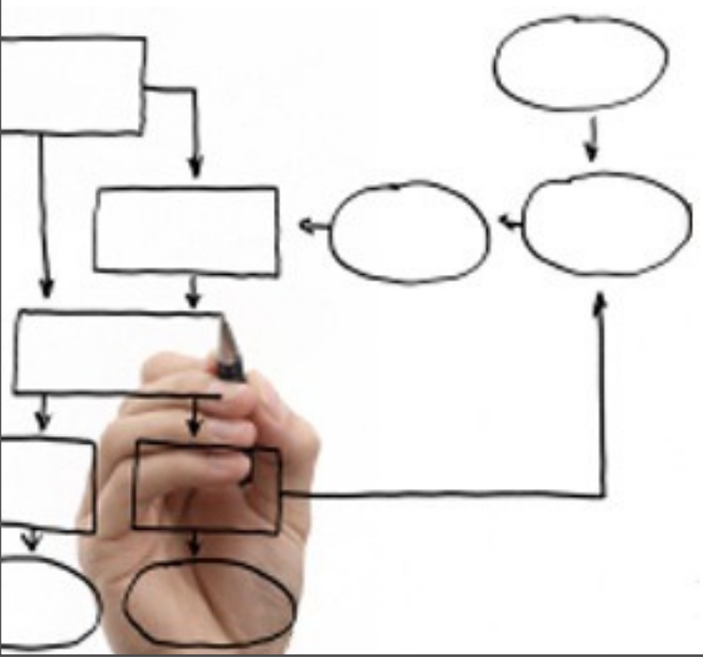
Methods for the specification and verification of business processes

MPB (6 cfu, 295AA)



Roberto Bruni

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02 - Business processes

Classes

Wednesday 16:00-18:00 Room N1

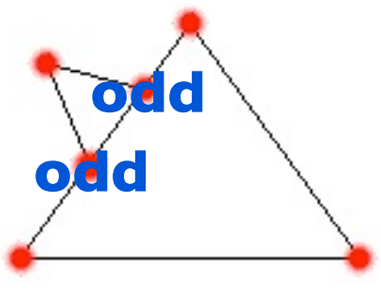
Friday 11:00-13:00 Room L1

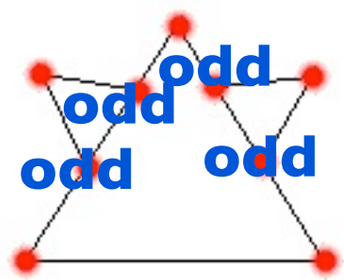
Today:

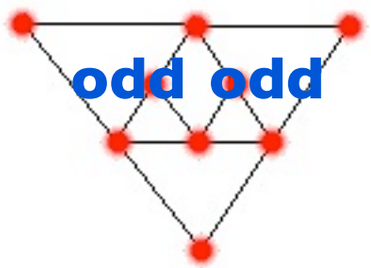
Ch.1 of Workflow Management: Models, Methods, and Systems

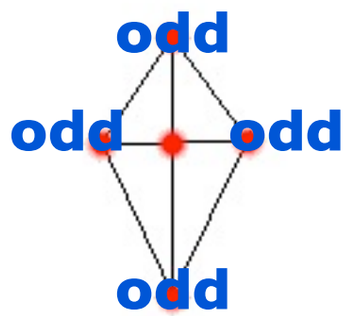
Ch.1 of Business Process Management: Concepts, Languages, Architectures

Digression...









Exercises: find Eulerian circuits in the graphs above or prove that they cannot exist.

Reference framework

Fix the business management context

Model and analyze processes

Functionality of processes management systems

Terminology

Generic terms, widely applicable to different working situations and companies

We fix preferred terms when possible, but allow one to use synonyms interchangeably

Issues

Role of work in the society

Processes and distribution of work

Principal-contractor relationship

Organizational structures

Process management

Work

People work to live
(or live to work?)

We need products to maintain our lives
(food, clothing, house, transportation, fun, health)

We are not capable to produce all we need
(or all we want, or all we are induced to want)
because we cannot be skilled enough

We buy products we cannot make ourselves

Business units

People organize specialized business units
(limited range of products, highly efficient)

Market

Products are supplied to people via markets
(distribution in exchange of money)

New services

Other work emerge, that would not exist
(trading, banks, advertising, transportation,
regulations, insurance companies)

There are services and products necessary to
keep the organization operating
(not making a direct contribution to keep us alive)

Complexity

Modern society is too complex for people to see
how their work fits in the overall scheme
(alienation can become a major social problem)

The same scheme applies to large companies:
high degree of work specialization
cause big picture be lost by employees
(why they have to do the things they are told to do)

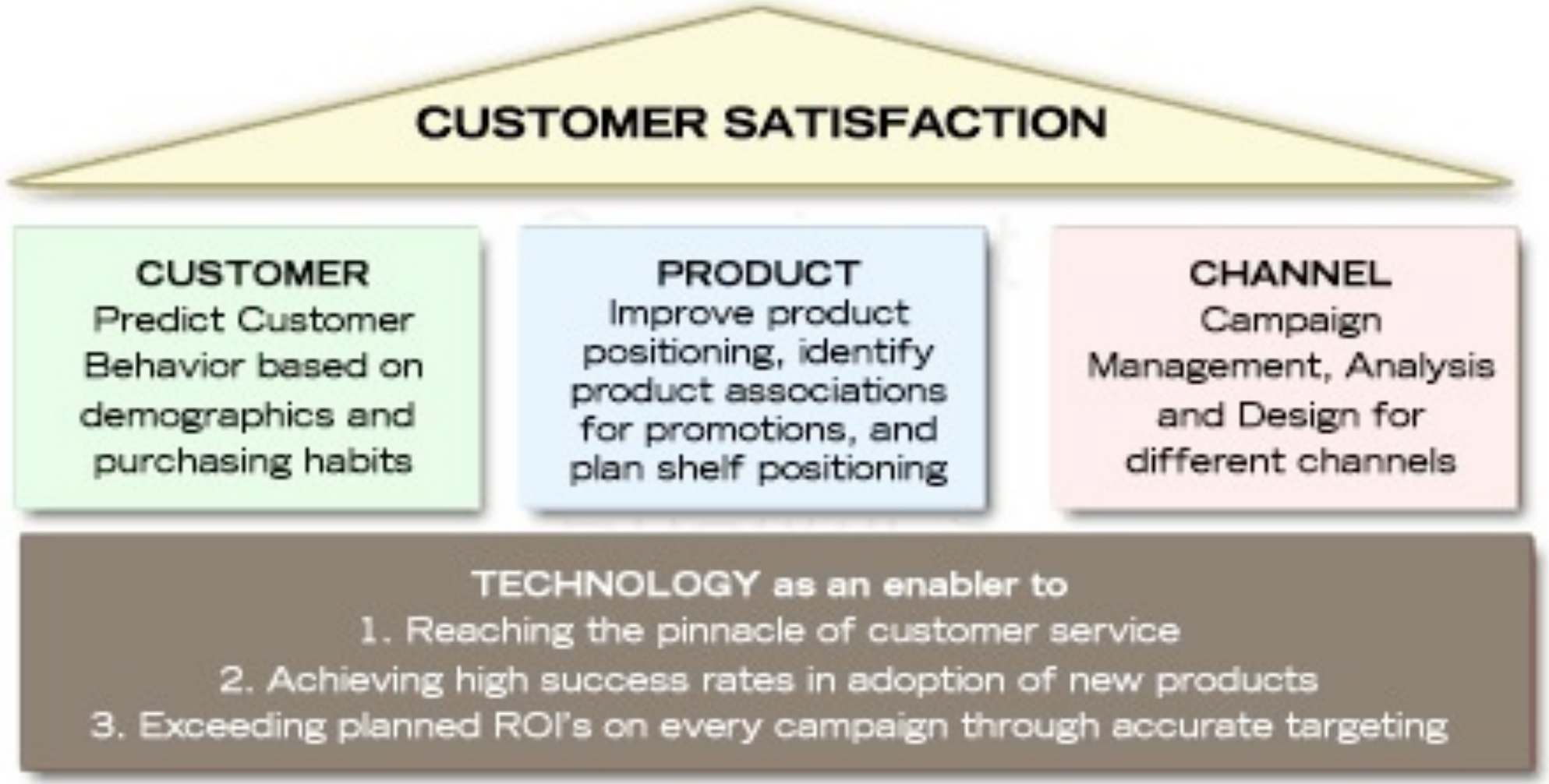
Paradigm shift

Alienation from work can have negative effects on (human life and) productivity

Companies can allow employees to know they are working for a particular customer
(increase motivation, self-esteem, productivity)

Shift:
from supply-driven economy (scarce means of production) to **demand-driven** economy (customers are scarce)

Organizational paradigm shift



ROI = Return On Investment

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Case

Many different types of work exist
(baking bread, making forniture, design a building,
collect surveys to compile a statistic)

They have in common the **case**:
one tangible thing produced or modified
(bread, forniture, house, diagram)
more abstract cases are also possible
(a lawsuit, an insurance claim, digital data)

Synonyms: work, job, product, service, item

Procedure

Working on a case is typically discrete in nature

Every case has a beginning and an end

Each case can be distinguished from any other case

Each case involves a **procedure** being performed: the tasks to be carried out and the conditions that determine the order of the tasks

Synonyms: process, project

Task

A **task** is a logical unit of work that is carried out as a single whole

Example: Make a Pizza

1. Check ingredients
2. Check tools
3. Make the dough balls
4. Prepare toppings (while dough rises)
5. Shape dough balls into pizza
6. Top it
7. Cook it

Tasks? Procedures? Cases?

Knowledge

Some tasks can be performed by a computer without human intervention

Executing some tasks may require human intelligence: a judgement or a decision
(a bank employee decides about a loan request)

Persons need **knowledge** to execute tasks
(their past experience, company guidelines)

Resource

A **resource** is the generic name for a person, machine or group of persons or machines that is responsible for a task

Activity

An **activity** is the performance of a task by a resource

Various cases may share the same procedure, but each case may involve different activities to be carried out, depending on case **attributes**
(one insurance claim may involve objections and another one may not)

Example: Make a Pizza

1. Check ingredients
2. Check tools
3. Make the dough balls
4. Prepare toppings (while dough rises)
5. Shape dough balls into pizza
6. Top it
7. Cook it

Knowledge? Resources? Activities?

Example: Make a Pizza

Knowing the procedure is essential, but

Not all recipees are the same

Not all pizzas taste the same

Execution is important

Training is important

Cases vs procedures

The number of procedures in a company is (generally) finite and far smaller than the number of cases to be handled

Example: it is easier to make
one hundred skirts with the same pattern
than one hundred skirts using different patterns

Example: off-the-rack is cheaper
than made-to-measure

Economy of scale

The cost per case fall as the number of cases increases

Strategy: keep the number of procedures small and make the number of cases that each can perform as high as possible

Profit, after all, is the ultimate objective
(not necessarily the best one)

Example

Insurance companies want to keep the number of claims as low as possible, but this is generally a factor they cannot control

They can try to keep low the number of procedures, but the risk is to make them too much complex (a unique procedure to handle all cases is possible in principle, but inefficient in practice)

Ideal situation: a small number of good procedures, with a lot of cases to be handled by each of them

Different examples

What about tailor-made suits?
one case per process?

What about architects and houses?
design from scratch for each case?

Not so different?

Tailors and architects can exploit standard approaches for each case

Tailor process:
take customer's measurement,
show a number of patterns,
modify the chosen pattern,
choose the fabric,
draw the pattern

Observation: tasks can be highly dependent on cases

One-of-a-kind processes

The first stage in tackling the case is the design of its specific process

Even in this case, standard tasks can be frequently found that are used to compile many specific processes

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Principal

Most people's work is assigned or outsourced to them by other people: their **principals** (they can be company departments or firms)

We can divide principals in two forms: **boss** and **customer**

Assignments ordered by bosses are related to work for customers (directly in case of production process, indirectly for support and managerial processes)

Contractors

A person who is assigned a task is called
contractor, or also **resource**
(assignments can be carried out by machines
and computer applications as well as by people)

Actors

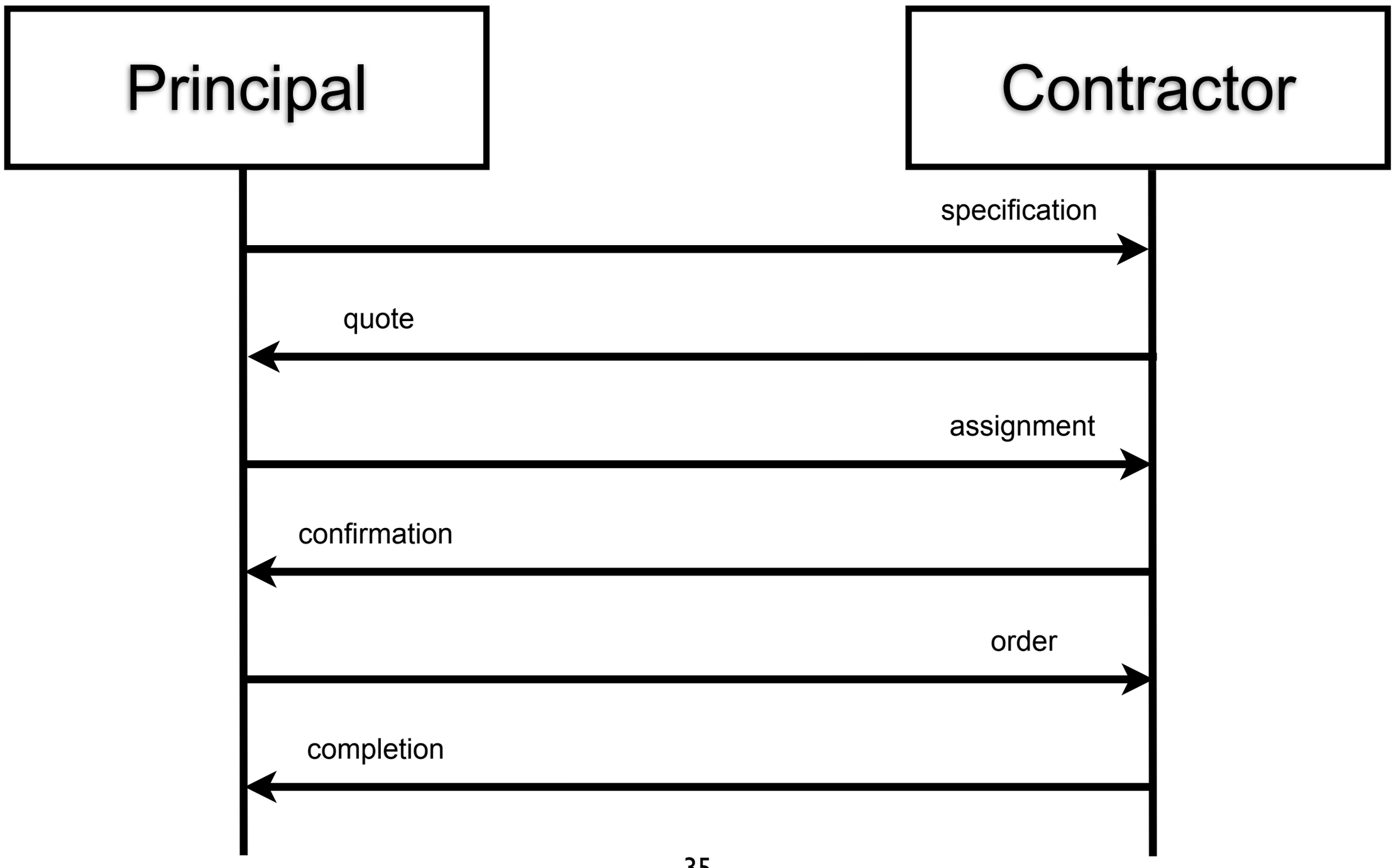
An **actor** can be a principal or a contractor, or play both roles at the same time
(contractors may redirect work to third parties)

Contract

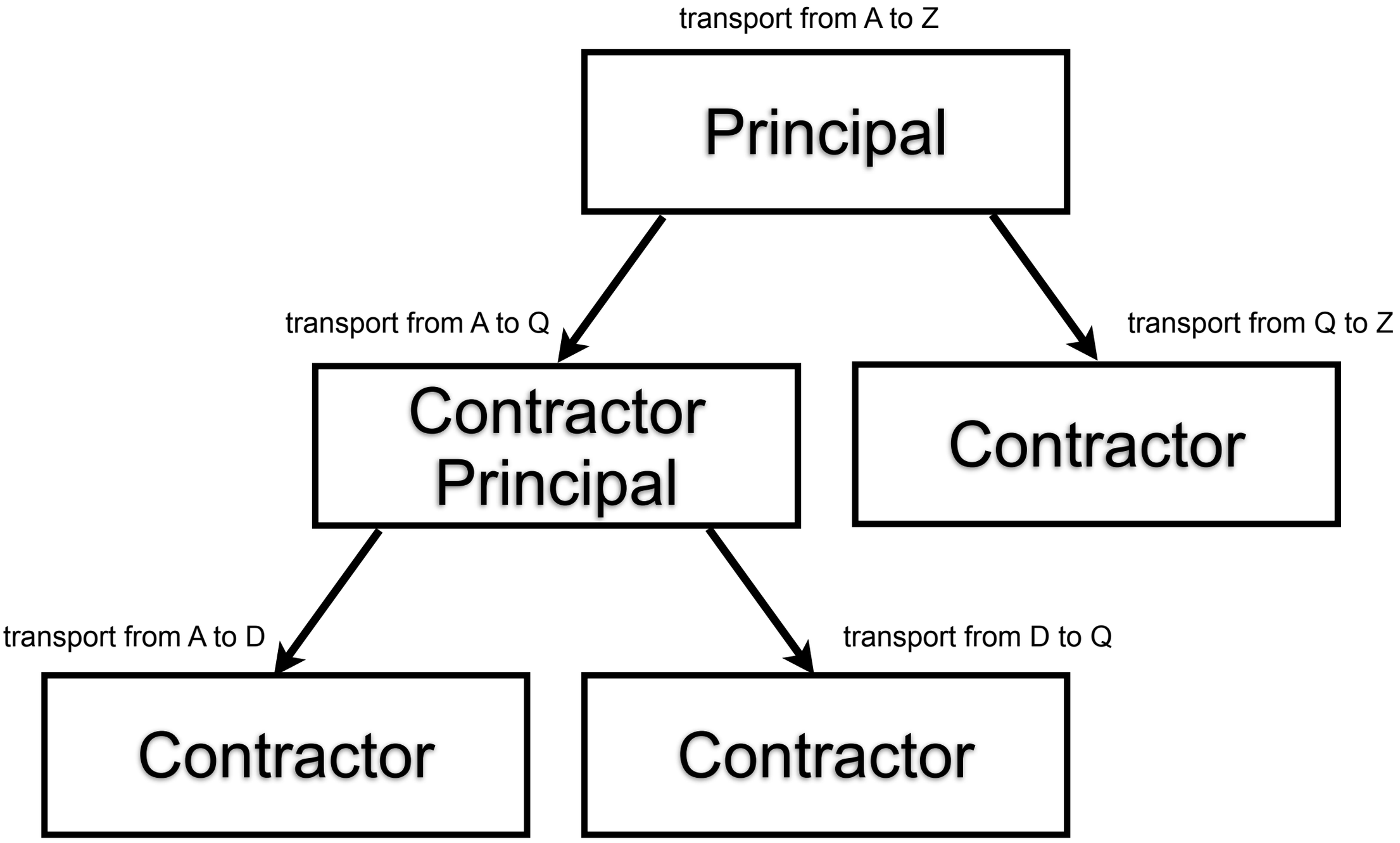
A **contract** exists between a principal and a contractor about the case to be performed (deadline for completion, price to be paid)

A **communication** protocol can be established between a principal and a contractor to exchange information

Protocol example



Contract tree example



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NORTH AMERICA SYNDICATE
Bennett
CHAIRMAN OF THE TASK FORCE TO REDUCE GOVERNMENT BUREAUCRACY
VICE CHAIRMAN OF THE TASK FORCE TO REDUCE GOVERNMENT BUREAUCRACY
ASSISTANT VICE CHAIRMAN OF THE TASK FORCE TO REDUCE GOVERNMENT BUREAUCRACY
AIDE TO THE ASSISTANT VICE CHAIRMAN OF THE TASK FORCE TO REDUCE GOVERNMENT BUREAUCRACY
ASSISTANT AIDE TO THE ASSISTANT VICE CHAIRMAN OF THE TASK FORCE TO REDUCE

Organizational structure

An **organizational structure** establishes how the work, authorities and responsibilities are divided up amongst its staff (roles and functions)

A single person can fulfill several roles, together or along time

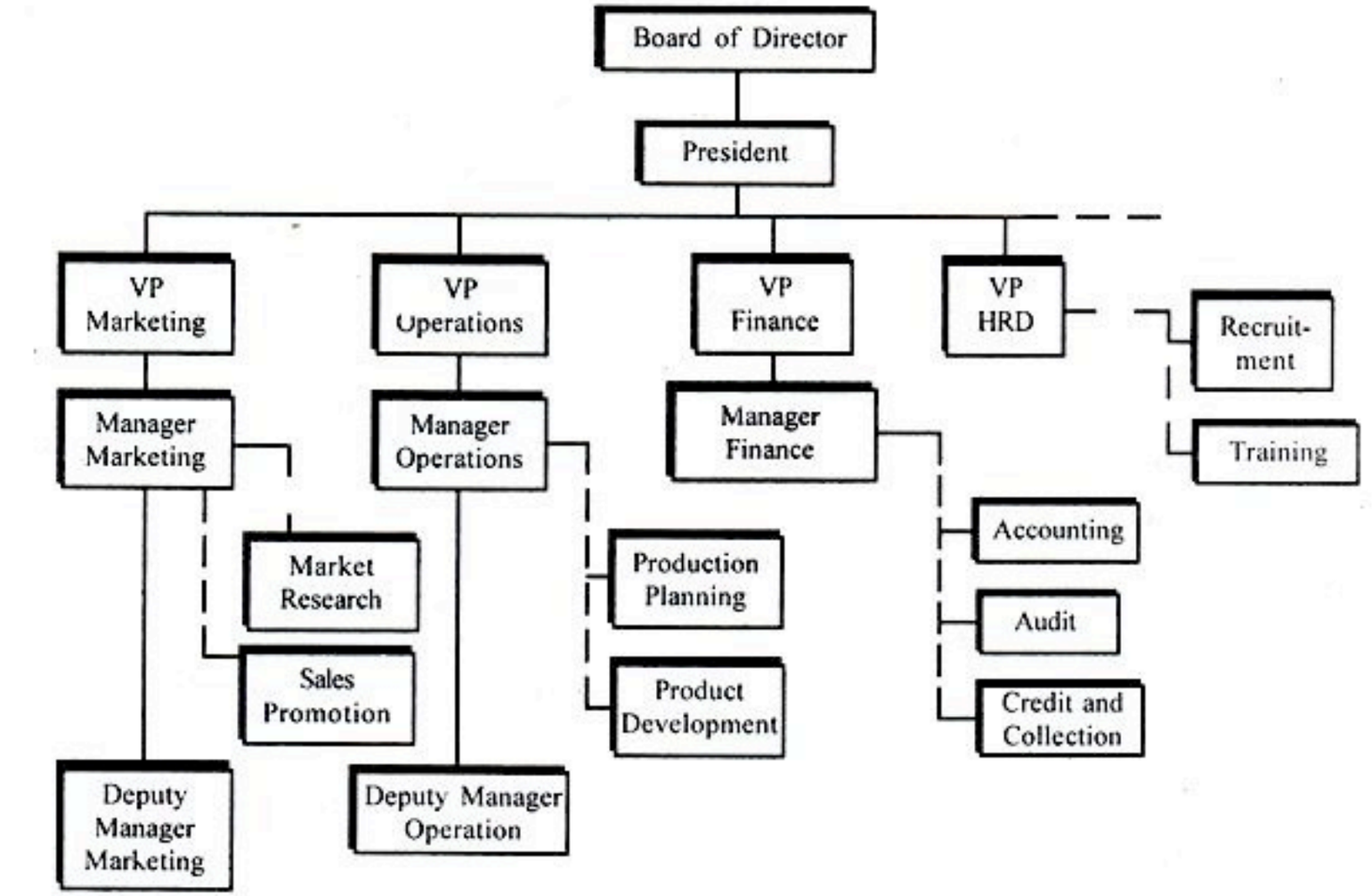
Most relevant forms of organizational structure

Hierarchical: structured as a tree, internal nodes are individual roles or functions, leaves are staff or departments, branches are authority relationships (independent of cases)

Matrix: add (dynamic) functional dimension (each person can have one or more functional bosses, known as project leaders)

Network: autonomous actors collaborate to supply products or services

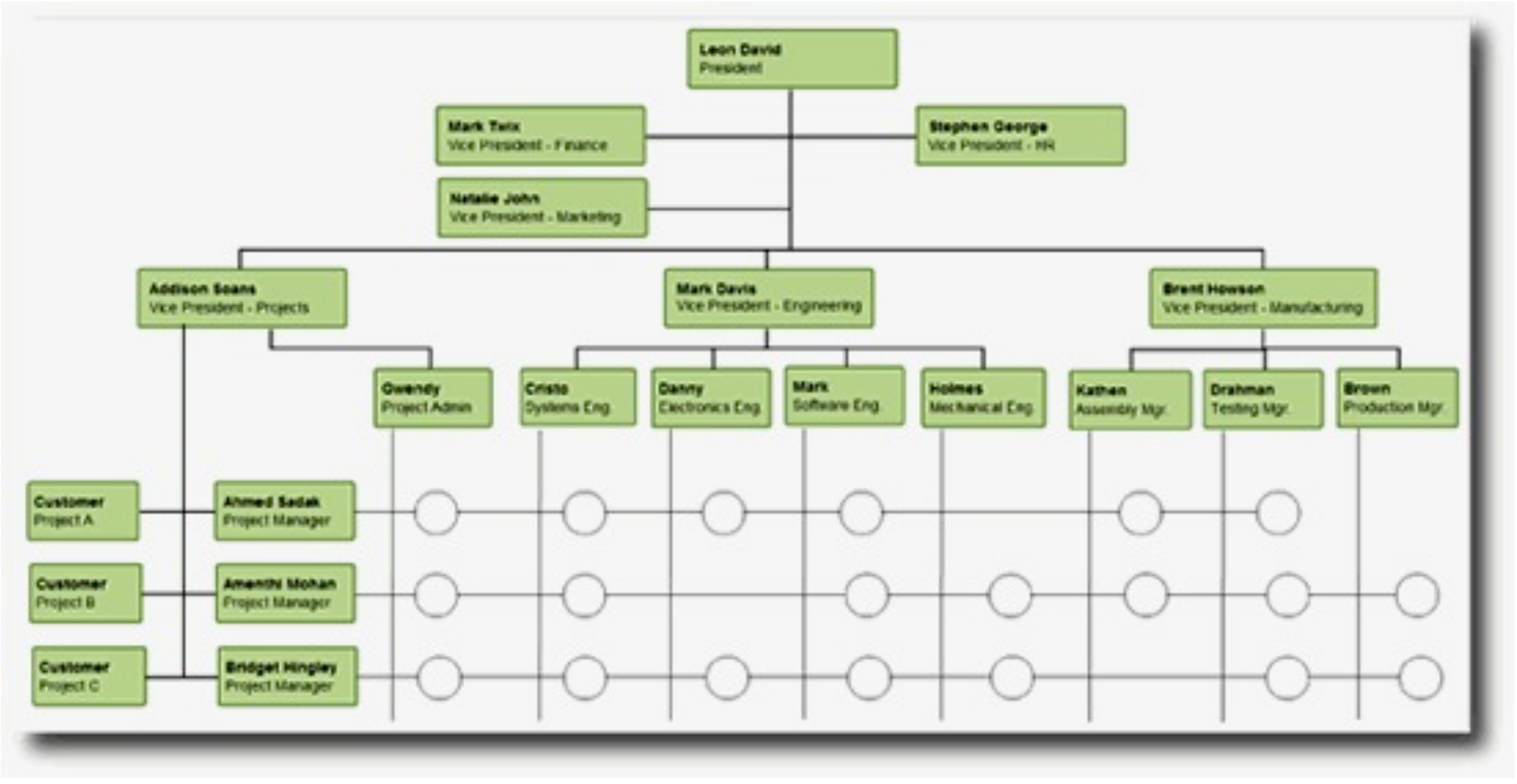
Hierarchical organizational structure



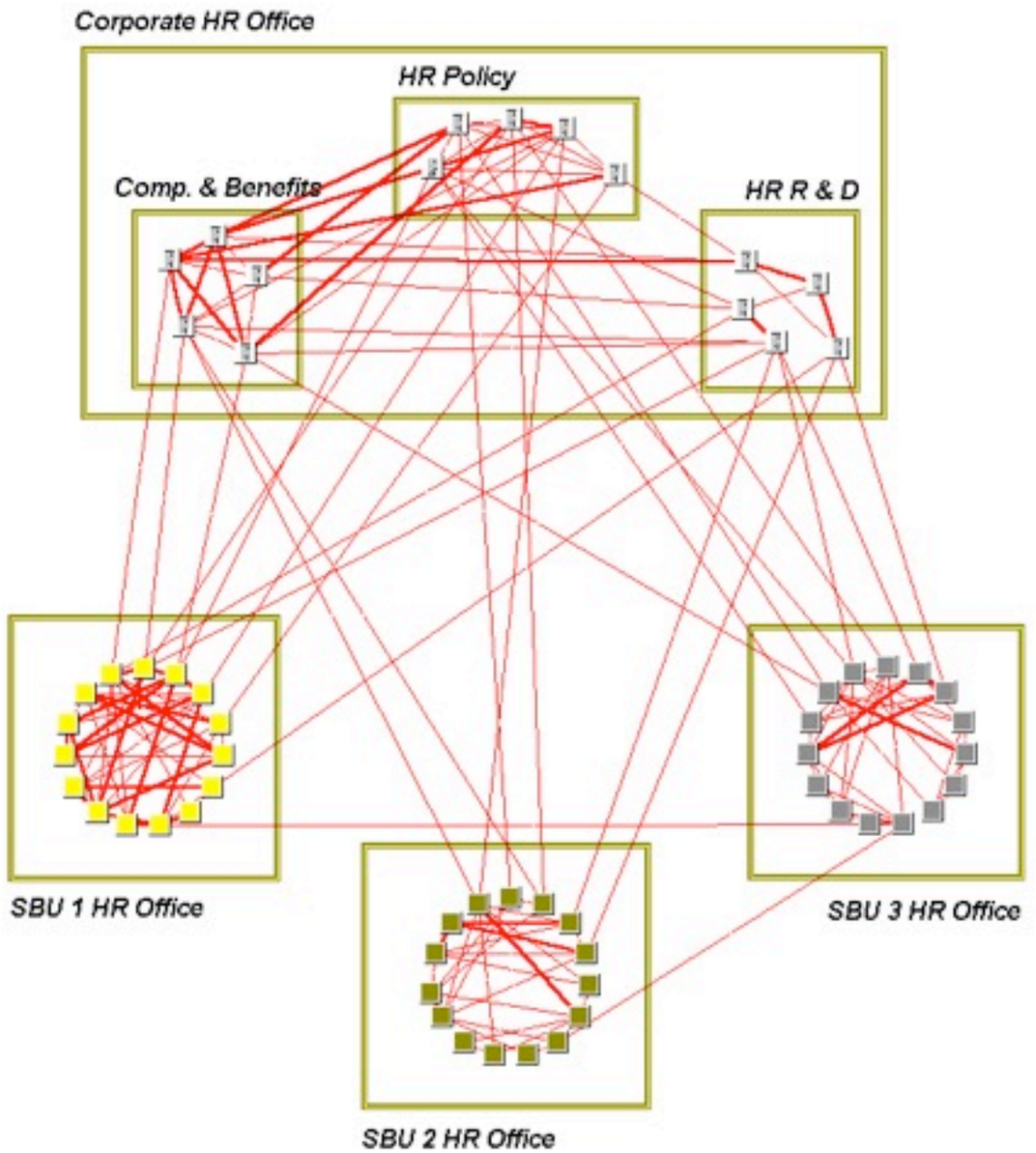
Legend : — Line Authority

-- Staff Relationship

Matrix organizational structure



Network organizational structure



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What is all about

Each **product** that a company
provides to the market
is the outcome of a number
of **activities** performed

Awareness

Process management systems
support and encourage
communication between employees
and make their activities more controllable

Narrowing the gap

Organizational business aspects

Information technology

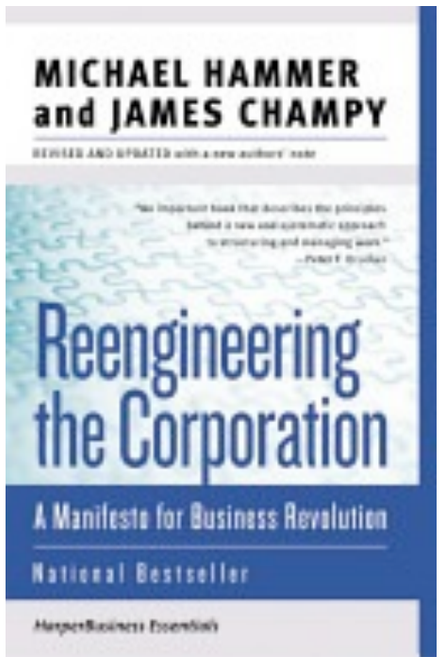
Enactment

Activities can be performed by employees **manually** or by the help of information systems

Other activities can be enacted **automatically** by information systems

Some activities can **trigger** or **inhibit** other activities

Process orientation roots (1990's)



Seminal book advocating
the radical redesign of the business
process of a company as opposed
to evolutionary improvements

A **business process** is a **collection of activities**
that take one or more kinds of **input** and
create an **output** that is of value to the customer

- Hammer & Champy (1993)

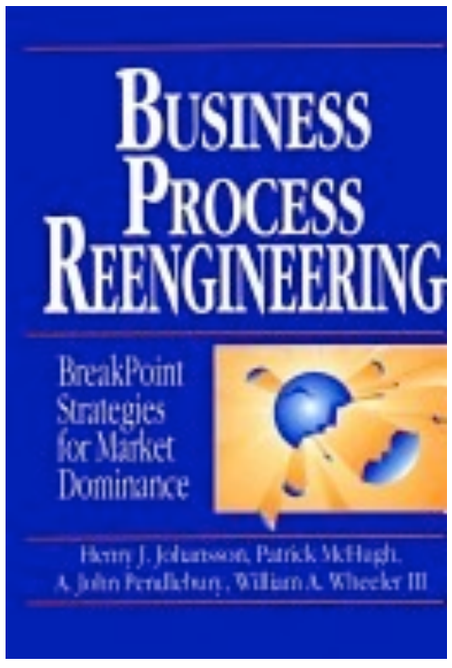
Keywords

Hammer & Champy: **collection, input, output**

How vs What

The main innovation is the shift of focus on the business logic of the process (**how work is done**), instead of the product perspective (**what is done**)

Process orientation roots (1990's)



The transformation that occurs in the process should add value to the input and create an output that is more useful and effective to the recipient either **upstream** or **downstream**

A process is a set of **linked** activities that take an input and transform it to create an output.

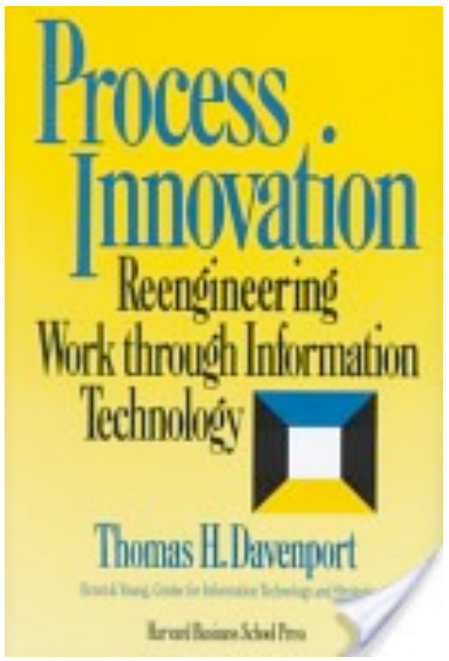
- Johansson et al. (1993)

Keywords

Hammer & Champy: **collection, input, output**

Johansson et al.: **upstream, downstream, linked**

Process orientation roots (1990's)



Processes as structured, measured sets of activities designed to produce a specific output for a particular market

A **process** is a specific **ordering** of work activities across **time** and **space**, with a **beginning** and an **end**, and clearly defined **inputs** and **outputs**: a structure for action.

- Davenport (1993)

Keywords

Hammer & Champy: **collection, input, output**

Johansson et al.: **upstream, downstream, linked**

Davenport: **structure, ordering, time, space, begin, end**

More from Davenport

Unless designers or participants can agree on the way work is and should be **structured**, it will be very difficult to systematically improve, or effect innovation in, that work

Whereas an organization's hierarchical structure is typically a slice-in-time view of responsibilities and reporting relationships, its process structure is a **dynamic view** of how the organization delivers value

More from Davenport

Furthermore, while we cannot measure or improve hierarchical structure in any absolute sense, processes that are clearly structured are amenable to **measurement** in a variety of dimensions have cost, time, output quality, and customer satisfaction

When we reduce cost or increase customer satisfaction, we have bettered the process itself

More from Davenport

Processes also need clearly defined **owners** to be responsible for design and execution.

Process ownership must be seen as an additional or alternative dimension of the formal organizational structure that, during periods of radical process change, **takes precedence** over other dimensions of structure.

Otherwise process owners will not have the power or legitimacy needed to implement process designs that violate organizational charts and norms

More from Davenport

In service industries it is nearly impossible to distinguish between innovative new services offered to the customers and the **innovative processes** that enable them

Following a structured process is generally a good thing, and there is nothing inherently slow or inefficient about acting along process lines

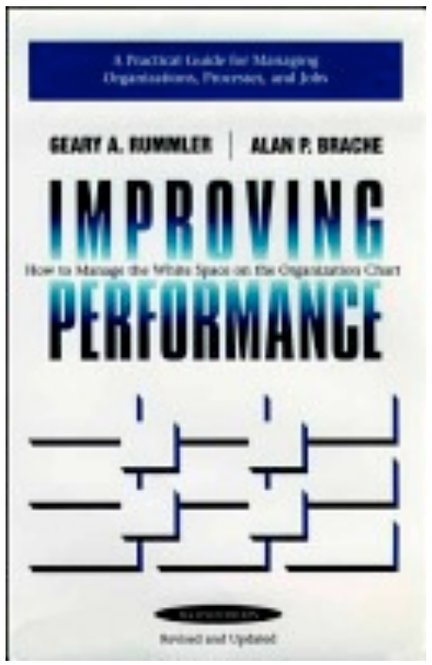
Keywords

Hammer & Champy: **collection, input, output**

Johansson et al.: **upstream, downstream, linked**

Davenport: **structure, ordering, time, space, begin, end, dynamic, measurement, owner, precedence of process view, innovation enabling**

Process orientation roots (1990's)



Most processes are **cross-functional**, spanning the 'white space' between the boxes on the organization chart. Some processes result in a product or service that is received by an organization's external customer.
We call these **production** processes.

Other processes produce products that are invisible to the external customer but essential to the effective management of the business.
We call these **support** processes

- Rummler & Brache (1995)

General applicability

The approach can be applied to both large and small processes: to the entire set of activities that serves customers, or only to answering a letter of complaint.

The larger the process, however, the greater the potential for radical benefit

Key generic business processes include product development, customer order fulfillment, and financial asset management

Typical processes in manufacturing firms

Operational: product development, customer acquisition, customer requirements identification, manufacturing, integrated logistics, order management, post-sales service

Management: performance monitoring, information management, asset management, human resource management, planning and resource allocation

Primary process

Produce company's products
(**production** processes)

Customer-oriented, even if sometimes the customer is not known in advance

Generate income for the company

Examples: raw materials purchase, service sale, design and engineering, distribution

Secondary process

Support primary processes
(**support** processes)

Examples: machinery purchase and maintenance, personnel management (recruitment and selection, training, work appraisal, payrolls, dismissal), financial administration, marketing

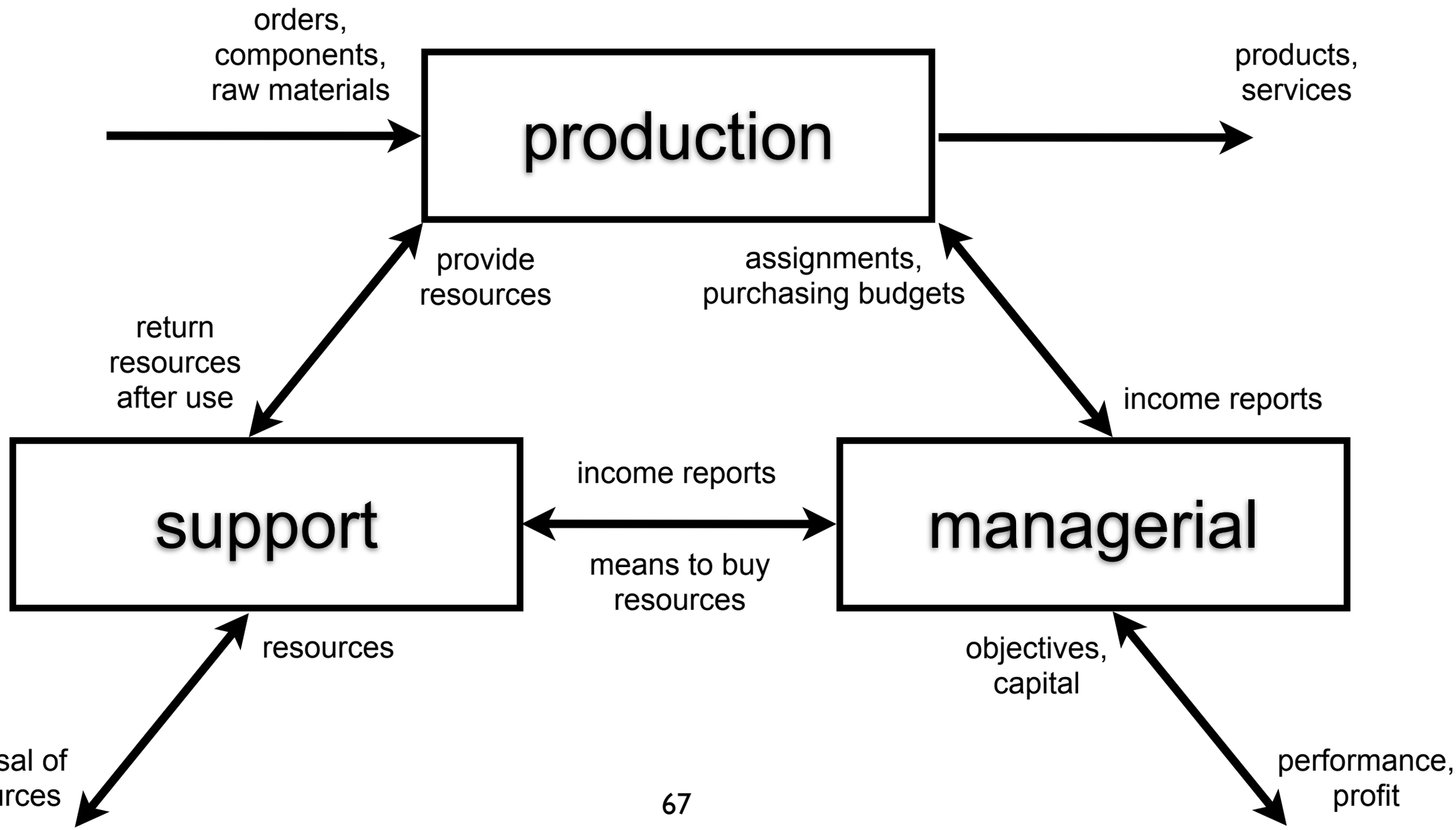
Tertiary process

Direct and coordinate primary and secondary ones (**managerial** processes)

Fix objectives, allocated resources and preconditions for the managers of other processes

Examples: maintenance of contracts with financiers and other stakeholders

1, 2, 3


orders,
components,
raw materials
production
products,
services
provide
resources
assignments,
purchasing budgets
return
resources
after use
income reports
support
income reports
means to buy
resources
managerial
resources
objectives,
capital
disposal of
resources
performance,
profit

Keywords

Hammer & Champy: **collection, input, output**

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Davenport: **structure, ordering, time, space, begin, end, dynamic, measurement, owner, precedence of process view, innovation enabling**

Rummler & Brache: **production, support, managerial**

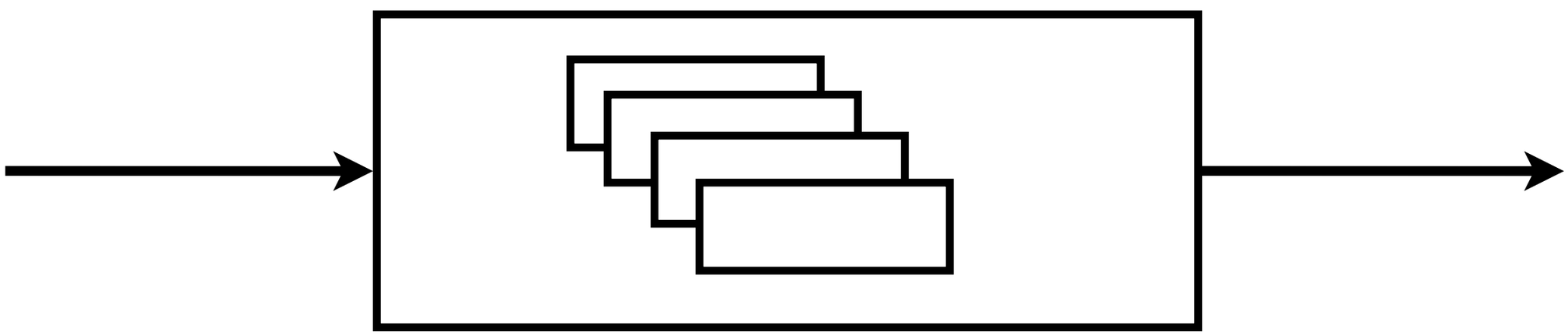
Summing up

Definability

Processes must have clearly defined boundaries, input and output

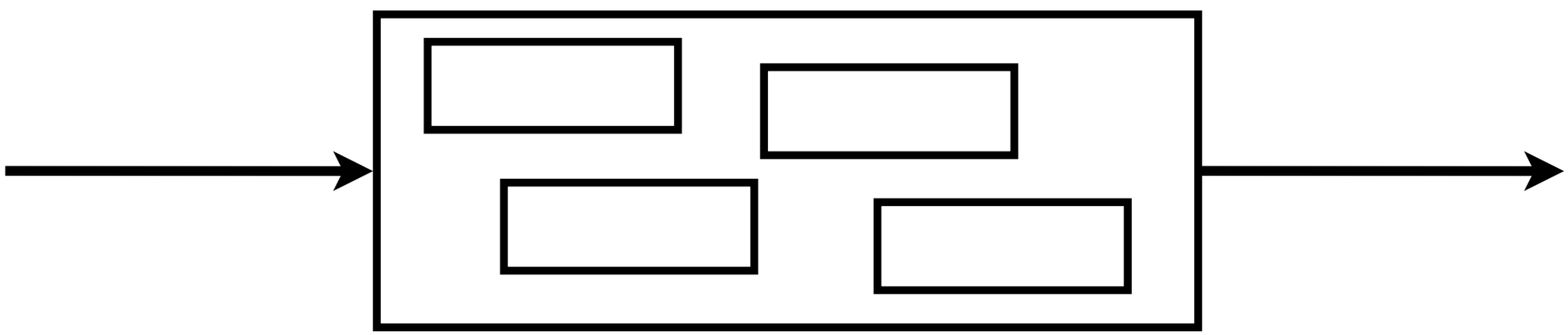
Structured

Processes wrap up a collection of tasks



Ordered

Process tasks are ordered according to their position in time and space



Digression

What is a **partial order**?

$(S, \sqsubseteq)$ S is a set

$\sqsubseteq$ is a binary relation included in $S \times S$

$\sqsubseteq$ is reflexive

$\forall x \in S$ we have $x \sqsubseteq x$

$\sqsubseteq$ is transitive

$\forall x, y, z \in S$, if $x \sqsubseteq y$ and $y \sqsubseteq z$, then $x \sqsubseteq z$

$\sqsubseteq$ is anti-symmetric

$\forall x, y \in S$, if $x \sqsubseteq y$ and $y \sqsubseteq x$, then $x = y$

Digression

What is a **total order**?

$(S, \sqsubseteq)$ is a partial order and

$\forall x, y \in S$ we have $x \sqsubseteq y$ or $y \sqsubseteq x$

Exercises

Are the following pairs partial / total orders?

$(\mathbf{Nat}, <)$ $(\mathbf{Nat}, \leq)$ $(\mathbf{Int}, \geq)$

$(\mathbf{Nat}, \emptyset)$ $(\mathbf{Nat}, \mathbf{Nat} \times \mathbf{Nat})$

$(\wp(\mathbf{Nat}), \subseteq)$ $(\mathbf{Nat}, \{(x, x) \mid x \in \mathbf{Nat}\})$

Digression

What is a **linear extension** of a partial order?

Let $(S, \sqsubseteq)$ be a partial order and $(S, \preceq)$ a total order

$(S, \preceq)$ is a linear extension of $(S, \sqsubseteq)$ if

$\forall x, y \in S$ we have that $x \sqsubseteq y$ implies $x \preceq y$

(or equivalently, $\sqsubseteq$ is included in $\preceq$)

Exercises

$$S = \{a, b, c, d, e, f\}$$

$$a \sqsubseteq b \sqsubseteq d \sqsubseteq f \qquad a \sqsubseteq c \sqsubseteq e \sqsubseteq f \qquad c \sqsubseteq d$$

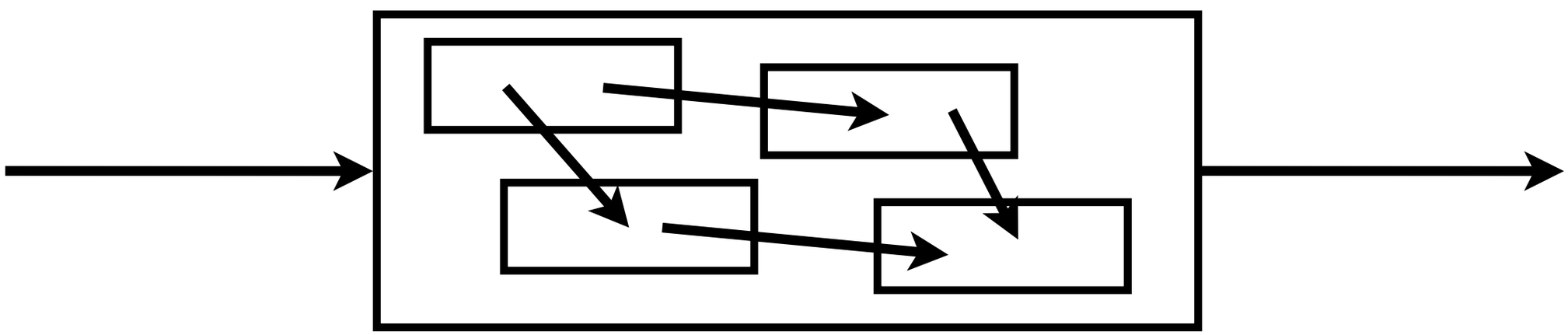
Which of the following are linear extensions?
(we write, e.g., abc for $a \preceq b \preceq c$)

abcdef abcedf abdcef

acebdf acbedf acefbd

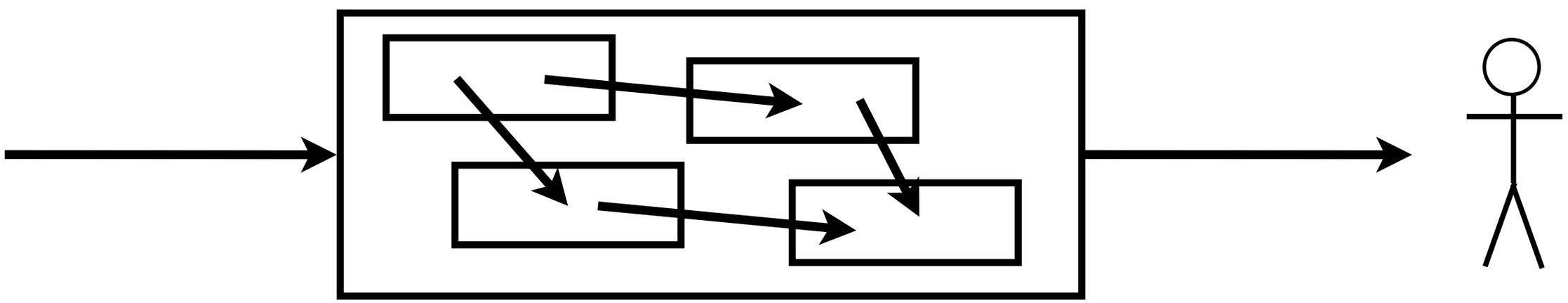
Linked

Process activities are linked along a value-added chain



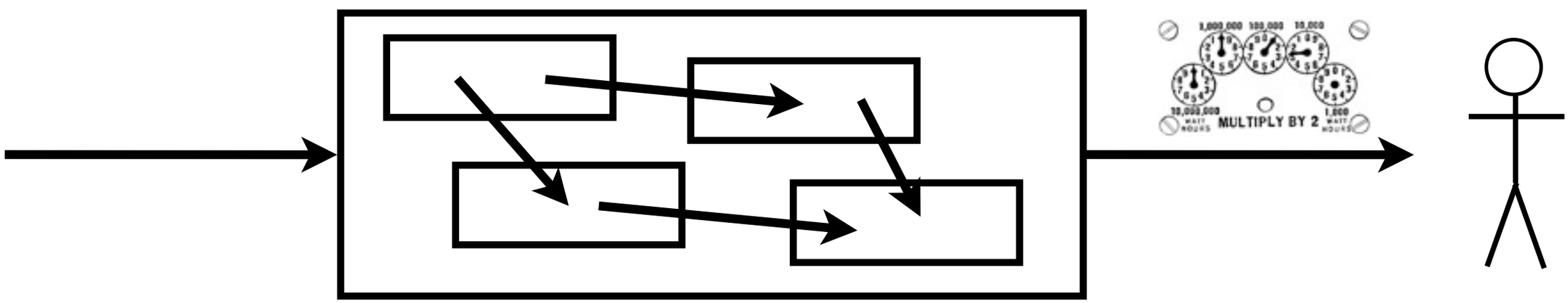
Customer

The process output has a recipient



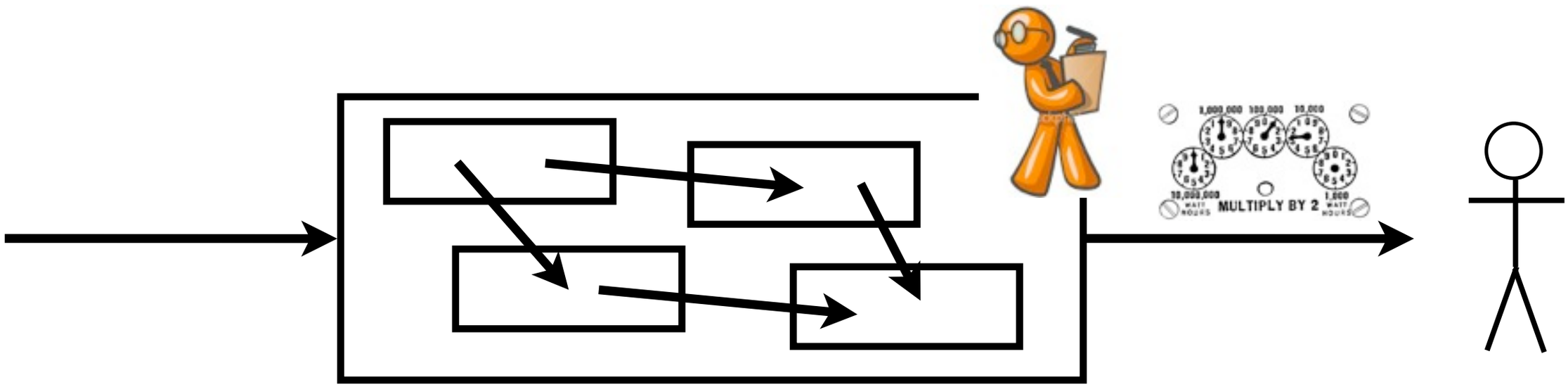
Measurability

The process output can be evaluated



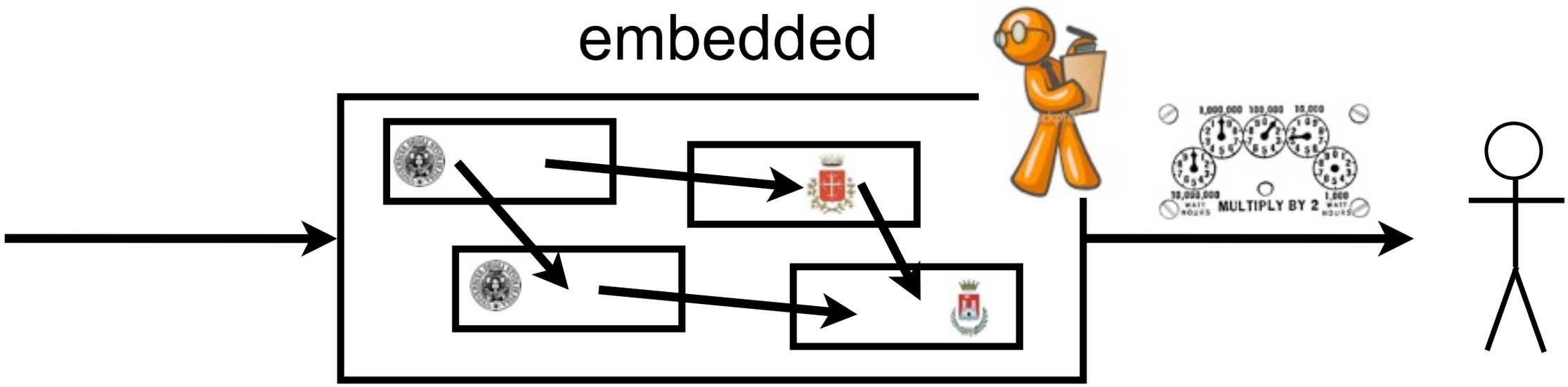
Ownership

There is one responsible for the performance and continuous improvement of the process



Cross-functionality

A process can span several functions within and across the organizational structure in which it is embedded



Some definitions

Business process

Definition: a **business process** consists of a set of activities that are performed in coordination in an organizational and technical environment.
These activities jointly realize a business goal.

Each business process is enacted by a single organization, but it may interact with business processes performed by other organizations.

- Weske

Business process management

Definition: **business process management** includes concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes.

- Weske

Business process management

The basis of business process management is the explicit representation of business processes with their **activities** and the **execution constraints** between them

Business processes can then be subject to **analysis**, **improvement**, and **enactment**

Business process management system

Definition: **business process management system** is a generic software system that is driven by explicit process representations to coordinate the enactment of business processes.

- Weske

Business process model

Definition: **business process model** consists of a set of activity models and execution constraints between them.

- Weske

Business process instance

Definition: **business process instance** represents a concrete case in the operational business of a company, consisting of activity instances.

- Weske

Model and instances

Each business process model acts as a blueprint for a set of business process instances

Each activity model acts as a blueprint for a set of activity instances

Abuse of notation

If no confusion is possible, the term business process is used to refer to either business process models or business process instances

Analogously, the term activity is used to refer to either activity models or activity instances

Process-driven software

Business process models are the main artefact for implementing business processes

This implementation can be done by organizational rules and policies, but it can also be done by business process management (software) system

In this case the software system is driven by explicit process representations

Process representations

Visual representations: diagrams and charts
(few conventions, intuitive)

Languages: precise syntax
(process dialects, XML)

Models: precise semantics
(Petri nets, YAWL)