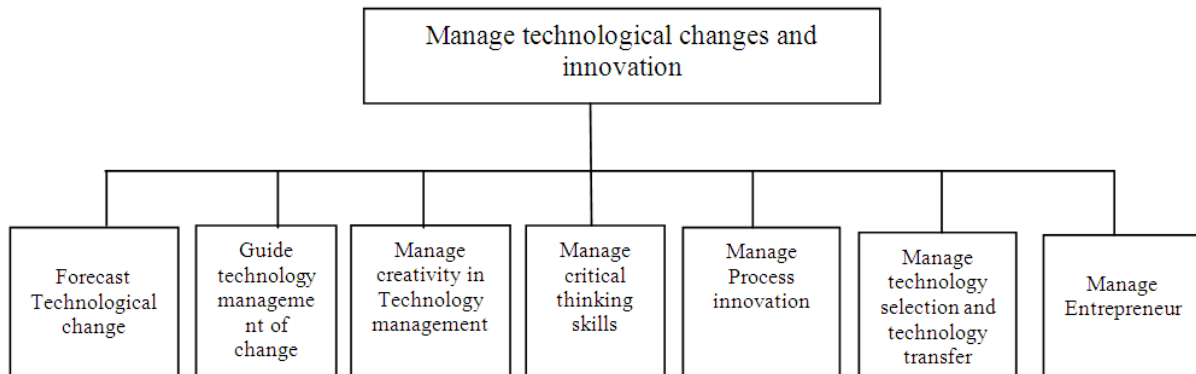


Fig.5. Technological change and innovation model

Manage critical thinking skills: including activities such as proper characterization of background issues, problem statement, solution precision, required vs desirable specifications along with relative weightings, interactions, cut-off criteria and balance between analytical and synthetic approaches

Manage process innovation: including activities such as invention as design for demonstration or feasibility, innovation as design for profitable commercial production, re-innovation as re-design for better specifications or lower costs or both, human and organizational resource requirements, cash flow management and potential profitability and when to start and when to stop.

Manage technology selection and technology transfer: including activities such as core technological competencies, accessibilities external competencies, mixing internal/external with new/old technology, criteria for islands of opportunity, riskiness and potential for success, product, process, systems and market positioning and short term needs versus strategic long term requirement, development prototypes to full scale production, inter-company transfers(sometimes across national borders), third party and turn-key projects, direct and indirect costs and/or profits, legal frameworks,

consequences for the next generational step, from a developed to a developing country context, and people based versus hardware and software type transfers.

Manage Entrepreneurs: including activities such as new ventures), commitment skills (entrepreneurs), organizational support, freedom, new venture decoupling from the systems, package of skills, business plans, coping with growth, development of functional specialization and managing a stable and competitive environment[10].

VII. MANAGE DEVELOPMENT OF PRODUCT AND PROCESS AND SYSTEMS

Development of product and processes and systems including many activities. In Fig.6 we present detail information and activities and show how is possible to manage it.

Understand factors related to Success and failure: including activities such as project management, degree of complexity, breaking down complexity, re-integration of units, interfaces and architectures, simulation models for development and commissioning.

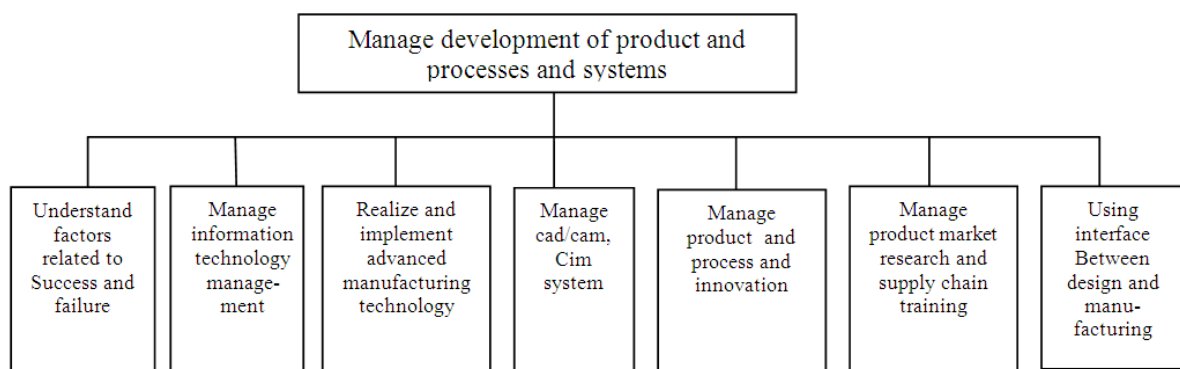


Fig.6. Development of product and processes and systems model

Manage information technology management: including management information system graphics and simulators, activities such as systems architectures and hierarchies, protocols and open systems, speed, power and control structures, access and security, integrity, faithfulness.

Realize and implement advanced manufacturing technology: including activities such as computer integrated manufacturing (CIM) which integrate all manufacturing functions and production control, just in time (JIT) as a integration of logistic functions, total quality management (TQM), material requirement planning (MRP), new material and process technology, market and financial analysis.

Manage CAD/CAM and CIM, JIT system: including activities such as integration and speed, power and faithfulness of CAD/CAM, compatibility (internally and externally with suppliers and uses), flexibility and responsiveness, networking and open systems of CAD/CAM and upgrade cycles.

Manage product and process and innovation: including activities such as different resource requirements for invention, innovation and re-innovation, technological paradigms and trajectories, robust designs and product families, product lifecycles, innovation in jobbing, batch, assembly and systems of manufacturing, matching product lifecycles to systems and forms of manufacturing, lean manufacturing for producing robust product families and commercially profitable manufacturing.

Using interface between design and manufacturing: including activities such as design for marketability,

make/buy decision and value added chain, strategic balancing of product families and life cycles across different forms and system of manufacturing, managing information in the IT systems to get at the technology in the products and manufacturing systems.

Manage product market research and supply chain: including activities such as customer needs, needs (and wants) analysis, price/non-price balances and mixes, technology driven versus driven innovations, product/market concepts and designing the supply chain with good quality, economy, logistics and make/buy decisions.

Manage interface between design and manufacturing: this activity integrates design, process planning manufacturing and other activities. More information in [11].

VIII. ORGANIZING TECHNOLOGY MANAGEMENT IN PROFESSIONAL TEAMS

Organizing technology management professional teams is very difficult task, and including many activities. In Fig.7 we present detail information and activities and show how one can manage it.

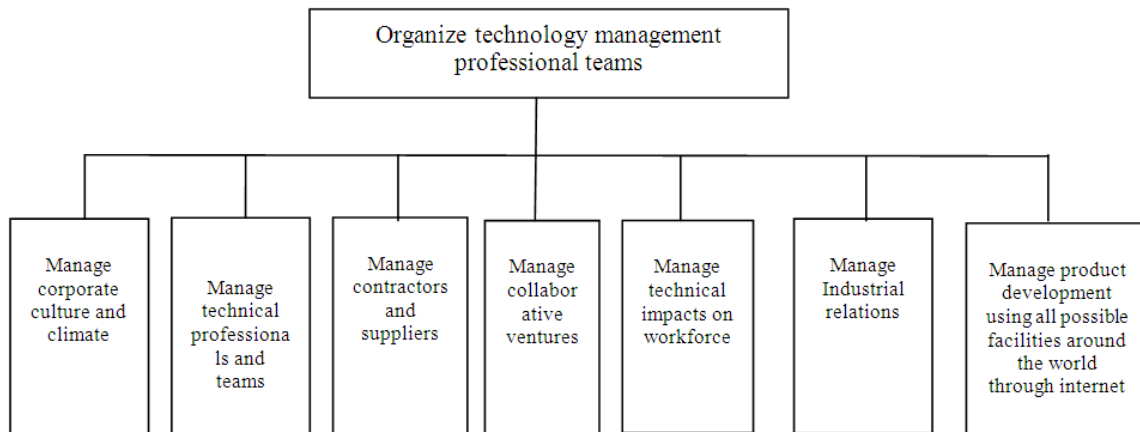


Fig.7. Technology management professional teams model

Manage corporate culture and climate: including activities such as identification of corporate strategic goals, delivering and disseminating information on business targets and objectives, induction, education and training about the corporate culture, promoting and identifying those who best exhibit and into practice good aspects of the company culture, resolution of conflicts and disputes, and people and systems excellence.

Manage technical professionals and teams: including activities such as team leadership and skills analysis, definition of project responsibilities, network analysis, program evaluation review techniques (PERT), progress review and reassessments, identifying and describing project landmarks.

Manage contractors and suppliers: including activities such as purchasing agents and contractors, single vs dual vs multiple sourcing, technological integration with

contractors or suppliers, quality vs price, and price quality strategies, value added chains and market/buy decisions.

Manage collaborative ventures: including activities such as different types (e.g. financial capital, markets, technologies, geographical regions), complementary core competencies, governmental schemes, accumulation of expertise and experience, when to start and when to terminate a collaborative venture.

Manage technical impacts on workforce: including activities such as redeployment (internally and externally), interaction at project planning stage and/or commissioning stage, new patterns of organizational change, new patterns of authority and management responsibilities, and De-skilling, re-skilling and upgrading.

Manage Industrial relations: including activities such as law of contact and union membership, management of terms and conditions of employment (redundancy,

dismissal, statutory rights of employees), employee representatives, and equal opportunities.

Manage product development using all possible facilities around the world through internet: including activities such as developing new product for competitive market demand by using all possible hardware and software facilities and experts through internet and web sites. More information in [12], [13] and [14].

IX. MANAGING TECHNOLOGY ASSESSMENT LAW AND ETHICS

Managing technology assessment Law and Ethics is very complex task, and including many activities. In Fig.8 we present detail information and activities and show how one can manage it.

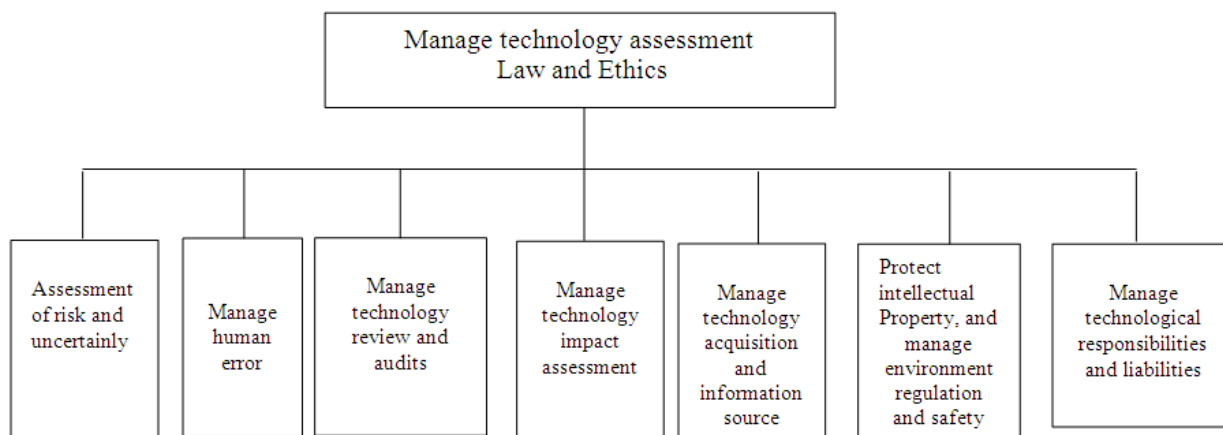


Fig.8. Technology assessment Law and Ethics model

Assessment of risk and uncertainly: including activities such as technical risk as the possible hazards of bad products or processes, technical uncertainty as the possibility of unforeseen accidental defects or events, historic records and future estimates.

Manage human error: including activities such as individual or corporate responsibility, safety training (company and governmental driven), operational training, contingency training, measuring, checking and analyzing human performance.

Manage technology review and audits: including activities such as technological balance sheets (R&D, patents, new products, manufacturing, marketing and human resource type assets), value added chains, profit and loss points, new source of technology, new market demands and competitor analysis.

Manage technology impact assessment: including activities such as in house consequences for workers and staff, user and public safety requirements, environmental considerations over a product's life time and eventual disposal, legal responsibilities, moral responsibilities and being a good corporate citizen.

Manage technology acquisition and information source: including activities such as licences, technology sharing agreements, market sharing agreements, consortia, technological information databases, consultants, confidential agreements and data protection.

Protect intellectual Property, and manage environment regulation and safety: including activities such as patents (as protection for the patentee or sources of technical information for other people), registered designs or design patents, copyright, national and international data systems, agents and legal documentation and corporate portfolios of intellectual property. Health and safety law, structure and

operation of regulatory institutions, sources of information and advice, selection and interpretation of data, relations between regulators, industry and other interest groups, public accountability, legislative and judicial oversight, enforcement (institutions, resources and mechanisms) and technology environmental impact assessments.

Manage technological responsibilities and liabilities: including activities such as best practice, product, process or system liabilities, customer care, after sales service, supplier policies, good citizenship and industrial leadership, ethical responsibility and employment training and cooperation

Managing technology strategically implies going beyond the anticipation of technological change and combining the external and reactive approach of forecasting and scenario methods with the internal and proactive perspective of management of innovation techniques. The strategic management of technological change as it is the determination of how technology can be used to create competitive advantage [6].

X. CONCLUSION

Technology management is set of management disciplines that allows organizations to manage their technology fundamentals to create competitive advantage. Typical concepts used in technology management are technology strategy (a logic or role of technology in organization), technology (identification of possible relevant technologies for the organization, possibly through technology scouting), technology roadmap (mapping technologies to business and market needs), technology project portfolio (a set of projects under development) and technology portfolio (a set of

technologies in use). The role of the technology management function in an organization is to understand the value of certain technology for the organization. In this paper elements of technology management is described and a system model is presented. It embarrass following models:

- Management of organizational context of technology
- Management of technology strategic
- Management of technology projects
- Manage technological changes and innovation
- Management of development of product and processes and systems
- Technology management of professional teams model
- Each model contains different elements of technology.

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AUTHOR'S PROFILE



Dr. Morteza Sadegh Amalnik

has been teaching and conducting research in design and manufacturing processes at the University of Tabriz and University of Qom science 1996. After graduating from New York State University in USA in 1978, and after getting his PH.D from university of Paisly in United Kingdom, He works as an assist. professor at University of Tabriz and University of Qom and published more than 120 papers in ISI and International Journals and conferences. He is currently director of environment research organization with 10 research groups in various areas and assistance professor of Mechanical Department of University of Qom.