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Application Study on Business Process Reengineering (BPR) about Petri Net

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Abstract: For strengthening the enterprise flexibility radically, it is necessary for enterprise to carry out Business Process Reengineering (BPR). The theory of expanded Petri net has been introduced into the domain of Business Process Reengineering (BPR) on the basis of comparison among several model tools frequently used in process description. A new Petri method net to describe the dynamic and parallel product development process is put forward, and the detailed model of designing and process planning of spare parts is built. All these will make us have a clear and overall description of product development process.

Key words: Business Process Reengineering (BPR); Petri net; process model

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1 Forward

Remarkable achievements have been made in studying and applying CIMS in China. However, many enterprises, which have applied CIMS, are now confronted with various problems brought about by the inharmony between the management mechanism and the technology of CIMS. The reason lies in that those who have carried out CIMS are built by to the principle of division of labor, and the operated mechanism is of function. In the process of carrying out CIMS, if using the methods of traditional system analysis and design, it would be a limitation for all activities dealt with to be functioned, and could not change the operating model of business process, this causes that productivity has been improved in part of the process, but it has no improvement in the whole business process. This kind of process is not symmetrical with CIMS, which is a kind of high—automatic technology. To succeed in applying comprehensive integration of CIMS, it should reengineer the business process and transform the business process completely. Business process reengineering is that it has business process as the object to be reformed, gives a radical thinking and analysis to business process from the enterprise strategic target and process prospect, uses information technology, employee and institutional management to make the business quality index and achievement greatly improved, and strengthens the enterprise flexibility radically.

Davenport and Short (1990) point out Business process is a series of job carried out logically to achieve the given business export[1]. In 1993, Davenport gives that Business process is a series of structural and measurable business activities, which is designed for the given customers or markets to produce specific output[2]. Among the popular viewpoints, business process has two important characters: (1) they all have internal and external customers. (2) They cross the organizational boundary (that is, they happen among the organization subunit) and are taken to discriminate business process.

There is one thing, we need to point out, that business process generally refers to all the intercourse among the enterprise business. We should emphasize those business activities about enterprise targets and those processes of making the products' value increase. To address this is very important for Chinese developing enterprises.

The paper will apply the extended Petri net to model and analyze the business process. A new method of using Petri net to describe the dynamic and parallel product development process is put forward, and the detailed model of designing and process planning of spare parts is built. All these will make us have a clear and overall description of product development process.

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Biography: XU Xu—shan (1973—), male, Doctor

The paper takes the following structure. Section 1 gives the model requirements of BPR. Section 2 introduces the BPR model tools, including Petri net. Section3 highlight the support of process model (PM) for BPR. Section 4 analyzes the product development process. Section 5 gives the conclusions.

2 The modeling requirement of BPR

Business process is a complex system. And how to discriminate the business process among the complicated activities and relations is the base of identifying and improving business process. Therefore, it is necessary to counter characters and needs of BPR, and needs special researches of the process model and relative model questions of BPR. That is to say, process model of BPR needs the following characters and capabilities:

1) Countering process and supporting the process reengineering;

2) Having the capability and means between system and circumstance;

3) Easy to exploit the manipulation enforcement plans;

4) Having parallelism and distribution;

5) Having descriptive abilities of system organizational factors and supporting the multi—intellect cooperation and communication;

6) Supporting static and dynamic analysis simultaneously.

The target of process model (PM) is to construct structural model elements and specifications so as to describe the complicated process structure and relation abstractly and made the readers agree with business process from the model. Accurate and clear business process model is the base of understanding, describing and reengineering business process.

Tab. 1 Comparison of the process description models

	Flow Charts	RADs	IDEF	Event—process chain	Petri Net
Process character	Function—ed	Functioned	Functioned	Cross functioned	Cross functioned
Model orientation	Mixed	Mixed	Function—countering	Function—countering	Mixed
Abstract (or not)	Not	Not	Ok	Not	Ok
Understandability	Quite well	Needing strict supports	Ordinary	Ordinary	Ordinary
Computerization	Ok	Ok	Ok	Weakly	Ok
Supporting of process reengineering	Weakly	Weakly	Weakly	Needing further developing	Needing further developing
Including organizational factors (or not)	Not	Yes	Not	Yes	Not
Dynamic or not	Yes	Not	Not	Yes	Yes

The traditional methods usually support the above model requirements, and therefore could not satisfy the model need of BPR. Today, there are some process description model methods that are often applied, such as Flow Charts[3], Role Activity Diagrams (RADs)[3], IDEF[4], Event—process chain[5], Petri net, which are put forward from different domain and different researched problems. Although they are not completely designed for process, and some are designed to counter functions, they all have the probability to be used to model business process, and have their own merit and inferior strength (seen table 1.).

In brief, among all the present kinds of business process models, there are no present modeling tools to completely satisfy the model of BPR. However, according to the synthesized comparisons and evaluations of various modeling tools in table 1, we can find Petri net fit for supporting BPR fairly well among those. From the viewpoints of validity, Petri net not only has well—considered theory as the base of system analysis, but has fairly good computerization.

3 Petri net is a modeling tool of BPR

Petri net is a modeling tool, which is designed for the description and analysis of complex system. Its merits can be reflected in describing simultaneous eruptions, conflicts, synchronism, and one of its characters is the strictness in supporting formal procedures and mathematical di-

agrams, especially it can be directly expressed and programmed. All these make Petri net become a more and more popular modeling tool. Although classic Petri net has been applied in many kinds of domain, it still needs necessary extensions and explorations in organizational factors description, model analysis and manipulation while used to subside th BPR model. Here, we will extend the Petri net into timed Petri net, and make timed Petri net as a powerful tool of modeling BPR.

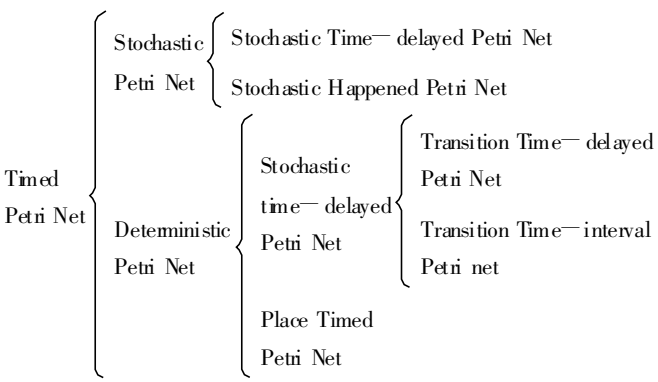

Fig. 1 Timed Petri Net

Timed Petri net (PN) is an kind of Petri net that places and transitions are of timeliness. Timed Petri net can be classified as described in Fig. 1. From Fig. 1, we know that timed Petri net can be classified into two types: Stochastic Timed Petri Net (STPN) and Deterministic Timed PN (DTPN). STPN refers that transition happening time and delayed time are stochastic. And it can be classified into Time—Delayed Stochastic Petri Net (TDSPN) and Happening Timed Stochastic Petri Net (HTSPN, or General STPN). TDSPN refers that the delayed time of transition is stochastic. And generally, it is exponentially distributed. HTSPN means that the happening time of transition is stochastic, and the delayed time of transitions is zero.

DTPN means that the assumed place and the delayed time are certain. And it can be classified into Place Timed Petri Net (PTPN) and Transition Timed Petri Net (TTPN). PTPN is used to set the delayed time of place, and TTPN is used to set the time of transition. TTPN can be defined into Time Delayed Petri Net (TDPN) and Timed Interval Petri Net (TIPN), TDPN emans the time interval of transition happening (time a1of starting fire, and time a2 of ceasing fire). Transition can only happens between the interval (a1, a2), and can't happen out of the interval. This paper uses TDSPN to build PM.

4 Support of PM for BPR

Decomposition and merger of PM are the technologies of separating or collecting PM according to different investigated problems in an abstract level, which base on the Petri synthetic technologies. The initial merging of Petri synthetic technologies was to avoid too much joints in analyzing a large system and flaws of extreme complication. In order to solve the problems there exits two ways. One is a method of withering them away; another is a synthetic method. In a word, there are two ways, one is from up to down, another is from bottom to top, which correspond the decomposition and merger.

The decomposition of PM often begins from a large model, which has ignored partial details. While separating the initial model into smaller scale models, it will pay attention to more details. The principles of decomposition include the following:

(1) Tally with the need of analyzing problems;

(2) Refer to the methods of dividing different domains among the whole business model;

(3) Satisfy the high integration among sub—models and low coupling among sub—models simultaneously.

The merger of PM, which is the adverse process of decomposition, is a process of integrating the separated sub—system model that has ignored the mutual actions. The essence of merger is the common places and transitions possessed by those different sub—systems models, e.g. the process actions on behalf of the same function, or the place of activity state between different sub—systems. These common places and transitions stand for the mutual actions among sub—systems. In the merging process, it should consider these mutual actions fully, and integrate the corresponding sub—systems into a much bigger sub—system by merging these places and transitions.

The supports of PM for BPR can be addressed in two ways. One is the support of systems thinking by analyzing models, another is the support of systems reengineering by reforming models. The former is the network character analysis, whose purposes are to evaluate and diagnose, and the latter changes and optimizes the network structure with the help of certain rules.

Since PM is a kind of model, which bases on Petri net, we can divide it into two types: internal and external characters analysis. For the PM of countering BPR, what is much more important is the analysis of its external characters. In the former of the paper, Petri net has been extended into timed Petri net, and its properties (such as time) have been introduced. All these are just for the convenience of analyzing PM's external characters. With the help of PM's properties, we can get some quantitative indexes by use of computing and analyzing so as to compare and evaluate the effect of modeling change. Timed analysis is an analysis of timed properties relation process. It influences the length of time in servicing customers, and it is a reflection of servicing speed and quality. Also it is one of the important factors in deciding the degree of customers' satisfactions. E.g. the time used in process responses the servicing speed, and the greatest time of process decides customers' biggest waiting time. If we extend the time property of PM into a group of mean time, largest time and shortest time, it can be further analyzed.

5 Analysis of Product Development Process

Product development is the key to success among the whole business process. At present, developments in many enterprises have lost contact with real productions because there are various irrational phenomena in the process of product development. The birth of a new product exists three cooperative workings. (1) Product designation, including product variety designing and structure designing. The former is decided by market and target, and product concept designation is its main content. The latter is the design of product structure, material and technology for manufacture. (2) Manufacture process designing, including productive plans, choices of equipments, the arrangements of workshops and technological processes. (3) The development of product servicing and systems maintenance, including markets and retails. Concept designing is the initial designing phase of product development, which bases on parallel process. And it is different from traditional parallel projects. The difference lies in that the traditional parallel projects make the business plans first, then begin to carry out product designing, productive management and manufacture process designing. After the introduction of the traditional parallel project, it goes on to start product concepts and project designs while carrying about business plans, and the management department will make policy of important design problems at any time. At the same time, the communication of mutual information product concepts design and projects design will improve the feasibility of ultimate designing, we may use these Petri net characters, combine manufacture product development process, and build up the product development process model of Petri net (as is shown in Fig. 2). The directions of places and transitions are given in table 2.

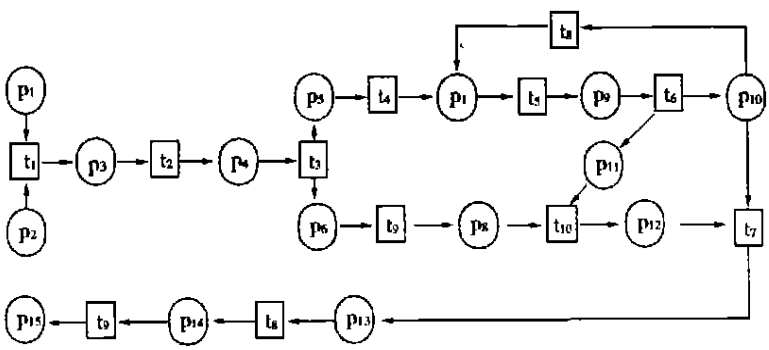

Fig. 2 The Petri net model of product development process

Indication: There is only one Token in the variable of p_1 and p_2, and the capacities are 1 whole

According to detailed mechanism of Petri net, we can detail the decompositions of many transitions in Fig. 2. Therefore, we detail the variable t_8, and the Petri net model of product parts designing and technological designing process (shown in the Fig. 3). At last, we detail and decompose the process on the basis of needs and carry about the process designation on the basis of built models.

Tab. 2 The direction of places and transitions in the Petri net model

Place	Contents	Trans— ition	Function
p_1	Market information	T_1	Product design policy
p_2	Changing of target product	t_2	Analysis of concept product characters
p_3	Concept product characters	t_3	Developing policy of product variety
p_4	Character design of product variety	t_4	Information process of product variety
p_5	The adopted parts among product varieties	t_5	Initial design of product varieties
p_6	Requirements of productive system	t_6	Classification of achievements in the initial design of product variety
p_7	The integrated data of modified information and adopted design information of product varieties	t_7	Policy of product design and manufacture system program
p_8	Manufacture systems functional analyzing results	t_8	Product spare parts' design and process design
p_9	Initial designing results of product varieties	t_9	Manufacture system functional analysis
p_{10}	Testing and policy department of initial designing	t_{10}	Initial manufacture system designation that integrates initial design of product variety
p_{11}	Information of initial product varieties design, which is useful for the manufacture system		
p_{12}	Results of manufacture system character design		
p_{13}	The adopted parts of initial product variety design and initial systems character design		
p_{14}	Resource data		
p_{15}	Productive plan outline		
p'_1	Analysis of product parts	t_{81}	Initial spare parts' design
p'_2	Department of initial spare parts design test and policy	t_{82}	Evaluation of initial spare parts' design
p'_3	Department of character design test and policy	t_{83}	Character design
p'_4	Character technological process test	t_{84}	Initial character evaluation
p'_5	The whole analysis of spare parts	t_{85}	Character technological design
p'_6	Department of whole spare parts test	t_{86}	Detailed character evaluation
		t_{87}	The whole design of spare parts
		t_{88}	Technological design of spare parts
		t_{89}	The whole evaluation of spare parts

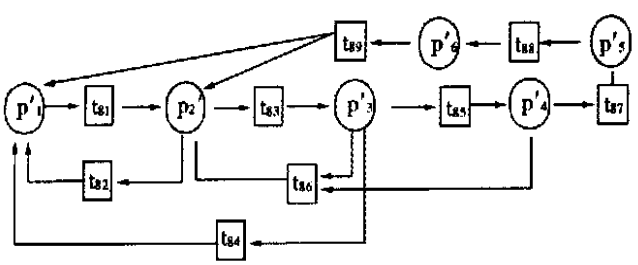

Fig. 3 Petri net of product spare parts' design and technological designing process

6 Conclusions

The abilities of Petri net in describing various relations such as process complications, conflicts and synchronizations make it fit for supporting process model of BPR in its validity and practicability. According to the abstract and detailed mechanisms and the decomposing and integrating mechanisms, we give an example to set up a Petri net model of product parts design and technological designing process. The next steps are to do the quantitative analyses, reengineer the business process scientifically, change the business process completely, and succeed in carry out the whole integration of CIMS really.

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Petri 网在经营过程重构(BPR)中的应用研究

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摘 要 为了强化企业的可变性, 执行经营过程重构是必要的。基于与几种常用的用于过程描述的工具的比较, Petri 网现已被应用于企业经营过程重构领域, 提出了一种新的Petri 网的运用。描述了一种新的动态的和平行的生产过程, 详细的模型的描述, 建立了各个不同部分的执行计划。

关键词 经营过程重构; Petri 网; 运营模型

(*From P.2*)

$\mathrm{Im}\mu=[0, \mu(\theta)]$, $\mathrm{supp}\mu=\{x \mid \mu(x)>0\}$
$\mathrm{Im}\mu^{+}=[1-0, \mu(\theta), 1]$, $\mathrm{supp}\mu^{+}=\{x \mid \mu^{+}(x)>0\}$

Proposition 3.1 Let G be a near—ring, μ the fuzzy R—subgroup of G. If

$\varphi: \mathrm{Im}\mu\to\mathrm{Im}\mu^{+}$, $\varphi(\lambda)=\lambda+1-\mu(\theta)$, $\lambda\in\mathrm{Im}\mu$, then φ is a lattice—homomorphism., and $\mu^{+}_{\alpha}=\mu_{\alpha+\mu(\theta)-1}$. ($\alpha\geqslant 1-\mu(\theta)$)

Proof It is clear.

Corollary 3.2 Let G be a near—ring, μ the fuzzy R—subgroup of G. If μ is not normal, then

$$supp\mu^{+}=G.$$

Corollary 3.3 Let G be a near—ring, μ the fuzzy R—subgroup of G, then supp $\mu\subseteq$supp μ^{+}, and supp μ = *supp* $\mu^{+}\Leftrightarrow\mu(\theta)=1$.

Theorem 3.4 Let G be a near—ring, μ the fuzzy R—subgroup of *G*, then μ is fuzzy isomorphic to μ^{+}. In other word, μ^{+} is only the upgrade of μ.

Proof Let $\varphi: \mathrm{Im}\mu\to\mathrm{Im}\mu^{+}$, $\varphi(\lambda)=\lambda+1-\mu(\theta)$, $\lambda\in\mathrm{Im}\mu$, by Proposition3.1, $\varphi$is a lattice—homomorphism.. Suppose that

$$f: \mu_{[0]}\to\mu^{+}_{[\varphi(0)]}, f(x)=x,$$

it is clear that the f is a isomorphism from μ to μ^{+}. Thus $\tilde{f}=<f, \varphi>: \mu\to\mu^{+}$ is a fuzzy isomorphism.

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拟环上模糊正规 R 子群的模糊同态

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摘 要 本文首先定义了两个拟环之间的模糊同态映射. 基于这种模糊同态, 证明了模糊正规右(左)R 子群+ 与模糊右(左)R 子群同构. 于是任何一个模糊右(左)R 子群均是一个模糊正规右(左)R 子群。

关键词 模糊同态; 拟环; 模糊 R 子群