Learning to Manage Resources: A Major Concern for Engineering Expertise in the 3rd Millennium

Kambiz Badie[1], Maryam Tayefeh Mahmoudi[1,2], Mahmood Kharrat[1]
[1]Knowledge Engineering & Intelligent Systems Group
IT Research Faculty
Iran Telecom Research Center
Tel: 021-88002455
[2] School of Electrical and Computer Eng.
University of Tehran, Iran
K_badie@itrc.ac.ir, Mahmodi@itrc.ac.ir, Kharrat@itrc.ac.ir

Abstract

Although the problems within the realm of engineering at the first glance may be viewed due to lack of capability/attention in the individuals themselves, it however seems that some deficits exist in engineering curriculum's requirements, which are to be overcome. Looking deeply into the structure of the above problems, one may find out that what engineers need to come with, is to become more knowledgeable in the way different kinds of reasoning are to be done regarding their problematic situations. These reasoning formats include the ways environmental sources of knowledge are to be utilized with the aim of justifying the engineering solutions.
In the meantime, the development of highly-potential CAD/CAM/CAE/CAT tools highlights the fact that what engineers need to know is to provide essential information for these systems (as essential resources) and help them operate in a satisfactory manner. On the other hand, limitations in environmental resources calls for pervasive efforts to arrange curriculums in a way to make engineers become aware of the necessity of considering the way these resources are to be coordinated and manipulated.
A major concern for engineering expertise in the environments with complexity, dynamicity, and uncertainty would therefore be to make new considerations under which engineers can learn to manage the existing resources.
In this paper, having reviewed the reasons for such a concern, some requirements will be explained at curriculum level that can help engineers achieve the expected goals at a promising level. At the end, a scenario will be discussed showing how the capability in resource management can yield a better performance for the engineers in their working environment.
Keywords: Engineering expertise, decision/action, engineering curriculum, environmental resource, resource management, working environment.

1- Introduction

The engineering expertise within the past decades has been shown to be problematic in certain aspects as follows:

(i) Many engineers, despite their success in handling certain situations, tend to become unsuccessful when these situations change. Let say engineers are mostly accustomed to treat the situations regarding decision areas (measurement / instrumentation, monitoring / control, design, debugging / trouble – shooting …) for which they have gained experience.

(ii) Engineers know to implement successfully their decisions / actions regarding certain goals, but do not necessarily know how to rationalize these decisions / actions on the ground of a domain theory. This is mostly because the engineering practice, though principally based on scientific principles, has the tendency to follow experience and the emergent outcomes which are principally difficult to be modelled.

(iii) Applying engineering routines faces a variety of problems, particularly in the situation where the environment gets to become heterogeneous rather than a simple homogeneous one. Although the above problems may at the first glance be viewed as due to lack of capability/ attention in the individual themselves (in following the proper solutions / protocols), it however seems that some deficits must exist in engineering curricula/ requirements, which are to be overcome.

Looking deeply into the structure of these problems, one may find out that what engineers need to come up with, is to become more knowledgeable in the way different kinds of reasoning format are to be applied regarding their problematic situations. These reasoning formats include the ways environmental resources of knowledge are to be utilized with the aim of justifying the engineering solutions.
In the meantime, the development of highly-potential (expert) decision support systems for CAD [1, 2, 3, 4, 5] /CAM [6, 7, 8 ,9, 10] /CAT [11] /CAE purposes, highlights the fact that what engineers need to know (get used to) in many cases is to provide essential information for these systems as essential resources, and help them operate (be operated) in a satisfactory manner.
On the other hand, limitations in environmental resources calls for pervasive efforts to arrange curricula in a way to make engineers become aware of the necessity of considering the way these resources are to be co-ordinated and manipulated. Putting the above facts together, one may notice that a major concern for engineering expertise in the environments with complexity, dynamicity and uncertainty would be to make new considerations particularly in its curricula, under which engineers can learn to manage the environmental resources.
Having reviewed the reason for such a concern, some requirements will be explained at curriculum level that can help engineers achieve the expected goals at a promising level. Finally, a scenario will be discussed showing how the capability in resource management can yield a better performance for the engineers in their working environment.

2- Motivations for Paying Attention to Resource Management As A Prime Concern in the Future of Engineering

It was discussed that a basic factor for failure of many engineers once they face a change in their problematic situation, is their inability in coordinating or manipulating the resources that should be somewhat taken into account to handle such a change. These resources not only include those at energy level, like instruments, tools , devices, …, but also those at information level, such as models, formula, rules, formats ..., and in addition to that, those at cognition level, like patterns / formats of reasoning, mete-models, meta-rules, … . To get able to handle such a coordination / manipulation, it is crucial for the engineers to capture some essential knowledge on the significance of these resources and the way they may make sense to engineering decisions (measurement / instrumentation , monitoring / control, design / planning, debugging / trouble – shooting , etc.), once a new semantic mode appears with respect to the related decisions. For instance, when a new goal is defined for the task such as design consisting of novel and particularly unfamiliar goals, based on the information belonging to this situation, the electronic engineer should get able to deduce what kinds of device (first at macro-level and then at micro-level) can help the design process come true under the new conditions. This necessitates a kind of mapping from the goal space onto the resource space, which enables the engineer to have first a rough estimation concerning the resources to be used. Mapping can then be performed using a variety of rules or schemas that implies the significance of certain ingredients in the resources based on the goal's characteristics. It should be mentioned that, in the classical approaches to engineering, such sort of knowledge doesn't exist in the educational texts (and references), and the engineer acts on the ground of some biased resources, which have been predefined according to the classical knowledge of engineering. This classical knowledge is however not adequate for responding to the entire situations, since the behaviour of a design pattern at certain resolutions may consist of a variety of characteristics that are not predictable since the beginning. One should however notice that many engineers are capable to extract these mappings (from goal space onto resource space) unconsciously (implicitly) based on their actual experiences, and in fact become able to extend these experiences to their future design tasks in an implicit manner. This however doesn't stand for the point that resource management has been considered in a systematic manner, since the principle of systematic-ness calls for the necessity of observing a number of protocols that can assure the right selection of the required resources. One should pay attention to the fact that there may exist certain situations where this mapping itself may not be performable, and a computer program may come necessary to fulfil it in a systematic manner. In these cases, one can claim that resource management has been achieved by a decision-support system, and not the engineer him / herself. In any case, the significance of the process of mapping from a goal onto corresponding resources is inevitable.

3-Requirements for Resource Managements as Curriculum Level

As was discussed in 2, it is crucial for the engineers to capture some essential knowledge on the significance of the essential resources and the way they may make sense to engineering decisions. This necessitates a kind of mapping from decision's goal space onto the resource space; which enables the engineer to hold estimation concerning the resources to be used.
Taking such a point into consideration, a novel subject called "Managing Resources in Engineering Tasks / Decisions" is worth being included in the curriculum of engineering both at general and advanced levels, respectively addressing the essential requirements for performing this mapping from general and domain-oriented view-points. The later is mostly concerned with the particular aspects related to a course of engineering with peculiar characteristics, i.e. electronic engineering, mechanical engineering, etc. The main items to be included in the syllabus of this subject are as follows:

(i) At general level
- Resources at energy, information and cognition levels
- Reviewing on the peculiarities of engineering decisions (measurement / instrumentation, monitoring / control, design, debugging/ trouble shooting, …) with no particular emphasis on the related domain
- Major resource-type entities in engineering decisions in a general view
- Types of goals within the domain of engineering decisions in a general view
- Inter-relations between goals and resources in terms of functions, rules, scripts, frames, schemas, diagrams, etc.
- Role of CAD/CAM/CAT/CAE in modelling and implementing the essential mapping formalisms in a general view
- Co-ordinating and planning resources within the possible processes of decision-making.
- Role of systemic paradigms & multi-agent systems in implementing the desired decisions.

(ii) At domain-oriented level

- Reviewing on the peculiarities of engineering decisions
- Resources at energy, information and cognition levels with emphasis on the course domain under study
- Major resource-type entities in engineering decisions taking into account the course domain under study
- Types of goals taking into account the course domain under study.
- Inter-relations between goals and resources with emphasis on the course domain under study, in terms of functions, rules, scripts, frames, schemas, diagrams, etc.
- Role of CAD/CAM/CAT/CAE in modelling and implementing mapping formalisms with emphasis on the course domain under study
- Co-ordinating and planning resources within the possible processes of decision-making with emphasis on the course domain under study
- Role of systemic paradigms & multi-agent systems in implementing the desired decisions with emphasis on the course domain under study.

4- A Scenario

To illustrate how resource management can be workable, a scenario is presented as follows:
Let us consider "Software Engineering" as a domain in the realm of engineering. Some of the required goals and the corresponding resources (consisting of models, tools and techniques) for this domain can be enumerated as follows:

a1. Goals1 (for developing softwares):
Requirement Analysis, Configuration Management, Documentation, Quality Assessment, Project Management, User Experience Design,…

a2. Goals2 (for managing web contents): Work-Flow Management, Document Management, Content Visualization, Automating Templates, Scaling Feature Sets, Upgrading Web Standards, …

b1. Resources1 (for developing softwares):
Models: Agile, Clean-room, DSDM, RAD, RUP, Spiral, Waterfall, XP, V-Model, FDD,…
Tools: Compiler, Debugger, Profiler, GUI, Integrated Developing Environment, UML, Diagrams,…
Techniques: Procedural Programming, Object-Oriented Programming, Model-Driven Programming, Aspect-Oriented Programming, Agent-Oriented Programming,…

(These resources can facilitate the requirement analysis using attempted solutions such as Agile softwares, UML and prototyping helping the users to accelerate their decision making process based on the existing system.)

b2. Resources2 (for managing web contents):
Models: Databases , Metadata, Artifacts, XML,….

Tools: SaaS, Aspire CMS, Oracle, Microsoft Sharepoint, Documentum, Joomla, Mia CMS, Plone,…
Techniques: Online Processing, Off-line Processing, Hybrid Systems

(These resources can facilitate the online document management activity including generation, edition, transformation and automation of contents which are known as the essential sub-goals in web content management helping the users to accelerate their decision making process based on the existing system.)

As discussed before, in order to manage resources in a favourable manner, it would be important to look for appropriate mappings from the possible goals onto the available resources; let say, to determine the proper inter-relations between the two.
With respect to Goals1, for the goal “requirement analysis”, some resources such as Use Case, Agile Software, and UML (as models or tools) and Prototyping, Object-Oriented Model Driven Techniques, … (as techniques) can be used , while for the goal “project management” some resources like RUP, Water Fall, … (as models) together with Program (or Project) Evaluation & Review Technique (PERT) and Capability Maturity Model Integration (CMMI) (as techniques) can be considered.
Also, with respect to Goals2, if for instance the goal is “document management”, a variety of resources such as XML, Databases and Artifacts (as models), Microsoft Sharepoint, Ducumentum and Joomla (as tools), and Online Processing and Offline Processing (as techniques) can be used, while for the goal “content visualization” some resources like Metadata and Artifacts (as models), Aspire CMS and Mia CMS (as tools), and Hybrid Systems (as techniques) can be considered.

Distributed nature of web, improves the potential of content management system in a multi-agent form of architecture.
For a software engineer who has done practical works in the areas of developing software and/or managing web contents, it is not so hard to be familiar with the inter-relations discussed above. One however should notice that knowing these inter-relations for a software engineering student who is just familiar with these concepts in a general sense (as a part of their courseware), is not so feasible. The main contribution of the suggested subject called “Managing Resources on Software Engineering Tasks/ Decisions” is to provide an encouraging forum for the computer students to get familiar with the capabilities of the ongoing resources in responding to the possible goals like those addresses above.

5- Concluding Remarks

Intelligent knowledge based decision-support systems for CAD/CAM/CAT/CAE purposes have provided a conducive medium for the engineers to translate their problems into appropriate solution frameworks. Such solutions not only cover the values (quantitative or nominal), which are to be considered in their decision scope, but also cover the physical actions, which are to be exerted by them to fulfil their tasks.

A major aspect in engineering problems-solving, as was discussed, is the way a problem’s goal can be translated into appropriate energy-level, information- level, and cognition-level resources. Such an aspect itself, can be either fulfilled by the engineer him/herself or a decision support system, which operates on the ground of interaction with a user. It seems that the more complicated the mapping from the goal onto the essential resources, the more an engineer would be expected to tend to a decision-support system. Under such conditions, it would be more reasonable for an engineer to learn operating (interacting with) the decision support system, rather than trying manually to fulfil the necessary mapping. Since, using a decision support system itself can be viewed as a kind of resource management, it can be plausibly concluded that the higher an environment’s complexities is, a higher level of abstraction regarding the essential resources would be needed. Conclusion is that resource management can be regarded as a major concern in the future of engineering taking into accounts the necessity for handling it in different abstraction levels.

References

[1] Insung Jung, and Gi-Nam Wang, “User Pattern Learning Algorithm based MDSS (Medical Decision Support System) Framework under Ubiquitous”, International Journal of Computer Science and Engineering, Vol.2, No.2 , Spring 2008.
[2] K. Subburaj and B. Ravi, “High Resolution Medical Models and Geometric Reasoning starting from CT/ MR Images”, IEEE 10th International Conference on CAD/ Computer Graphics, Beijing, China, Oct 15-18, 2007.
[3] K. Singh, P. K. Reddy, D. Joshi, K. Subburaj, and B. Ravi, “3D Junctions in Castings: Simulation-based DFM Analysis and Guidelines”, INAE International Conference on Advances in Manufacturing Technology, Feb 6-8, 2008, Chennai.
[4] K. Subburaj and B. Ravi, “3D Shape Reasoning for Identifying Anatomical Landmarks”, International CAD Conference, Orlando, Florida, June 23-27, 2008.
[5] Nagahanumaiah, K. Subburaj and B. Ravi, "Computer Aided Rapid Tooling Process Selection and Manufacturability Evaluation," Special Issue in Produt Lifecycle Modeling, analysis and Management, Computers in Industry, 59, 262?276, 2008.
[6] B. Arthaya, Y. Y. Martawirya, “The Development of Generic Algorithm to Bridge CAD and CAPP”, The 9th Asia Pacific Industrial Engineering & Management Systems Conference & The 11th Asia Pacific Regional Meeting of International Foundation for Production, Research, Nusa Dua, Bali - Indonesia 3 - 5 December 2008.
[7] Paryana Puspaputra and Risdiyono, “The Application of CAD/CAM Technology for Small Industries in Developing Creative Culture Design of Art and Jewelry”, APIEMS 2008 Proceedings of the 9th Asia Pasific Industrial Engineering & Management Systems Conference, Indonesia 3-5 December 2008.
[8] A. Maruf and C. Nugraha, “Development of a Computer Aided Transfer Line Design System”, APIEMS 2008 Proceedings of the 9th Asia Pasific Industrial Engineering & Management Systems Conference, Indonesia 3-5 December 2008.
[9] Y. H. Jen, Z. Taha, L. K. Shin, R. A. Ghazilla, N. Ahamad, “Development of a 3D CAD Model Conversion and Visualization System using Lexical Analyzer Generator and OpenGL”, APIEMS 2008 Proceedings of the 9th Asia Pasific Industrial Engineering & Management Systems Conference, Indonesia 3-5 December 2008.

[10] K.H.Tan, C.P.Lim , K.W.Platts and H.S.Koay, “An intelligent decision support system for manufacturing technology investments”, International Journal of Production Economics, 104 (1). pp. 179-190. ISSN 0925-5273, 2006.

[11] Collins, John, Ketter, Wolfgang and Gini, Maria, “Flexible Decision Support in Dynamic Interorganizational Networks”, ERIM Report Series Reference Number ERS-2008-082-LIS, May 12, 2008.