Industry 4.0

An introduction

Agenda

Speaker

Dr. Stefan Karl Mayer

Academic lecturer, Senior Consultant, CEO

Key Industry Sector

Telecommunication & IT,

Automotive, Insurance, Retail

Clients

Upon request

Professional experience and academic background

- More than seven years consulting experience concerning strategic procurement & sales
- International experience in China, (Western) Europe and USA
- PhD in Decision-Making system at Technical University of Munich focusing on game, auction and social contract theory, publications in Production and Operation Management (2014) and other journals
- Developing global procurement and sales strategies
- Restructuring of global sourcing departments
- Currently focusing on industrial purchasing and pricing negotiations in the automotive industry
- Designing sales mechanisms and bidding languages

Consulting and Project Experience

- Industry 4.0
- Development and validation of auction mechanisms for the sales of spectrum licenses
- Improvement of procurement strategies via bundle offers (Industry 4.0)
- Development of strategic procurement strategies using split-award reverse auctions which include an implicit insurance premium
- Sales for consumer goods in Asia-pacific – beer of Riegele (http://www.riegele.cn)
- Founding and managing more than 25 sales departments within central China (Metropolitan area of Chongqing) – focus: beer of Riegele
- M&A negotiations

Speaker

Dr. Stefan Karl Mayer

Academic lecturer, Senior Consultant, CEO

Key Industry Sector

Telecommunication & IT,

Automotive, Insurance, Retail

Clients

Upon request

Lectures

- Operations Research
  - Decision Theory
  - Linear Optimization
  - Integer programming
  - Network flow problems
- Auction Theory and Market Design
- Game Theory
- **Industry 4.0 and Business Analytics**
  - Data Warehousing,
  - Data Mining,
  - Predictive analytics
  - Discrete Choice Modeling
- Economics and Computation
- Project management

Agenda

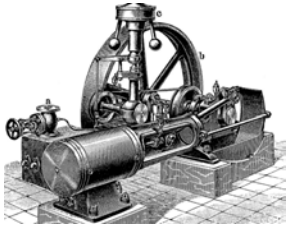
Definition of industry 4.0

Definition
» Individualization of products by a flexible and lean manufacturing » In the value chain of the industry 4.0 manufacturing companies, • their business partners, • relevant suppliers • potential customers for the greatest possible value are linked

Industry 4.0 can be explained on a historical perspective

An overview

TImeline



1. Industrial Revolution

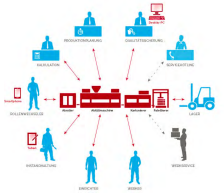
Machines replace humans

2. Industrial Revolution

Massproduction

3. Industrial Revolution

Microchips



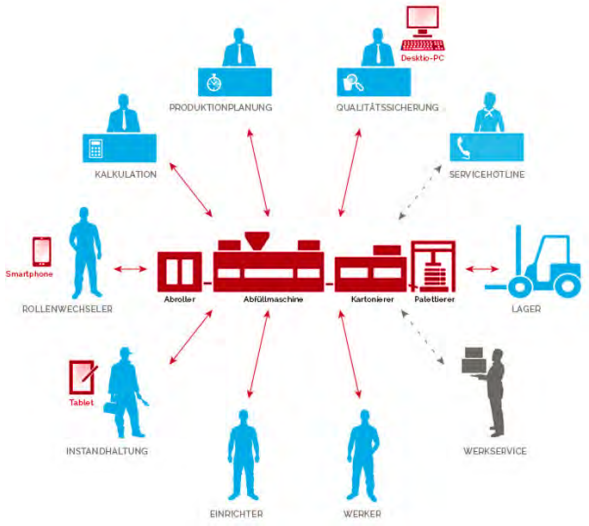
4. Industrial Revolution

18th century | **19th century** | **20th century** | **1970s** | **Today**

Industry 4.0 cannot be defined by a single word, but by 13 buzzwords

Review

- Interdisciplinarity
- Social Media
- Mobile Computing
- Digitalization/Virtualization
- Smart objects
- Big data
- Predictive analysis
- Internet of things
- Internet of services
- Assistant systems
- Cyber Physical Systems
- Smart Factory
- **Strategic Procurement**



By the fusion of the real and virtual world, product requirements, installations and tools can be coordinated, changed and done in real time

Social media and interdisciplinarity allow cross-functional collaboration

Interdisciplinarity

- “Interdisciplinary" means the connection and combination of independent (academic) disciplines and their methods.
- Various strategies are here linked together for the best possible result, which can lead to new ways of thinking and solution paths for problems
- Synergies between individual disciplines are established
- Examples are
  - Business Engineering
  - Information Systems
  - Business Mathematics
  - Bio Informatics
- Companies need a new skillset for their employees.

Social Media

- The advantage of social media is the easy exchange of information between users and sometimes even applications.
- Companies use this medium to enhance their internal and external processes.
- Social media support the global corporate image with high accessibility
- Multimediality and Networking as possible.
- The crucial difference to the other media (newspapers, radio and television) is the ability of the recipient to respond to any information instantly.
- Examples:
  - WeChat
  - RenRen
  - Tencent

Mobile computing is a basic requirement for industry 4.0

Definition

- Mobile Computing includes the computer work of people on a portable device and includes mobile communications, as well as hardware and software.
- Usable Mobile computers can be among other laptops, tablet PCs, smart phones, or data glasses.
- The anywhere, anytime access to company data and applications, which should be as simple and intuitive done, will become the standard for all companies.
- This development is limited, for example, by the comparatively low transmission rates of mobile internet, current safety standards, or the energy consumption of devices

Digitalization, Virtualization and smart objects are indispensable

Digitalization, Virtualization

- “Digitalization” or "Virtualization“ are enabled by methods of computer science
- Hereby, a virtual plane is formed herefrom real existing resources such as machines, which makes it possible to divide the available resources and to make transparent to the user and optimum utilization.
- One known way, for example, is to run an operating system within an Other.

Smart objects

- Smart objects can e.g. its packaging, objects or workpieces, with a digital memory.
- Hereby, the digital world is linked to the physical.
- Devices can detected at any time..
- Examples among others are
  - RFID,
  - NFC
  - IBeacon.

If big data is interpreted right, predictive analysis gets our competitive edge

Big Data

- The data storage is growing due to the technological development and the Internet, because it is always easier to collect large amounts of data to store and analyze.
- Big Data refers to this world existing data volume that replicates with increasing speed and comes from analog and digital sources.
- According to Gartner's IT Glossary it is a Big Data situation only when one of the three following criteria is too large for relational database systems:
  - Volume of the data
  - Speed of data
  - Diversity of data
- The added value of Big Data for production arises only when the raw data are refined by heuristics and pattern recognition
- This leads to novel gaining knowledge for the automate, visualize and analyze the processes can be used.

Predictive analysis

- Through statistical methods from pure data information is generated.
- Filtering out certain important information from a large amount of data is also called "data mining" or pattern recognition:
  1. Collect data!
  2. Analyze data!
  3. Predict situation
  4. Profit from data
  5. Use this competitive edge to be a step ahead!

By the Internet of Things also machines and devices communicate to each other

Internet of Things

- The extension of the existing Internet for Internet of Things is the technical idea to include objects of any kind in a universal digital network.
- This is a universal communication, enables both among the objects as well as their surroundings.
- So the physical world of things to blend seamlessly into the virtual world of data.
- A possible future scenario in the Internet of Things is that each device has its own IP and is connected to the Internet.
- The biggest challenge for the Internet of Things represents a single communication standard between the systems.
- See the distribution of IP addresses below

Internet of Services offers the services and functionality on a web-based platform

Internet of services

- Provider make services available on the internet and offer these on-demand.
- About Web Services technologies, the individual software modules or services can be integrated with each other.
- Companies can orchestrate the individual software components into complex yet flexible solutions.
- There is a strict correlation:
  - Internet of Things
    - All devices are connected to the Internet
  - Internet of Services
    - Result will be cheaper and better than existing ones
  - New Business models
    - Hereby new business models are developed that act in turn as a catalyst for the Internet of Things and Services

Assistance systems are indispensable to control increased complexity

Assistant systems

» Permanent advanced technologies, equipment, systems, processes and procedures have the last decades following increase in the challenge level lacked with him

» Complicated problems are predictable, manageable and can be automated if you have enough knowledge about it.

- Complicated problems can calculate and they can therefore no man, be solved solely by IT
- As an example two chess computer can easily compete against each other.

» Complex problems can not be predicted, only observed.

- Although complex problems can be influenced, but without the consequences to foresee, therefore not controllable.
- Precise planning for a complex system is de facto pure illusion!

» Complexity has to be reduced by assistance systems, the "acting" in humans "incoming" complexity to a manageable level.

» Assistance systems are to produce the following positive effects on the situation:

1. Assistance systems improve outcomes
   - As a metaphor of Brake Assist in the car can be used, which improves the braking distance and the track and hold when braking.
2. Assistance systems increase the users' competency
   - As a metaphor, the navigation system may in the car are used, the non-local drivers, the ability to navigate in unfamiliar cities.
3. Assistance systems allow otherwise impossible situations
   - As a metaphor can serve a modern fighter aircraft which can not be flown by the pilot alone without assistance systems.

Cyber Physical Systems control themself

Cyber Physical Systems

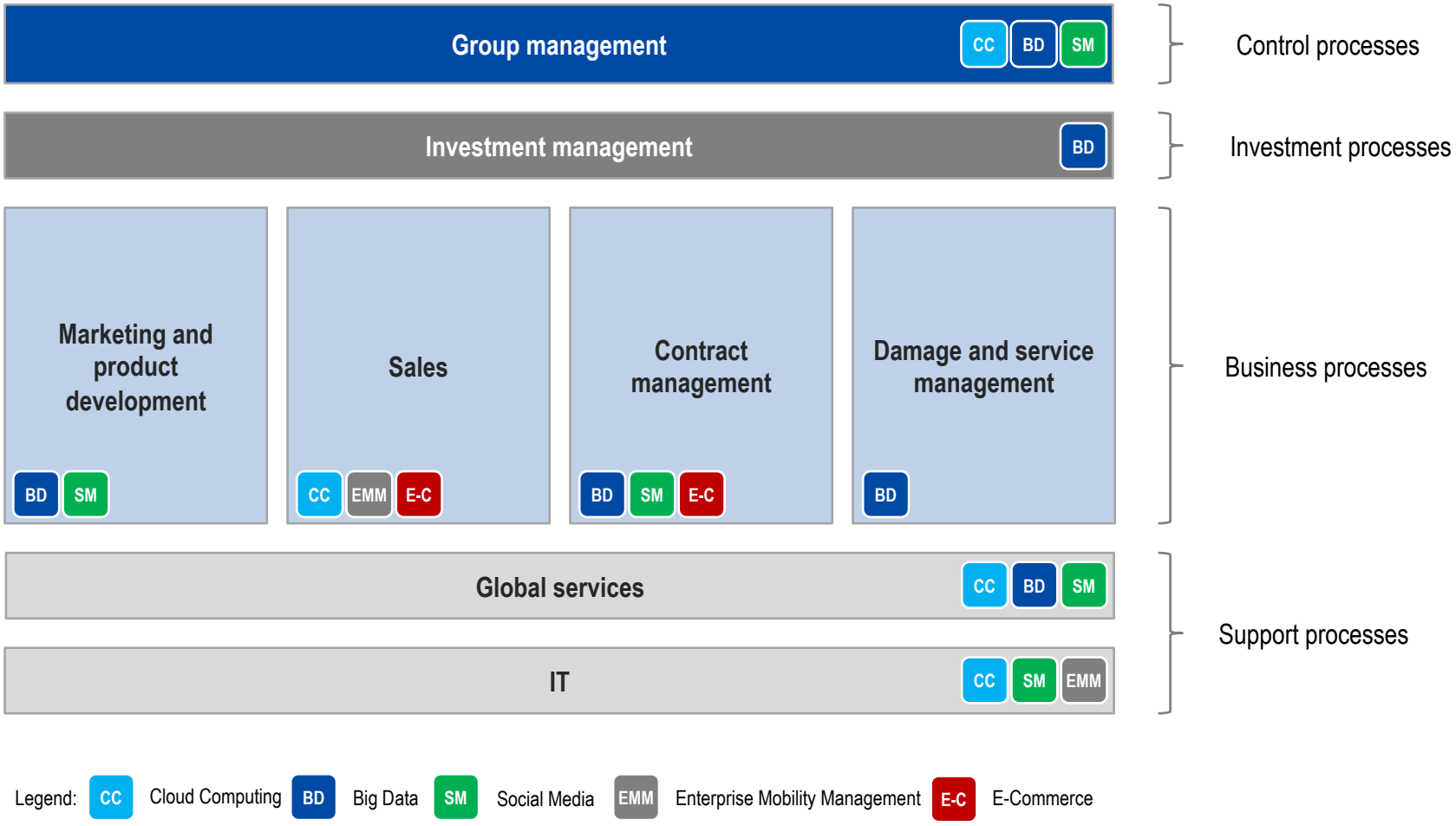
- Cyber Physical Systems are items that move along the production lines and control themselves.
- For this purpose they are digitized and receive their own data storage for information on carrying.
- In addition to data storage, it may be useful to "embedded software" to carry out their own decisions to make.
- Intelligent industrial assistance systems with direct access to all integrated systems and "Multi-interpreter" allow the people as decision-makers to influence the Point to Point communication of cyber-physical systems.
- This gives space for a completely new design of production systems. As a communication medium, the Internet and corporate intranet is used.
- Example from the engineering: A wind sensor measures and reports the wind speed is exceeded a defined value, the actuator automatically moves an awning.
- Fraunhofer IIS defines CPS as follows:
- "In 'cyber-physical systems' are to distributed, networked and communicating in real-time, embedded systems, which monitor the processes of the real, physical world by means of sensors and actuators by controlling or regulating in this action. They also often characterized by a high adaptability and the ability to deal with complex data structures. ".

A smart factory benefits from different industry 4.0 components

Smart factory

- The idea of "Smart Factory" realized a new understanding of Internet use for production.
- The "Smart Factory" means the transition to a more resilient (“resilienten”) factory
- People, machine and components communicate with each other
- By that only this is produced, what is actually needed
- The raw materials, semi-finished products, and products of a production cycle are now intelligent and interact with their environment, people and equipment.
- People, machines and resources of a company are integrated here into a network and work hand in hand
- With the help of "assistance systems" it will be possible in the future to manage a manageable process complexity without sacrificing process performance and process robustness.
- In the "Smart Factory" a better energy and resource efficiency and higher productivity is realized thanks to the real time control of the Internet of Things, which are immense benefits that industry 4.0 offers companies.

The following process model of a typical insurance company gives you a hit where industry 4.0 creates impact



Agenda

Industry 4.0 allows to improve strategic procurement

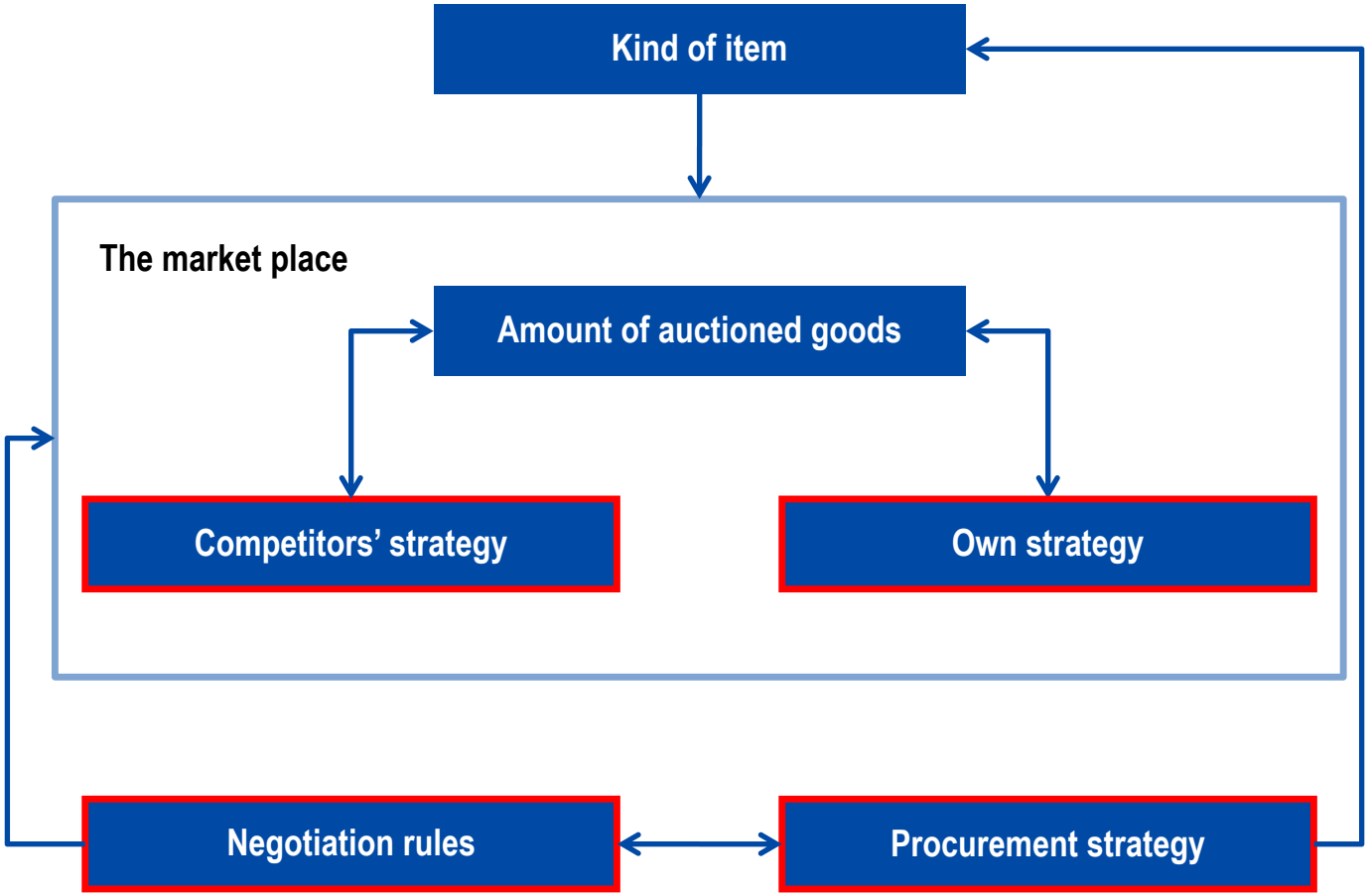
Review

- Many companies have introduced e-sourcing and global sourcing programs during the past 10 years
  - 64% of companies use e-sourcing in a survey by AberdeenGroup (2007)
  - Further possibilities for savings in e-sourcing by leveraging economies of scale and scope
- Many procurement departments and strategies have been redesigned during the past 5 years
- The INFORMS Edelman Award recognizes outstanding practical applications of mathematical methods
  - Procter & Gamble, 14.3% in recommended savings
  - Motorola, 3.75% savings
  - Mars Inc., 6% savings

Sustainable savings can be achieved

The definition of parameters to set up the decision support system have to been worked out in the preparation phase of the bid

Influencing factors



As first step of our approach, we structured the external parameters for split award auctions

External influencing factors

Negotiation rules

- Dynamic auction
- Parallel auction
- Eligibility: You have to submit a bid within any round, otherwise you are not able to bid in the next round
- Termination rule:
  - As soon as there is no overdemand, i.e. the demand is smaller or equal to the offer, the auction terminates
- Single item bid language
- First price payment rule
- Feedback:
  - Is there overdemand or not?
- The price decrement "tick" per round is 10

Procurement strategy

- A split award auctions is used for the purchasing of microcontrollers due to several reasons:
  - Risk consideration
  - Avoidance of dependence / monopoly structure
  - Insurance premium: If one supplier goes bankrupt, another one will be available
  - Larger number of suppliers is induced to bid
- The purchase department requests 2 tranches of 100.000 microcontrollers

Competitors' strategy

- Competitors use a best response respectively straightforward strategy:
  - Since each bidder is only allowed to win a single tranche, they only bid on that tranche that maximizes the margin given the current prices
  - Straightforward bidding is an ex-post equilibrium
- The marginal cost / quality function for each competitor i has been estimated:
  - $TC_i = a * q^2 + b * q + K$ wheras
    - a is the quality factor
    - b are the variable costs
    - K are the fixed costs

Internal parameters have been defined to develop the straightforward and powerset bidding strategy

Internal decision parameter

Own strategy

- Walk away prices for both tranches have to be defined
- The target tranches have been defined
- Targets have been set according to the market strategy (market entrance vs. market protection)
- Minimum and maximum objectives per tranche / overall have been defined
- Action profiles are determined:
  - Straightforward bidding
  - Powerset bidding: Bid on all tranches that generate a positive margin given the current prices
- The powerset and straightforward bidding strategy are approved by the management
- The decision support tool has been implemented

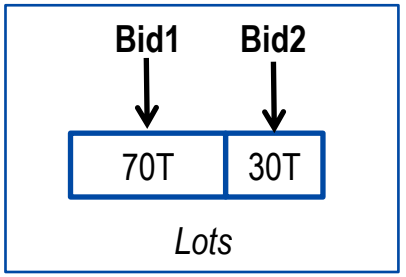
Internal and external parameters have been identified and named – besides, an activity diagram structures the parameters

Combination of internal and external parameters

Parameter identification

» Two items:

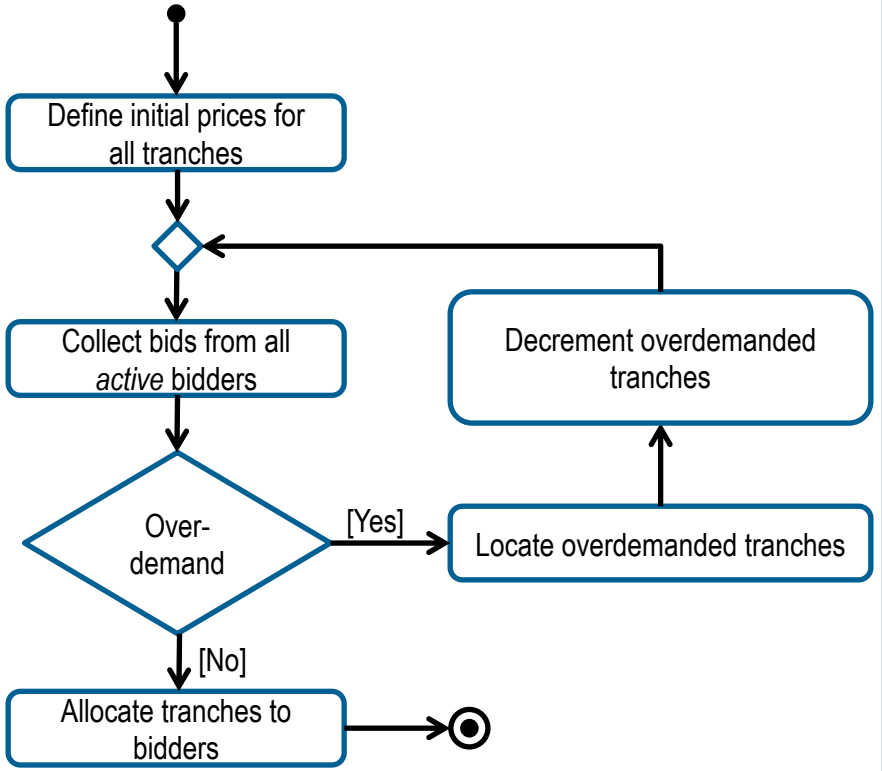
- Large tranche
- Small tranche
- Each supplier can win at most 1 tranche but bid on both tranches



» 3 other sales departments act as competitors

» 1 procurement department acts as auctioneer

Parameter structure



The simulation prepares for the real auction while the decision support system provides a management summary

The simulation and decision support system

Simulations

Decision support system

The simplified decision support system

Item	Old price	My current price (0 means I get off the auction	Current best price	Marginal Cost/Quality	Old margin	Current margin	Walk away margin
70	490	0	480	310	180	-310	400
30	60	0	50	190	-130	-190	200

We show you the prototype in the demo session!

.

A supplier has been supported recently within an OEM auction for KTL and base coatings

Reference (1/4)

Challenges	Our method	Results
» The purchase department of a German automotive manufacturer restructured the procurement of KTL and base coatings » All the suppliers face a decreasing margin	» Analysis and documentation of the procurement procedure » Development, evaluation and review of strategies, actions and best replies within the framework of the auction process » Derivation of behavioral rules » Development and implementation of simulations and role games as preparation for the actual auction » Participation into the real auction and management support	» Development of a deep understanding of OEM's procurement auction process » Application of strategic rules within the auction

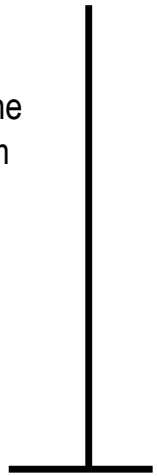
The supplier reached a high market share and an adequate margin!

Game theoretical insights have been given into the second price sealed bid (Vickrey) auction of the OEM

Reference (1/4)

First price sealed bid auction

a likely outcome for the first price mechanism



bid 1: €8

bid 2: €6

bid 3: €3

Bayes-Nash equilibrium

Second price sealed bid (Vickrey) auction

a likely outcome for the second price mechanism

bid 1: €5

bid 2: €4

bid 3: €2

Dominant strategy equilibrium

Bidding as well as best response strategies have been derived to reduce the complexity for procurement managers!

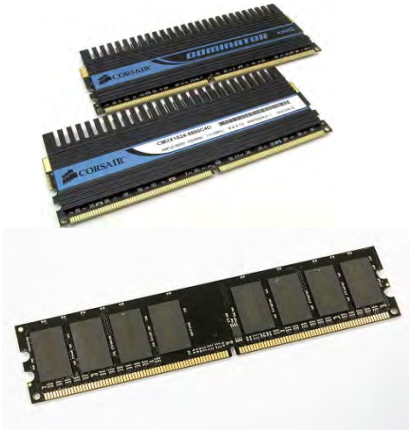
The procurement policy of a leading hardware producer has been optimized

Reference (2/4)

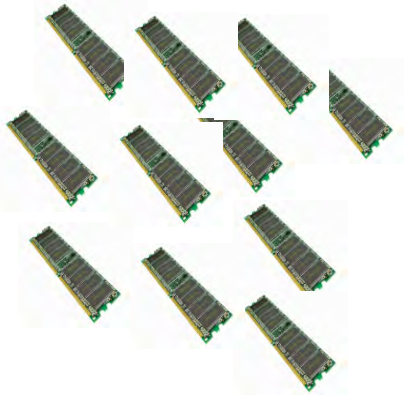
The sourcing of large volumes of memory chips

Business rules
(max. 3 winning suppliers)

Economies of scope
(Discounts on overall spend)



Economies of scale
(Discounts on volume)



The procurement department minimized the costs for 20 kind of different memory chips under specific business constraints!

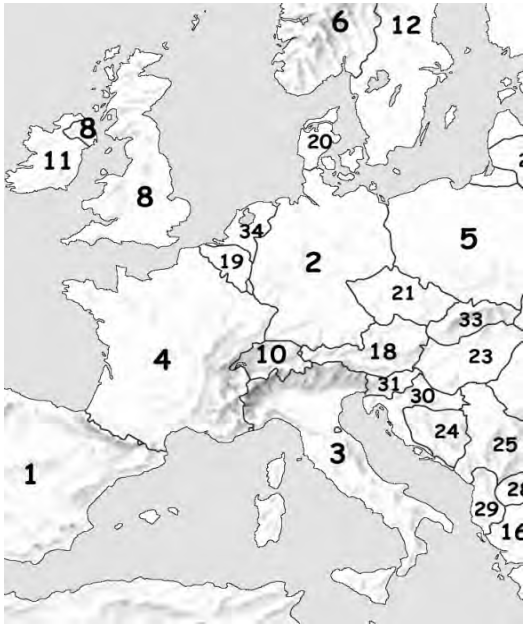
An auction has been implemented to buy services in regions across Europe

Reference (3/4)

Challenges

- Different geographical regions
- 20+ suppliers - there are local suppliers and (global) suppliers which cover multiple regions
- Global suppliers have economies of scope and provide volume discounts on larger packages
- Complex business rules have to be defined to select the “right” suppliers

Regions



The procurement costs have been reduced by over 11%!

Bidding strategies have been developed as preparation for a procurement auction

Reference (4/4)

Different bidding strategies

- Avoidance of the exposure problem in case of complementarities
- Tacit collusion by bidders through signaling
- Jump bidding can be used as a strategy
- Budget binding: One can bind budget of other budget-constrained bidders, resulting in high prices for everyone
- Parking: Bidders maintain their eligibility by parking in spots the bidders are not interested in, and then move to true interests later
- Waivers and bid withdrawals open up more options for the bidding strategy (seen in a consulting project in the Czech auction)
- Hold up: Bidders make clear that they are difficult to outbid and resell the items after the auction (if resale is allowed)

Different motivations affect competitors significantly

- The following explanations have been used to explain companies' behavior in auctions:
  - Risk attitude
    - Companies often behave risk averse to increase the probability to win
  - Joy of winning
  - Envy
  - Spite
  - Regret
  - Strategic complexity to derive the right bid
  - Wrong expectations of other biddings behavior

Complex bidding strategies are a result of the auction format, corresponding parameters, the behavior of the competitors and the own objective.

We support procurement as well as sales organizations by using a tool set based on game and auction theory as well as microeconmoic engineering

Areas of expertise (1/3)

- Developing and applying negotiation strategies based on game theory (mechanism design)
- Designing procurement auctions
- Simulations in the area of procurement auctions
- Training of 1:1 situations
- Conducting and/or participating in procurement auctions
- Derivation of „optimal“ strategies in procurement and/or split-award auctions to reduce the purchasing costs
- Analysis of bidding behavior
- Guidance and lessons for procurement managers

We convert game theory findings to monetary benefits for our customers, covering a wide range of application fields.

We optimize procurement strategies and/or organizations

Areas of expertise (2/3)

- Designing purchasing processes in order to minimize the procurement costs and ensure the independence from a single (group of) supplier(s)
- Developing global sourcing strategies and/or organizations
- Developing e-sourcing strategies, cross functionally optimized purchasing processes and corresponding complex business rules
- Applying different procurement constraints in an interactive manner to select the “right” set of suppliers
  - Min / max number suppliers
  - Lower / upper bound for overall quantity per supplier
  - Lower / upper bound for overall quantity per supplier and item
  - Lower / upper bound for overall spend per supplier or group of suppliers

We help you to improve your procurement department!

We optimize sales strategies and/or organizations

Areas of expertise (3/3)

- Developing sales strategies
- Designing sales processes in order to maximize the revenue
- Optimizing processes and saving time for sellers
- Negotiation support in M&A projects or major strategic projects
- Applying and proposing various sales auctions
- Real-time sales analysis and support within auctions
- Developing custom decision support tools for sales auctions
- Negotiation support in sales auctions

We help you to improve your sales strategy!