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## Four types of manufacturing process innovation and their managerial concerns

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### Abstract

Manufacturing process innovation (MPI), an organization-wide effort involving radical redesign of manufacturing related processes and systems to achieve dramatic improvements in critical manufacturing performance measures, encompasses various kinds of activities. Some MPI initiatives focus on technological innovation and others may intend to change work processes and organizations' behavioral routines. Some organizations adopt new technological solutions or work methods that are externally available, while others may develop and adopt novel technologies or organizational routines which are new to the state of the art. Different focus in MPI initiatives requires different approaches and preconditions for achieving desired outcomes. However, MPI has been mostly treated as one type of innovation in literature and further classifications of MPI have not been made. This paper presents four types of MPI and discusses what managers can expect and prepare for each type of MPI. Basic strategic directions in terms of what type of MPI can be conducted at a specific organization is also discussed. The four types of MPI is developed through a literature review of various research fields, for instance manufacturing strategy, process innovation, organizational innovation, typology of innovation, and new product development.

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### 1. Introduction

Severe competition in a global arena requires manufacturing companies to continuously develop their manufacturing functions for greater efficiency and speed. Moreover, in a business environment characterized by fast-paced change, it is hard for manufacturing functions to sustain operational competitiveness as long as the speed of improvements is moderate. The functions must have a capacity to undertake large-scale improvements of a radical and innovative nature, as a complement to incremental improvements. This paper features innovation in manufacturing related processes that is referred to as manufacturing process innovation (MPI).

MPI encompasses a wide range of activities. Some MPI initiatives focus on technological innovation, for instance adopting new technologies or installing new pieces of equipment at factories. Some other MPI

initiatives may involve changing work processes, material and information flows, or organizations' behavioral routines in factories. In MPI, a manufacturing organization may adopt new technological solutions or work methods that are externally available, or it may develop and install novel technologies or work routines which are new to the industry.

Different types of MPI exist, and the different types may require different approaches and preconditions in order for an organization to achieve desired outcomes in MPI. Although a number of researchers have discussed typologies of innovation in literature [1, 2], they have not paid much attention to different types of MPI, nor have they discussed what approaches and preconditions can be needed to achieve different types of MPI.

The purpose of this paper is to propose types of MPI and to discuss possible approaches and important factors that managers need to consider for each type of MPI. A basic strategic direction in terms of what type of MPI

can be conducted in a specific manufacturing organization is also discussed. The types of MPI have been developed through a literature review of research fields such as manufacturing strategy, process innovation, organizational innovation, and innovation management.

## 2. Conceptualization of MPI

In this section, MPI is conceptualized in more detail. Manufacturing process innovation can be defined in various ways, but in this paper it is defined based on the well-known definition of process innovation suggested by Hammer and Champy [3]; an organization-wide effort that involves fundamental rethinking and radical redesign of manufacturing related processes and systems to achieve dramatic improvements in manufacturing performance measures such as cost, quality, service, and speed. In MPI, changes are made not only in the processes of transforming raw materials into products, but also other support processes and systems related to, for instance production planning, logistics, purchasing, administration, engineering, and management [4]. Since MPI is an organization-wide effort, it is usually conducted in a form of a project or an initiative. This paper focuses on factory-level MPI. Some researchers describe MPI as an abrupt step change, while others discuss that MPI does not necessarily mean one big jump but can be a result of many smaller changes that occur in concert and reinforce each other toward a radically new form [5].

A life cycle of MPI, here termed as a process of MPI, has been analyzed by a numbers of researchers. Various life cycle models of MPI have been presented in the literature [6, 7]. These models are different at a detail level but in general they contain three phases that can be called, preparation, design, and implementation. Each phase involves different activities as shown in Table 1.

Table 1. Phases in a process of MPI

Phase	Activity
Preparation	Securing management commitment, identifying processes to be improved, aligning with corporate and business strategies, establishing process vision, setting stretched targets, forming a promotion organization and/or a steering committee, formulating projects, providing education
Design	Analyzing focused processes, exploring alternatives, designing new processes, prototyping and evaluating new processes
Implementation	Implementing new processes, training employees, monitoring performance measures, continuing improvements

Some researchers advocate a normative and linear process of MPI, based on the assumption that that a change can be managed and controlled through well-thought-out and analytical-driven planning exercises. The mentioned kind of approach toward a change is often called deliberate approach [8]. Some other researchers advocate another kind of approach so called deliberate-emergent approach [8, 9, 10]. In the deliberate-emergent approach, MPI is initiated and its targets are set by the management, but how to achieve the targets are largely left to employees to discover through experiments and learning.

## 3. Approach toward classifying MPI

One of the purposes of this paper is to classify MPI into a few types. To meet this purpose, the present study adopted an approach including three steps;

- Undertaking a literature review to gather models, frameworks, discussions, etc. that can be relevant to classifying MPI,
- Analyzing the gathered information to identify appropriate dimensions of classifying MPI, and
- Constructing a model that presents types of MPI.

### 3.1. Literature review

The literature review started with searching with keywords such as “innovation and type”, “manufacturing, innovation, and type”, “process innovation and type”, “manufacturing, strategy, and type”, in online databases for instance Web of Science, Google Scholar, Emerald, etc. The articles and books that included models and frameworks classifying various kinds of changes or innovations were selected for the review. The selected articles and books were from various research fields, such as innovation management, process innovation, manufacturing strategy, organizational innovation, and new product development.

### 3.2. Analysis of the collected models and frameworks

The models, frameworks, and discussions in the reviewed literature classified changes or innovations in one or more of following three dimensions; scale of change, subject of change, and innovativeness of change.

The scale of change refers to at which system level a change occurs. A change can happen at a subsystem (e.g. a small part of a factory) or across the whole system (e.g. the whole factory) [11]. This dimension is less relevant to the classification of MPI, because MPI is related to a large-scale change.

Another dimension is the subject of change. It concerns what is mainly intended to be changed or

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