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# Industrial information integration—A literature review 2006–2015

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ABSTRACT

In the last few years, Industrial Information Integration Engineering (IIIE) has attracted much attention by the information and communications technology (ICT) community. However, despite of the dynamic nature of this research area, a systematic and extensive review of recent research on IIIE is unavailable. Accordingly, this study conducts an intensive literature review on IIIE and presents an overview of IIIE's content, scope and findings, and potential research opportunities by examining existing literatures from 2006 to 2015 in all databases within Web of Science. Altogether, 497 papers related to IIIE are grouped into 37 research categories and reviewed. The results add knowledge to the existing ones by answering what the current level of development on IIIE is and what the potential future research directions of IIIE are.



## 1. Introduction

Industrial Information Integration Engineering (IIIE) is "a complex giant system that can advance and integrate the concepts, theory, and methods in each relevant discipline and open up a new discipline for industry information integration purposes" ([477], p206). Broadly speaking, IIIE is a set of foundational concepts and techniques that facilitate the industrial information integration process; specifically speaking, IIIE comprises methods for solving complex problems when developing information technology infrastructure for industrial sectors, especially in the aspect of information integration. IIIE emerges as a new scientific subdiscipline [477]. IIIE was first proposed as a scientific subdiscipline at a meeting of the International Federation for Information Processing (IFIP) Technical Committee for Information systems (TC8) held in June 2005 at Guimarães, Portugal. In 2007, the Institute of Electrical and Electronics Engineers (IEEE) Systems, Man, and Cybernetics (SMC) Technical Committee on enterprise information system (EIS) was established, focusing on the interface between engineering disciplines and industry information integration engineering.

According to Xu [477], the discipline structure of IIIE has five layers as shown in Fig. 1. In Fig. 1, IIIE is at the top level. Relevant scientific, engineering, management, and social science disciplines are at the second level. At the third level are application engineering fields. The fourth level and the level below have many relevant frameworks, theories, and models. As an interdisciplinary discipline, IIIE interacts with scientific disciplines such as mathematics, computer science, and almost every engineering discipline among the 12 engineering discipline defined by the U.S. National Academy of Engineering (http://www.nae.edu/MemebersSection/Sections.aspx). Xu [477] points out that IIIE interacts with almost each of these disciplines in separate layers. For example, IIIE interacts with computer science and engineering, industrial systems engineering, information systems engineering, and interdisciplinary engineering in terms of scientific and engineering methods. Meanwhile, IIIE interacts with aerospace engineering, bioengineering, civil engineering, energy engineering, communication engineering, material engineering, and earth resources engineering at the application layer in different industrial sectors. Furthermore, IIIE interacts with management and social science as well. In practice, rapid advances in industrial information integration methods have spurred tremendous growth in the use of enterprise systems. Consequently, a variety of techniques have been used for probing IIIE so far. These techniques include business process management (BPM), workflow management, enterprise application integration (EAI), Service-Oriented Architecture (SOA), grid computing, and others.

Although IIIE has attracted much attention in academia and many techniques have been used for probing IIIE in practice so far, systematic and extensively reviews of recent research on IIIE are unavailable. Accordingly, this study conducts an intensive literature review on IIIE and presents an overview of IIIE's content, scope, and potential research opportunities by examining existing literatures from 2006 to 2015 in all databases within Web of Science. Altogether, 497 papers related to IIIE are grouped into 37 research categories and reviewed. The results add knowledge to the existing ones by answering what the current level of development on IIIE is and what the potential future research directions on IIIE are.

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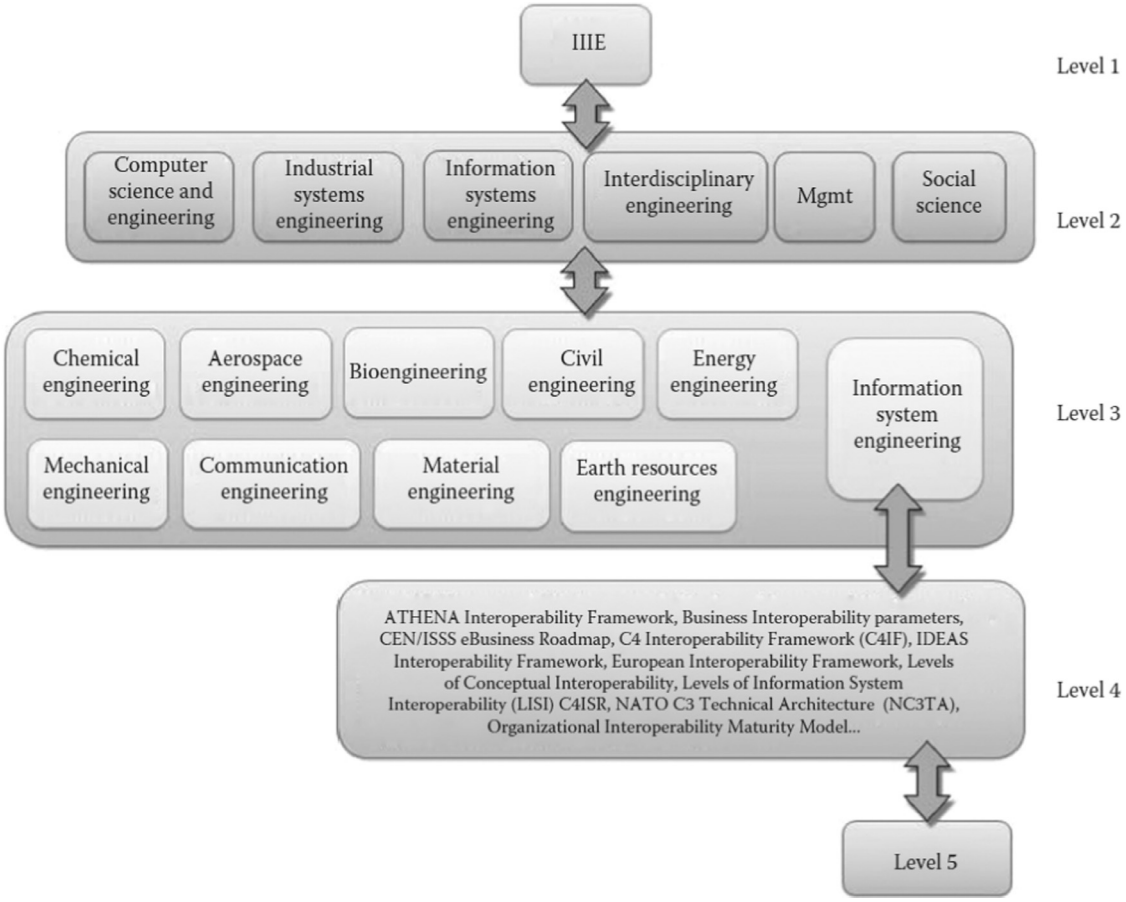


**Fig. 1.** Discipline structure of IIIE [477].

The remainder of this paper is organized as follows: Section 2 introduce the research methodology adopted in this study. Section 3 summarizes the content of selected papers in the 37 research categories. Section 4 outlines the findings of the literature review and provides potential directions for future research on IIIE. At the end, Section 5 provides the conclusions.

## 2. Methodology

This study chooses "Industrial Information Integration" as the keyword for topic search and searches published papers from 2006 to 2015 collected by all databases in Web of Science, including Web of Science Core Collection, BIOSIS Citation Index, Current Contents Connect, Data Citation Index, Derwent Innovations Index, KCI-Korean Journal Database, MEDLINE, SciELO Citation Index, and Zoological Record. The search returns 1407 results, which cover diverse industry sectors. Additionally, the authors of these papers come from a widely geographically-spread countries. The search results indicate that since it was initiated in 2005, IIIE has actively driven research and promoted industrial and service activities. Next, the abstracts of these 1407 papers were carefully reviewed and then unrelated ones were dropped. At the end, 497 papers were left and they then were grouped into 37 research categories as shown in Table 1.

Research categories in this study extend the disciplines that Xu [477] identified in the second and the third levels of IIIE (see Fig. 1). For example, agriculture/food, disaster, ecosystem, environment, healthcare, information and communications technology (ICT), supply chain, and security are not in the levels of IIIE identified by Xu [477], but they have attracted much attention from scholars in recent years.

The distribution of publication years of the 497 papers is listed in Table 2. It can be seen that the number of publications doubled in 2008 compared with those in the previous two years. Since 2008, the numbers of publications have been stable. Overall, the distribution of publication years indicates that IIIE has attracted much attention from 2006 to 2015.

## 3. Industrial information integration in industrial sectors

This section summarizes the content of selected 497 papers, which are grouped into 37 research categories. Potential directions for future research are discussed in the research category as well if the selected papers cover them.

### 3.1. Aerospace

Monitoring machining process needs fast, efficient, easy and open communication standard. Accordingly, Szulewski [420], the only paper in this research category as shown in Table 3, presents the office Ethernet implementation, an inexpensive and ordinary network system, as data transmission structure for monitoring Heuristic-Systematic Model (HSM) process in aerospace industry. He also did laboratory tests with different protocols and configuration and formulated several rules to help potential users.

### 3.2. Agriculture

This research category has 14 papers as shown in Table 4. These papers can be grouped into two research sub-categories: agriculture and food.