Chemical Engineering Software and Legal Protection Thereof

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Abstract

In recent years, an increasing number of Chemical Engineering Software (CES), which play an important role in improving efficiency in the petroleum industry, has been introduced to the market. Generally, software is the product of intellectual creativity, but protection of the intellectual property residing in software is the subject of some controversy.

This paper explores the legal protection of software products and its evolution over time. The approach of selected countries to software protection is reviewed in comparison with the Iranian legal regime in the same field. Important concepts that need to be considered in acquiring effective protection of CES are presented. Software-related patent classifications were reviewed and US inventions relating to them were collected using a professional patent data base. Finally, the CES inventions in each classification were investigated in comparison to the total number of software patents. Consequently, the most referable classification for CES invention has been determined in this paper.

Introduction

There is little need to emphasize the key role of computers and chemical engineering software (CES) for the petroleum industry and chemical engineering related topics. Since the early days of computing, information technologies have been used by chemical engineers for every aspect of their business. Modeling and simulation have been useful tools for technical and economical evaluation of assets such as chemical, refineries and petrochemical plants. Simulation is a valuable tool that enables organizations to investigate possible strategies for performance improvement and reducing operating costs. It is widely used in various application areas, and as a result of this, there are numerous simulation packages available on the software market [1].

"The market of scientific and technical software in the petroleum industry is constantly monitored by consulting firms. Therefore, good estimates are available. In downstream applications, the overall worldwide market size is estimated to be 800 M€, with around 300M€ for offline process simulation and optimization and approximately 500M€ for online systems and operators training. Such markets have generated a reasonably sized software industry with several large vendors providing integrated series of tools addressing a significant part of the scope"[2].

The above-mentioned figures clearly show that CES could be regarded as valuable assets in the market, However, acquiring and sustaining competitive advantage based on software products is a challenging task due to the special nature of software.

Generally, software is good information and its value stems from its information content although it may be distributed on physical medium such as CR-ROM [3]. The value of a software product becomes clear to a potential buyer only after revealing the underlying information for him, at which time he has acquired the information at no cost [4]. The marginal cost of each copy of software is very low, but the initial development cost is quite high. It can be concluded that software, by nature,

is costly to produce but costless to use. Given the key role of software in many economic and industrial sectors, including petroleum industry, establishing property rights in the field of software is therefore praised by government. Determining the optimal form and scope of legal protection offered, however, has been a serious concern for law-makers in different jurisdictions.

The paper explores the legal protection of software products and its evolution over time. The approach of selected countries to software protection is reviewed in comparison with the Iranian legal regime in the same field. Important concepts that need to be considered in acquiring effective protection of CES are presented. Software related patent classifications were reviewed and US inventions relating to them were collected using a professional patent data base. Finally, the CES inventions in each classification were investigated in comparison to the total number of software patents. Consequently the most referable classification for CES invention has been determined in this paper.

Software Protection Mechanism

A range of intellectual property regimes is implicated in the protection of computer software. These state created legal regimes also restrict the uses, domestically and internationally, of software. This section briefly introduces the legal mechanism most frequently used for securing important intellectual property rights, which resides in software products, namely copyright, patent and sui generie in the US and European context[1].

Copyright

Copyright is a bundle of exclusive legal rights concerned with the protection of literary and artistic works, often referred to just as 'works'. The aim of copyright is to promote science, culture and the arts. The general term of copyright protection is 50 years after the death of the author [5].

A number of developed countries, such as US and most European countries amended their national copyright legislation in the 1980s to explicitly put computer software under the copyright umbrella as a literary work. Regionally, various treaties and directives such as various European commission directives did the same over the next 15 years. Both the 1995 TRIPS[2] agreement (Art. 10 (1)) and the 1996 WIPO[3] Copyright Treaty (Art. 5) state that computer programs, both in source and object code, must be protected by copyright [6].

The Berne Convention (1886) is the oldest multilateral copyright treaty and it has 164 members from all over the world [7]. It aims to harmonize to a certain extent the copyright laws of all contracting parties by providing for minimum standards of protection for authors. The Berne Convention gives a long but not exhaustive list of things that are considered to be 'literary and artistic works' [5].

1- Trade mark and trade secret law may also used in protecting some aspects of software products, but they are not explored here
2- trade-related aspects of intellectual property rights
3- World Intellectual Property Organization

There are two branches of opinion in discussions on protection of software by law. These separate software into the two concepts of idea and representation. The representation of software is protected under Copyright Law. Software representation, put more specifically, means programs [8].

Patent

According to the definition stated by WIPO: "A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. In order to be patentable, the invention must fulfill certain conditions, namely novelty, inventive step and it must be of practical use. A patent provides protection for the invention to the owner of the patent. The protection is granted for a limited period, generally 20 years. Patents provide incentives to individuals by offering them recognition for their creativity and material reward for their marketable inventions. These incentives, which encourage innovation, assure that the quality of human life is continuously enhanced" [9].

At the beginning of software technology growth, software was not protected by patent law in most jurisdictions [6]. At present, a look at the patent laws of countries throughout the world shows that although many countries consider software technology as unpatentable, but then there are many examples of large numbers of software inventions, which have already been patented.

Software patents in the United States have been following a cyclical pattern with the patentability of software being extremely difficult to obtain in the 1970s to being fairly easy to obtain in the 1990s, and further being challenged in mid 2000s [10]. Fig. 1 shows the sudden increase in the number of software patents in the United States since the 1990s [10].

In Europe software or programs as such, are not protected by law, but software which is an integral or functional part of some other machinery or invention can be patented [6]. In other words, software inventions should have technical effect meaning that the invention must use technical features and solve a technical problem in order to enjoy patent protection in Europe. In computer programs, this technical effect must go beyond the "normal" physical interaction between program and computer. The program is then more than a "program as such". A technical effect can be, for example, a reduced memory access time, a better control of a robotic arm or an improved reception and/or decoding of a radio signal. It doesn't have to be external to the computer on which the program is run; reduced hard disk access time or an enhanced user interface could also be a technical effect [11].

It is important to know that it is software ideas that are protected by patent. This is in contrast to copyright, which only protects the form or presentation of software products. The patent system has long protected exceptional algorithms as method inventions. Consequently, the invention of software technology with algorithms
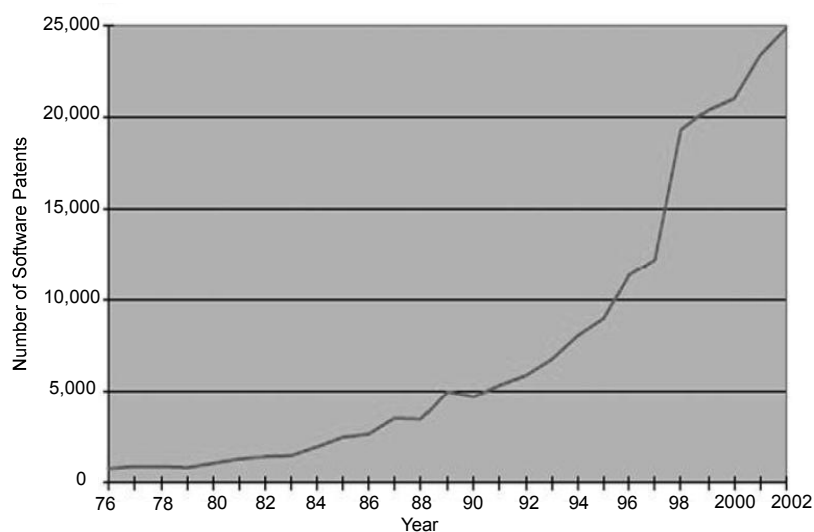
Figure 1- Growth rate of Software Patents in the US [10]

that are a new and excellent technological concept is patentable and the programs written in various programming languages or by various writers are examples of implementation of the invention. Therefore, the algorithm lies at the heart of software patent [8].

Generally software patent can be classified into 7 categories, namely [8]:
(1) Controlling the apparatus by computer
(2) Fundamental software patents
(3) Application software patents
(4) System software patents
(5) Network system
(6) Patents for financial business system
(7) Patents for the software of computer games

It should be noted that there are different approaches for software patent classification depending on the purpose of analysis. A useful classification that covers most of the patents in the field of software accompanied with the number of issued patents in each class is proposed by the US Patent and Trademark Office as illustrated in table.1 [12].

Sui generies

Despite the advantages of extending established legal mechanisms, e.g. patent and copyright, to new subject matters, sometimes the new phenomenon is so distinct from the already covered fields that introducing a customized legal system seems inevitable. Law makers usually try to avoid this option, since it overcrowds the legal landscape and complicates enforcement. Moreover, implementing a Sue generis system is usually a complex and time-consuming process. Protection term, registration requirement, minimum eligibility requirements, infringement threshold, and enforceability are usually among the most important features that attract most attention in designing a Sue generis IP system [13].

Table 1- The distribution of patent classifications [12]

Rank	USPTO Classification	No. of Patents
1	Data processing: structural design, modeling, simulation, and emulation	5270
2	Data processing: speech signal processing, linguistics, language translation, and audio compression/decompression	14584
3	Data processing: financial, business practice, management, or cost/price determination	13484
4	Data processing: artificial intelligence	6459
5	Data processing: database and file management or data structures	23303
6	Electrical computers and digital processing systems: multicomputer data transferring or plural processor synchronization	26657
7	Electrical computers and digital data processing systems: input/output	26426
8	Data processing: presentation processing of document	6941
9	Data processing: software development, installation, and management	7114
10	Electrical computers and digital processing systems: virtual machine task or process management or task management/control	3446
	total	133684

Integrated Circuit is an example of a new technological field for which Sui generis IP systems have been implemented in different jurisdictions [14].

The distinct nature of software as compared to literary and artistic works on one hand and inventions on the other hand has motivated some legislators to pursue design of a Sui generis legal system for software protection. They refer to technical and applied nature of software as it departs from the aesthetic characteristic of works eligible for copyright protection. They also point to the deficiencies of patent system in properly protecting software [13].

One shortcoming attached to Sue generis systems is related to acquiring transnational rights. Sui generis systems are usually designed and implemented in a way to best serve domestic needs. This context-dependent or customized nature causes right owners to face different systems and rules as soon as they decide to acquire protection outside their own jurisdiction. In some instances, these systems are only implemented in limited number of countries and there has not been any initiative to converge the already existed rules.

Software protection in Iran

In recent years, dozens of countries have entered the competitive market of exporting software products and services. A research that has been done on these "new software exporting nations" categorized them into four groups based on three criteria namely export revenues, cluster size, and maturity. According to the same research, in which countries like the United States, Canada, Japan and India are categorized in group 1 or "major software exporting" nations, Iran is placed in the group 4 or "infant stage software exporting" nations [15].

Hereafter, the IP protection afforded to software in Iran by three different legal regimes, namely patent, copyright, and sui generis, is examined.

Copyright

Literary and artistic works in Iran are covered by the law on protection of writers, composers, and artists or simply the Iranian Copyright Law enacted in January 12, 1970. In accordance to Article 3 of the Iranian Copyright Law, author's rights include exclusive right to publish, broadcast, perform and publicize works, and further right to any financial and intellectual profit resulting from his work or name. Article 12 of the law makes it clear that the financial rights of the author are transferred to his heirs, or by covenant, for a period of thirty years after his death. Article 13 indicates that the financial right of work produced by employees belongs to the employer for a period of thirty years from the date of production, unless a shorter period or more limited arrangements has been agreed upon. The protection of the Iranian Copyright Law only afforded to works that are printed, distributed or performed for the first time in Iran. In the Law there is no explicit reference to inclusion of software in literary and artistic works, which is clearly expected

regarding its enactment in 1970s [16]. On January 26, 1992, however, an Iranian court ruled against an unauthorized use of a software product referring to the Article 2-11 of the same law. The aforementioned article extends the coverage of the copyright protection to the original technical works. The decision made it clear that the Iranian copyright law has the potentiality of offering a minimum level of protection to software.

Given the fact that Iran has not accepted to Bern Convention, the level of copyright protection afforded to literary and artistic works is not compatible with international norms and standards and as mentioned earlier, is limited to works published for the first time in Iran. Non-Iranian works, therefore, are only protectable in Iran if they are first published in the country.

Patent

Patenting has a rather long history in Iran. The first Iranian patent law dates back to 1924 [17]. According to that law and its improvements enacted in 1931 exclusive rights could be given to anyone who registers "an invention or discovery in the various fields of industry or agriculture". However, "financial schemes", "inventions harmful to public law and order, or public health or morality", and "pharmaceutical formula or compounds" were excluded from patentability according to Article 28 of the same law. Looking at Articles 26 and 27 on patentable subject matters and also considering Article 28, one could conclude that computer software with industrial applicability were covered and protected by the patent law. The old law was replaced by a new law entitled "Patent, Industrial Designs, Trademarks Act", hereinafter called Industrial Property Law, which has been passed by the parliament in January 22, 2008 and formally entered into force from February 16, 2009 [18].In general, the changes introduced into the new law, made some clarifications on issues like the patentability requirements, priority, exclusion from patentability, grace period, Joint inventions and hire-to-invent situations, civil remedies, compulsory licensing and also the intention to shift to an examination based system. As computer software is not mentioned as exclusions from patentability in Article 4 of the new law and, again, it can be inferred that the Iranian legislators have not meant computer software to be excluded from patentability [19,20].

Sui generis

Ambiguities in the legal protection of software had caused the creators of software products not to feel protected or pursue enforcement of their rights against alleged infringers and unauthorized users [21]. Developing a sui generis legal mechanism, hence, was considered by the Iranian legislators trying to remove the ambiguities and to provide more protection to software. On January 9, 2001 a new law entitled "The registration and protection of computer software", which was meant to improve all aspects of software protection, was enacted.

The law categorizes software to "literary and artistic works" and "inventions" and introduces the registration as a requirement for protection. Moreover, Article 22 of its regulation provides for the possibility of simultaneous protection under both patent and copyright systems. According to this law, hereinafter referred to as Software Law, the economic rights of software creators will be valid for a period of 30 years and moral rights have no time limit. The Software Law is very clear when it comes to infringement remedies. Article 13 says that a court may award monetary damages as a remedy for infringement act and infringers will be sentenced to corrective imprisonment for a period of time not more than 91 days and to pay statutory damages, which range from a minimum of 10,000,000 Rials (almost $1000) to a maximum of 50,000,000 Rials (almost $5,000). Article 16 of the law limits the protection only to those software products "created and published" for the first time in Iran [22].

With regard to Article 9 of Software Law, any enforcement actions can and will only take place after receiving a "Technical Certificate": an important milestone in the process of software registration. "Technical Certificate" is issued by the Iranian "High Council of Informatics" (HCI) after the software meets certain requirement. This only happens if its "Publication Clearance" has been previously issued by the Ministry of Culture and Islamic Guidance (MCIG). Publication Clearance mostly concerns the effects of software on public morality and its compliance with Islamic teachings.

A "Patent Committee" formed under the supervision of HCI examines each software invention to see whether it qualifies to receive the Technical Certificate. The committee consists of three software experts and a law expert appointed by HCI and a representative from "The Registration Organization for Deeds and Properties of Iran". Article 2 of the Software Law regulation and the guideline of the Patent Committee clearly preclude all sorts of computer algorithms (not merely mathematical algorithms) from patentability. Moreover, according to Article 2 of the regulation, successful completion of all stages of software development, namely analysis, design, construction, and implementation is a prerequisite for enjoying protection of Software Law [23&24].

The guideline of Patent Committee applies the general patentability requirements, namely novelty, inventive step and industrial applicability, to software patents, too. However, there are no details on the specific standards of patentability in the field of software. The same guideline excludes software merely used for mathematical calculations from patentability. It also allows granting patent right to business method software inventions. Applicants are required, according to the same guideline, to provide the Iranian Patent Office with an electronic copy of their software together with their application [24].

In Software Law, there is no explicit reference to the Iranian Copyright law, although almost similar rights envisaged for the right owners. However, the Patent Law is clearly incorporated by reference in Article 2 of

the Software Law and also Article 22 of its regulation. Therefore, it can be inferred that as far as the software inventions are concerned, the most important role of the software Sui generis system is to clearly underline their patentability. In relation to copyrighted software works, its role is to repackage the existing Copyright Law in a way to: (1) remove any ambiguity in the software protection; (2) add the registration requirement; and (3) limit the protection only to the works created within Iran. In Article 2 of the regulation of Software Law, software is defined as "a set of computer programs, procedures, rules, and associated documentation and also data pertaining to the operation of a computer system with specific application being recorded in a computer-readable recording medium".

Chemical Engineering Software Patents

In this section, the general patent landscape in the field of CES is analyzed using publicly disclosed patent information. This information has always been used, inter alia, for technology trend analysis [25, 26]. To this end, one of the most comprehensive patent databases, QPAT® [27], has been searched using International Patent Classification (IPC) and a selected keyword.

Our search was limited to US patents due to the fact that the number of software patents issued by the US patent and trademark office by far surpasses those of other countries.

The classification, being a means for obtaining internationally uniform classes of patent documents has as its primary purpose the establishment of an effective search tool for the search and retrieval of patent documents [9]. After carefully reviewing the classifications, those shown in table 2 are concluded as relevant to software patents.

Table 2- No. of US patents relating to digital processing class

The detail subject of mathematical operation*	No. Of US patent
Solving equations	626
Solving simultaneous equations	152
Solving differential equations	175
Correlation function computation	840
Matrix or vector computation	970
Function evaluation by approximation methods	825
Evaluating statistical data	1506

*. No. of patents related to the subject "Digital computing or data processing equipment or methods, specially adapted for   specific functions such as complex mathematical operations for …."

The search strategy for identifying CES patents has been developed using these classifications in combination with the keyword "chemical". Our results show that a majority of CES patents are related to "digital computing or data processing equipment or methods specially adapted for specific functions" such as complex mathematical operations. In the field of chemical engineering and

among those mathematical operations listed in table 2, operations for solving equations and evaluating statistical data are the subjects of more CES patents in comparison with others as illustrated in table No. 3.

Table 3- No. of US patents relating to digital processing class in the field of chemical engineering

Subjects of mathematical operations in CES patent	No. Of Us patents
Solving equations	22
Simultaneous equations	8
Differential equations	6
Correlation function computation	8
Matrix or vector computation	14
Function evaluation by approximation methods	5
Evaluating statistical data	43

As we know, modeling and simulation are two important aspects in chemical engineering. Use of computers accelerates the process for performing mathematical calculations and hence more software in this field have been developed. As illustrated in table 1, approximately 4 percent of total US software patents refer to simulation and modeling and it seems the same percent belongs to CES.

The class related to "controlling the apparatus by computer" can be considered as a common referable subject in the field of chemical engineering and the inventions relating to process control instruments can be classified as computer implemented inventions. To control various apparatus application has developed on the extended line of the sequential control. In some fields, about half the applications are of their kind. The substance of the invention lies in the software; however, the expressions for the apparatus are widely done. One example of these software patents is "Method for collecting pressure data from fuel tank" USP 5,652,393 (Lawson) Jul. 29, 1997 [8].

In chemical engineering, some examples of computer implemented inventions are those that use software for controlling instruments such as pressure, temperature meters and recorders.

Case study: Aspen Technology Inc.
To better understand the economical significance of CES and the increasing use of patent protection by top CES developers, the case of Aspen Technology as one of the pioneering providers of CES is briefly introduced here.

Over 75,000 users at over 1,500 companies, many of which are active in petroleum industry, rely on Aspen-Tech's CES. AspenTech's engineering product line is used to design and improve plants and processes, maximizing returns through an asset's operating life [28]. For over 25 years, AspenTech customers have achieved hundreds of millions of dollars in cost savings and performance improvements.

Aspen Tech. was founded in 1981 by Dr. Larry Evans,

a professor of chemical engineering at MIT. Today, Aspen Tech. solutions are used by virtually every leading company in the process manufacturing industry. For 2006, Aspen Technology reported $12.8 million in profit on revenue of $293 million [29]. Our research shows that AspenTech has about 30 CES related inventions (see Annex 1 for more detail) patented and protected in different jurisdictions. "Controlling or regulating systems" and "digital computing or data processing equipment or methods specially adapted for specific functions" respectively are two categories that most patents of Aspen Tech fall into. Analyzing the filing date of registered patents reveals the increasing use of patent rights as an effective protection shield by AspenTech.

Conclusion
In this paper the economical significance of software products and more specifically CES, were studied. The outstanding role of Intellectual Property rights in protecting software assets was also introduced. In addition, various legal mechanisms used in protecting software were presented and the corresponding mechanisms in Iran were analyzed. The analysis of statistics related to software patents revealed the increasing use of patents for CES protection. Ultimately, Aspen Tech, a leading company in production of CES, along with some data on its patenting activities was cited as an example.

It should be reminded that the protection stemming from patent law extends to the underlying idea and algorithm of software. Having this and the ever increasing industrial application of CES in mind, one could expect increasing pursuit of patent protection by CES developers. The Iranian lawmakers, however, have excluded software algorithms from patentability, which is in contrast with common practices in other jurisdictions. Therefore, it could be concluded that the Iranian law, as far as the patent protection of software is concerned, suffers a major setback that, inter alia jeopardizes future development of the Iranian software industry. The negative consequences would be more serious for CES developers. Accordingly, if there is national strategy to foster in-house CES development competencies, amending the mentioned law should be taken into consideration.

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Annex 1- List of AspenTech's CES patents

Rank	Title	Patent No.
1	Computer method and apparatus for constraining a non-linear approximator of an empirical process	US2010057222
2	Systems and methods for modeling of crystallization processes	US2010063783
3	Computer method and system for predicting physical properties using a conceptual segment model	WO2007041134
4	Methods of modeling physical properties of chemical mixtures and articles of use	US2005187748
5	Methods, systems, and articles for controlling a fluid blending system	US2004221889
6	Methods and articles for detecting, verifying, and repairing collinearity	WO2004086155
7	System and method for organizing and sharing of process plant design and operations data	US2004133290
8	Non-linear dynamic predictive device	WO03036396
9	Computer method and apparatus for petroleum trading and logistics	WO200221401
10	Computer network communication method and apparatus	WO200215529
11	Automated closed loop step testing of process units	WO200205042
12	A method and a system for on-line screening of chemical customers	WO200184352
13	Sensor validation method and apparatus	WO200148571
14	Computer method and apparatus for optimized controller in a non-linear process	WO200146762
15	Computer method and apparatus for determining state of physical properties in a chemical process	WO200125863
16	Robust steady-state target calculation for model predictive control	WO200018420
17	Polymer property distribution functions methodology and simulators	WO9953387
18	Computer method and apparatus for automatic execution of software applications	WO9946711
19	Non-linear dynamic predictive device	WO9917175
20	Method and apparatus for simulating and optimizing a plant model	US6041263
21	Analyzer for modeling and optimizing maintenance operations	US6246972
22	Apparatus and method for selecting a working data set for model development	US5809490
23	Hybrid linear-neural network process control	US5877954
24	System for removal of noxious fumes	CA2157944
25	Polymer component characterization method and process simulation apparatus	US5687090
26	Plant simulation and optimization software apparatus and method using dual execution models	CA2149169
27	Process flow diagram generator	US5596704
28	Control system using an adaptive neural network for target and path optimization for a multivariable, nonlinear process	CA2106049
29	System for displaying different subsets of screen views, entering different amount of information, and determining correctness of input dependent upon current user input	US5008810