**摘要**

当今信息互联网时代下，业务流程再造（Business Process Reengineering, BPR）吸引了包括航空制造企业在内的许多企业的目光，纷纷将这一概念运用到采购供应过程中去，以提高企业自身的市场竞争力。业务流程再造对企业的业务流程进行了根本的重新思考和彻底的重新设计，目标就是获得各方面的企业业绩提升。自从该方法问世以来，许多的企业通过自身实践证明了业务流程再造确实是一种行之有效的改革方法，企业优化了自身的经营模式，提升了自身的实力优势，使企业能够在错综复杂的市场竞争中立于不败之地，保持了可持续发展的活力。

然而，许多企业在实施再造的过程中并没有将自身的采购业务流程与技术评价系统做到有效的集成，也没有将其中蕴含的大量的技术、社会、组织、经济和人事风险考虑进去，从而使得业务流程再造的优势无法得到充分的体现，进而付出了高昂的代价：采购业务流程再造实施成本高、过程长，各个企业失败的例子比比皆是，甚至比例远远高于成功的比例，影响了其他企业采用业务流程再造方法的积极性。探究其原因，固然是因为它们没有以系统的观点思考企业的采购业务流程和其他的业务流程，领导和员工没有从根本上抛弃固有的陈旧观念。更重要的是，目前缺乏系统科学的流程再造方法指导，从而无法可靠地实施再造的过程和验证再造的效果，缺乏非常有效的数学理论和计算机工具的支持。因此本文通过作者在工作实践期间参与完成的航空制造企业的流程再造实施工作，探索一种能够应用于航空制造企业采购业务流程再造的设计、分析、实施和验证的工具，从而在保证了使用科学的方法论来指导流程，降低了实施再造的风险，取得了良好的效果。

本文在回顾了包括波音公司、空客公司和中国商飞在内的国内外航空制造业的采购模式的基础上，对航空制造业的市场发展，采购部门在企业中的意义，以及几种采购模式进行了阐述，并且分析了互联网数字时代下航空制造业采购流程业务的特别之处。本文使用管理学中的SWOT 分析方法提出了当今的市场对于航空制造业流程再造的发展模式带来的挑战，从而引出了对业务流程本身进行科学建模、改造和验证的课题。接下来，本文明确了业务流程再造的概念、目标、原则、实施步骤和评价指标体系。通过选择，分析和对比，对于几种现有的主流流程建模方法进行了概览，包括了数据流程图方法（DFD）、集成化定义（IDEF）方法、作用活动图（RAD）、事件链模型分析（EPC），最后选择了兼具数学基础和直观图形化表达的Petri网络作为分析的基础工具。

本文接下来讨论了Petri网络的基本理论和对Petri网络的时间、层次和有色的扩展，并且运用扩展的 Petri网建模方法来对业务流程进行建模。针对中国商飞的企业业务流程特点，以物料采购流程的实际再造为实例，验证了基于Petri网络的业务流程再造对于航空制造企业的重要意义。着重通过网络覆盖性质判断，帮助决定了流程的有界性、可达性、无死锁、终止性、活性以及可逆性，并且引入了流程的稳健不变性作为工作流网络优化的指导原则，通过一系列的网络的优化规则指导业务流程再造的过程。其次，通过关联矩阵和不变量的分析，指导了Petri网络层级扩展的分解，也方便了静态特性的分析。最后还使用随机平稳过程Petri网络（GSPN）的仿真工具识别出业务流程再造的关键步骤，并且提出了优化后的业务流程，使用仿真工具验证了优化的有效性。

可以看到，基于 Petri 网络的方法进行流程再造，具有图形化描述、语义精确、表达能力强、关注业务活动之间的状态关系的优势。可以用来评测流程的正确性、稳定性和响应时间性能，也可以使用层级方法再造整合全部的流程和细化子流程。本文在对航空制造业的采购业务流程再造有所启发和借鉴的同时，也提出了一些现有Petri网络方法的不足和对未来面临挑战的展望。

**关键词：**业务流程再造，航空制造业，工作流建模，扩展Petri网络

**ABSTRACT**

Under today's Internet age of the, Business Process Reengineering, or BPR, has attracted a lot of attention of many businesses, including aviation manufacturing enterprises. They have to apply this concept to the process of procurement and supply, in order to improve their market competitiveness. The enterprise business process reengineering requires fundamental rethinking and radical re-design. The true goal is to get all aspects of business performance improvement. Since the advantage of this method, many enterprises have proven that business process reengineering is indeed an effective approach to reform enterprises, optimize their business model and enhance the strength of their own advantages on the market, so that enterprises can compete in the complex market position, maintaining the vitality of their sustainable development.

However, many companies do not have to pay enough attention of how their own buying business processes integrate with technical implementation and evaluation of the system, nor in how a large number of technical, social, organizational, economic and personnel risks inherent should be taken into account. Therefore, BPR advantages cannot be fully reflected, and the enterprise then paid a high price: The purchase BPR implementation leads to high cost, long process. There are more examples of various businesses failing everywhere, even the proportion is much higher than the proportion of success. That influences other companies to lose the enthusiasm of business process reengineering approach. To explore the reason, of course, it is because they are not in the master of systematic thinking enterprise integrating business processes and other business processes. Their leadership and staff did not abandon inherent stern thinking fundamentally. More importantly, it is because the lack of systematic and scientific methods to guide process reengineering, and thus we cannot reliably verify the implementation of the reconstruction process and the effect of reconstruction. Also, there is a lack of effective mathematical theory support and computer tools. Therefore, author of this article, who was involved in a practice of implementation of aviation companies purchase process reengineering, explored a way and a tool to design, analyze, implement and verify what can be applied in aviation manufacturing enterprise business process reengineering tools. By doing this, it ensures the use of science methodology to guide the process, reduce the risk of re-implementation, and achieved some good results.

This paper reviews the purchasing patterns of domestic and international aviation industry enterprises including Boeing, Airbus and China Commercial Aircraft Co., Ltd. It describes the significance of the market development of aviation manufacturing, the purchasing department in the enterprise, as well as several procurement model. It also analyzed why aviation manufacturing purchasing process is special in the Internet era of digital business. As used in management science, a SWOT analysis is performed to reveal the challenges of today's market for the aviation industry to develop BPR, which leads to the need of a scientific business process modeling, transformation and validation ways.

Next, the paper defined the concept of business process reengineering, objectives, principles, actual steps and evaluation system. Through selection, analysis and comparison of several existing mainstream process models, including the method of data flow (DFD), integrated definition (IDEF) method, role activity diagram (RAD), the chain of events model analysis (EPC), the final choice becomes Petri Netss with both mathematical foundation and intuitive graphical representation to serve a basis for analytical tools.

Then the article discusses the basic Petri Nets theory and some extended Petri extended network like time Petri Nets, hierarchical Petri Nets and colored Petri Nets. It uses extended Petri net modeling method to model business processes. The thesis features China Commercial Aircraft Co., Ltd. Shanghai Aircraft Manufacturing Factory, the actual purchasing of metal parts of the procurement process as an example. The method is based on Petri Nets to verify the Business Process Reengineering for aerospace manufacturers. Firstly, it focuses on network coverage graph to determine the work flow properties like boundedness, reachability, deadlock-free, termination, liveness and reversibility, it also introduces the soundness of a process workflow as network optimization guidelines, by applying a series of network optimization rules guiding our BPR process. Secondly, by analyzing the index matrix and invariant, it guided the expansion of the network level Petri decomposition and also facilitates analysis of static characteristics. Finally, it used a Generalized Stochastic Petri Nets (GSPN) simulation tools to identify critical steps of the business process reengineering, and proposes optimized business processes, verify the validity of this optimization by profiling and simulation tools.

As we can see from the thesis, Petri Nets as a process reengineering method, has a graphic descriptions of semantic precision, and focus on the advantages of using state and the relationship between business activities. It can be used to review not only the correctness and stability of the process, but also response time performance. It can also be used to integrate all-tiers of reengineering processes with every sub-processes refined. In this thesis, aviation manufacturing purchasing business process reengineering can be inspired, but it also raised deficiencies and the future challenges we face of some existing Petri Nets methodology.

**Keywords:** business process re-engineering, aviation industry, purchase workflow modeling, extended Petri Nets