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Chair for Information Management and Systems

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Discussion Paper

Market Engineering - Towards an Interdisciplinary Approach

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15.12.2002

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ABSTRACT

The success of electronic markets does not only hinge upon scalable IT platforms combined with extensive marketing campaigns. Scientists and practitioners tend to agree that electronic markets have to be carefully designed, since even small failures in design decide on the overall success or failure of a marketplace. Unfortunately, traditional market design literature is often limited to the design of the trading rules. To solve practical challenges, the design of an adequate business model for the market operator and the design of individual IT platforms are also essential.

The paper introduces a conceptual framework based on secondary literature research that attempts to integrate the various theory streams of market design. By applying the grounded theory method, a market engineering process is derived. With the concept of Computer Aided Market Engineering (CAME) the present paper provides the vision, to analyze and structure the problem domain and to guide market designers in their task supporting them with an integrated tool suite.

1 Rise and Fall of Electronic Markets

In Information Systems electronic markets are commonly defined as inter-organizational information systems that allow buyers and vendors to exchange information about prices and product offerings (Bakos 1991). It is widely acknowledged that they bear the potential to reduce the transaction cost of trading (i.e., money and time necessary for gathering product information concerning quality and price) of the participants, speed up business processes, provide access to global buyers and seller, provide a whole new array of transaction methods, increase efficiency and overall shift hierarchical to more market coordination (Malone, Yates et al. 1987; Moai Technologies 2000; Kauffman and Walden 2001).

By 2000, this electronic market hypothesis[1] seemed to become reality. In deed, a vast growing importance of electronic markets was observed. In the press, especially B2B markets had been predicted to revolutionize traditional forms of interaction and to be a milestone within the evolution of the network economy. Major research agencies topped one another with ever increasing estimates about turnover and revenue volumes. For instance Gartner Group predicted that, the turnover of B2B markets would amount to $7.29 trillion by 2004 (Knight 2000). Similar results predict an online transaction volume of over $6 trillion by 2004.

The last two years have, however, also experienced the silent disappearance of many of these markets. Many had been suffering from meager transaction volume and equally meager revenues (Wise and Morrison 2000).

Argumentations for this decline can be drawn from a micro as well as from a macro perspective. In the latter case, i.e., the burst of the Internet bubble is accused to have seized the marketplace industry. In the former case, the argumentation is more complex and addresses designing – the process of con-

[1] The 'Electronic Market Hypothesis' refers to the aforementioned predicted shift from hierarchical to market coordination.

sciously organizing – electronic markets in all their facets. Due to the limited scope, this paper exclusively focuses on the micro level of electronic markets.

The remainder of the paper is structured as follows. Section 2 illustrates the fundamental understanding of market design. The issues of market design stem from various disciplines (e.g. software engineering, incentive engineering, price theory etc.). Accordingly, markets cannot only be viewed from one perspective. The present article derives in section 3 a conceptual framework that comprises the key factors of electronic markets. This framework is used as a reference point for the market engineering process, which is derived by applying qualitative research methods. Section 4 briefly depicts the engineering process. Section 5 concludes with a summary and the vision of a tool suite designated to support the engineering process.

2 Fundamentals of Market Design

In literature, the process of market design is tightly connected with the field of Economics. In his salient New York Times column, the famous Economics Professor Hal Varian lately emphasized this natural relationship as follows: "Economists are increasingly being called on to give advice about how to design markets" (Varian 2002). What he had in mind was that the design of the trading rules (i.e., economic institutions) determines the market outcome. Accordingly, it is not astonishing that economists are increasingly being called on to give advice about how to design markets (Roth 2000; Roth 2002; Varian 2002). This has happened in various applications such as the design of spectrum auctions, power exchanges, financial exchanges and a variety of other market and market-like mechanisms. Consequently, "[…] economics looks more like engineering than it does pure science"(Varian 2002). In this context, the market designer is perceived to be an economist who applies principles of economic analysis to design economic institutions. In theory markets are adequate to achieve the envisioned goals such as an efficient resource allocation. However, in practice electronic markets have not yet proven their theoretical potentials. Harvard Professor Al Roth illustrates this by the metaphor that "markets are not always growing like weeds, some of them are hothouse orchids" (Roth 2002).

The reason why electronic markets work better in theory than in practice stems from the fact that is not sufficient to just implement a technical infrastructure and launch comprehensive marketing campaigns as it has been done in many practical cases. Electronic markets are not just evolving, but they have to be carefully designed. However, design is not only restricted to the design of the market mechanisms. In fact, numbers of other factors have to be regarded to ensure customer satisfaction.

Lack of a coherent interdisciplinary theory, the market designer has to improvise where existing theory streams are silent. In analogy to the picture of the economist as an engineer, the market designer can also perceived to be an engineer. The process of designing markets is thus dubbed "Market Engineering".

Having motivated an engineering-like approach for market design it is necessary to identify the issues of market engineering. But what exactly are these issues, and, moreover, which concepts and tools can guide a market engineer to high quality electronic markets?

3 Perspectives of Market Engineering

Answering those questions is not an easy task. First of all, the definition of market quality is cumbersome. Possible quality concepts range from liquidity over efficiency to more complex aggregates such as best execution (see for example Budimir, Holtmann et al. 2001). In the following, details of the quality debate are not further pursuit because, regardless of the applied quality concept, the market engineering process can be worked out.

Note, that market quality is formed by the interaction of market participants. The way buyers and sellers come together in the agreement process determines the market outcome. Clearly, the market designer cannot influence the negotiation behavior and has accordingly no direct control over the market quality. However, all the market designer can do is to define the structure of the market in a way that the participants have an incentive to interact in a certain way.

This understanding is similar to the market structure-conduct-performance (S-C-P) theory (Mason 1939; Bain 1968; Tirole 2000) taken out of industrial organization: The market (standing for industry in this context) structure influences the conduct in that industry, which has in turn an influence on the market outcome. However, talking about electronic markets sways the notion of market structure. What exactly determines the structure of an electronic market?

Based upon an extensive secondary research, a conceptual framework is derived by extending the S-C-P. This conceptual framework (Miles and Huberman 1994) is envisioned to explain the structure of an electronic market. The main topics to be studied in market engineering – the key factors, constructs or variables – and the presumed relationships among them will be identified. The framework identifies three main perspectives, which are introduced in the following and illustrated in more detail in section 3.1-.3.3.

The first perspective concerns the market's microstructure (the market's mechanisms). Secondly, from an information technology view it is essential how these rules are provided (the market's infrastructure). Thirdly, from a business oriented view it is necessary to determine how much is charged for the single market services (business structure).[2]

Thus, the traditional understanding is enlarged: The combination of these three interdependent perspectives builds the market's structure. The market microstructure (What?) as well as their realization by IT (How?) and the pricing (How much to charge?) of the single trading services affect the strategic behavior of the participants in the market and, consequently, the market outcome (see Figure 1).

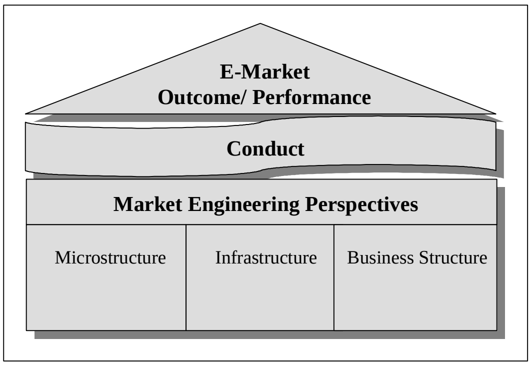

Figure 1: Market Engineering Perspectives and their indirect relation to the market outcome.

Two examples – from the participants' as well as from the designers' point of view – can illustrate this understanding. The Participants will change their bidding behavior if no longer open but sealed bids are allowed, and/ or, if face-to-face interaction is replaced with computer front-ends, and/ or if transaction fees are doubled. On the other hand, the market designer will have to adapt the pricing of the services supplied if these services or the underlying infrastructure is changed.

An interdisciplinary analysis of the interdependencies among the market structure perspectives as well as between structure and conduct is missing and state-of-the-art theory fails to answer the questions, what exactly these design issues in electronic market engineering are, and which concepts and tools are necessary to guide the market designer to build high quality electronic markets.

The next chapters illustrate the three perspectives in more detail before the vision of a market engineering tool suite is introduced.

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[2] In the remainder of the paper, the terms market engineering perspectives and design areas are considered similar. The term structure is used to characterize the result of a design task, whereas, the term design addresses the process of structuring or organizing.

3.1 What to provide – Microstructure

Ever since the establishment of a separate discipline, Economics deals with markets. However, traditional theory abstracts from the specific market mechanism. Most of its models assume perfect information, which basically means that all participants have all available information. Long before the Nobel price winners Stiglitz, Akerlof and Spence had started working on asymmetric information, Hayek already emphasized that the market process can communicate dispersed information which allows a better resource allocation (Hayek 1945). The classical metaphor of the "walrasian auctioneer" assuming perfect information is inadequate to explicitly explain the precise functioning of a market. New approaches therefore address these shortcomings by incorporating aspects such as the working of mechanisms, risk and information allocation (e.g. auction theory, market microstructure theory, mechanism design, incomplete markets, information economics).

Closely related to those aspects, many theoretical and experimental research focuses the question, how exactly different institutional definitions (e.g. auctions) affect bidding/negotiation behavior (auction theory, mechanism design, and negotiation analysis and many more). By varying the trading rules, the changed incentive scheme alters the market outcome. Market microstructure design thus determines the trading rules according to a set of goals.

Traditionally only those mechanisms are analyzed which equilibrate demand and supply over the price (Milgrom and Weber 1982; McAfee and McMillan 1987). In recent years the trend shifts to more complex mechanisms that allocate more than one good either heterogeneous (combinatorial auctions, e.g. Rassenti, Smith et al. 1982) or homogeneous (multi unit auctions, e.g. Ausubel and Cramton 1996; Krishna 2002). The more complex the relationship between the goods is, the more are the borders between economics and operations research blurring. Operations research allows the development of algorithms that approximately approach the optimal solutions by reducing the complexity tremendously (Rothkopf, Pekec et al. 1998; Nisan and Ronen 2001; Sandholm 2002).

Since the start of the Internet boom, more research projects have been analyzing not only market microstructure design as isolated area but also explore the interdependencies with system and business design (Cohen, Maier et al. 1985; Massimb and Phelps 1994; Schwartz 1995; Spulber 1999).

3.2 How to provide – Infrastructure

The infrastructure – or more precisely the IT infrastructure – is concerned with the mapping of the microstructure into the world of IT and into running systems. There are generally two strategies conceivable, how to perform this design task.

Firstly, the existing trading rules (microstructure) can be purely translated into an information system. The first electronic stock exchanges, for example, just implemented the rules of the existing floor exchanges. The arguments for this *electronification* usually comprise efficiency aspects: Trading processes can be performed faster and at lower costs. Furthermore, electronic markets do not require participants to be located at a certain floor to participate in the market, remote memberships are possible. The potential range of the market is almost unlimited. Operating targets in infrastructure or system design also comprehend issues such as standardization, flexibility, and interoperability with other systems (e.g. marketplaces or ERP (enterprise resource planning) systems). The better the marketplace is integrated with the firms' information system landscape, the greater are the efficiency gains that can be achieved.

Secondly, information systems can also be used to design new markets, as IT facilitates the establishment of more complex trading methods that have desirable properties. In contrast to electronification, this is often referred to as *electronization*. For example mechanisms that allocate a product to the participant who values it most (economic efficiency) do exist in theory. With the help of information technology such complex auctions, in this case the Generalized Vickrey Auction (Varian 1995; Ausubel and Milgrom 2002), can be practically performed. In this respect, the area of computational mechanism design aims at developing mechanisms that embody desirable economic properties (e.g.

strategy proofness, efficiency, revenue maximization) without incurring their disadvantages (e.g. computational tractability, information requirements)(Nisan and Ronen 2001; Bichler, Kalagnanam et al. 2002; Conitzer and Sandholm 2002). Overall, detailed studies how exactly the infrastructure affects the behavior of the market participants are currently missing.

Infrastructure design is clearly a software engineering activity. As such the approaches in software engineering must be transferred to the implementation of an electronic market. Here, the interdependencies with microstructure and business play an integral role. Therefore, it is necessary to identify these interdependencies in the first place.

3.3 How much to charge – Business Structure

Traditional non-electronic markets such as floor stock exchanges were often established as non-profit organizations (registered associations). The rationale behind this form of organization stems from the high costs of operating floor exchanges. Interest groups co-operated in building an institution to reduce the coordination costs. As a consequence of this registered association, all members together were responsible for the companies' decisions and strategies, and also, for the market's structure.[3] This shared responsibility entails in a market structure that is characterized by balanced interests of the members (Stoll 1992; Picot, Bortenlänger et al. 1996; Di Noia 1999). In recent years where the establishing and operating organized markets is due to the advances in information technology no longer as costly, registered organizations lost in importance (Domowitz and Steil 1999; Lee 2000). For instance, many stock exchanges have been altered from registered associations to private profit-maximizing firms.

Analogous to industrial firms, electronic markets are exposed to competition among the customers. Accordingly, the operators are forced to offer the best service portfolio to the lowest possible fees if they want to remain active in the fierce competition. The business structure reflects the strategy of the market operator. The strategy primarily encompasses the bundle of services that are offered and the corresponding revenue model.

The challenge in the business design lies in the sound balancing of shareholders and non-shareholder interests, as well as of profit-optimization and market quality assurance. Furthermore, it is important in strategic positioning that reconciles market's microstructure, infrastructure and business structure.

Hitherto, literature that conceives the market as a firm is still in its infancy. Accordingly a deep pool of related research papers is missing (Schwartz 1995; Di Noia 1999; Lee 2000). However, viewing markets as a firm allows the application of (general) business administration literature. Where applicable, it has to be adjusted to the special aspects of electronic markets.

The comprehensiveness of business design already hints at its importance in connecting the perspectives. Gluing all three together can result in a closed, sound concept that is likely to be successful in the competition. Contradictions to the other design areas can, on the contrary, result in the overall failure of a market. Consequently, it is the interdependencies among the design areas that are critical factors to success.

After having illustrated these three most important engineering perspectives, a guide to a structured design process with regard to the customer is introduced. Every single step consists of a detailed analysis of the three single perspectives and there interdependencies with each other concerning the overall market outcome.

[3] Recall, that this structure fundamentally influences the market's outcome and thereby for example the cost of trading for every single member.

4 Process of Market Engineering

Lack of profound (scientific) knowledge, the process of designing markets has been characterized by trial-and-error (Macey and O'Hara 1997). However, if markets should enfold their predicted potentials, trial-and-error must be superseded by a structured, systematic design approach (Babin, Crainic et al. 2001; Neumann and Weinhardt 2002).

The systematic application of scientific knowledge in creating and building electronic markets is deemed to have a deep positive impact on their quality. As in any other industry quality assurance must also be considered not only during *design* but also during *operation*.[4] In the remainder of the paper, the engineering *not* the operation of markets is illustrated in more detail.

As such, the development of a comprehensive engineering process – from the conception over implementation and comprehensive testing – is a way to increase the chances of markets. The proposed electronic market engineering process is assumed to comply with the phase scheme depicted in Figure 2.

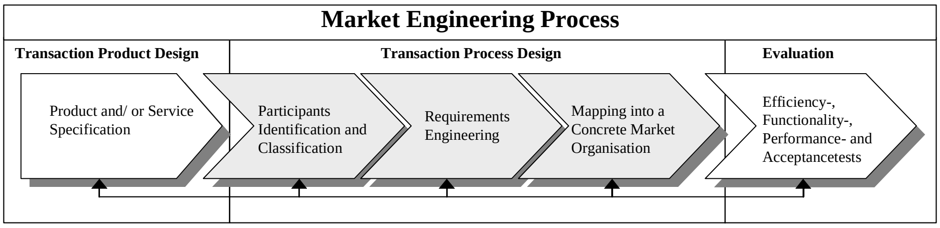

Figure 2: Market Engineering Process (Budimir, Holtmann, Neumann (2001)).

The engineering process is based upon the understanding of best execution demands of heterogeneous groups of investors (Budimir, Holtmann et al. 2001): Market participants use to prefer different trading vehicles depending on the product to be traded and their trading strategy (Macey and O'Hara 1997; Neumann, Holtmann et al. 2001; Neumann, Holtmann et al. 2002).

As illustrated, the engineering process – which was derived applying grounded theory approach (Strauss and Corbin 1998)[5] – comprises three different stages (with 5 phases), namely the product development, the trading procedure development and the evaluation.

Stage 1: Product Development

At this early stage of the engineering process the transaction product or trading object (the group of goods being traded on the market) must be determined. If necessary, products must be harmonized depending on their inherent properties (development of taxonomies and ontologies) and subsequently categorized to (preferably) homogeneous groups.

Depending on the harmonization two extreme forms of traded goods spanning a continuum can be identified. On the one extreme, the goods of a group are perfect substitutes such that highly fungible markets (e.g. stock markets) evolve, whereas on the other extreme the goods of a group can be weak substitutes (e.g. real estate). The latter case obviously requires different trading mechanisms, system features, complementary services, and business plans than the former. Accordingly, the market operator must first strategically decide on the specific market segment(s) he is intending to serve. Then, contingent on this strategic positioning, the corresponding tailored portfolio of complementary services can be compiled.

Stage 2: Trading Procedure Configuration

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[4] As we understand the market as being the product or service of a firm, market engineering is the customer-oriented process of product design.

[5] Due to space restrictions, the applied qualitative research procedure is omitted in this paper.

The configuration of the transaction process generally comprises the explicit formulation of the market structure. Elements of the trading rules particularly concern market access, trade transparency, price discovery, supervision and settlement (Röhrl 1996; Gomber 2000).

In order to induce participation the underlying trading rules of a market must meet the needs and requirements of the relevant stakeholders or target customers respectively. The accurate determination of these interested groups is subject to the identification process, which initiates the transaction process configuration. One major drawback of the configuration process constitutes the heterogeneity of the various requirement profiles. Typically, these profiles – depending on the product that is traded – are contradicting each other. There is typically no one-size fits it all mechanisms (Wurman 2001).

Due to this natural heterogeneity of the total market, electronic markets usually aim at a specific target group with requirements that are homogeneous to a certain extent. The mapping of these (formal and informal) requirements marks the difficulty of defining trading rules in effect (Budimir and Holtmann 2001). This particular difficulty stems from the interdependencies of the trading rules with the implemented infrastructure and business structure.

As illustrated, the microstructure together with its implementation embedded within a business strategy affects the strategic trading behavior of the participants. Consequently, holistic market engineering must account for the specifics of all three areas.

Due to the interdependencies and even contradictions among these three areas, the decisions in one design area have an impact on the other. Since the behavior of the market participants is influenced by all three, the evaluation of the quality occurs in the next phase of the market engineering process.

Stage 3: Evaluation

The quality of a market is certainly no one-dimensional criterion. Accordingly, it is frequently not sufficient that the electronic market generates good prices. Other economic criteria such as immediacy and transaction costs but also technical aspects like reliability, performance etc. account for the quality (Budimir, Holtmann et al. 2001). Traditionally market quality is measured by concepts such as liquidity, transaction costs, and efficiency. However, those measures are influenced by the strategic interaction of the participants. An ex-ante determination of all quality attributes is thus not possible. A realistic, game theoretic reasoning is, moreover, extremely difficult taking the numerous variables into account.

Empirical methods – especially laboratory experiments – can help to explore the acceptance and quality of a market's structure before it is used in real-world settings. Feedback of these tests can also provide accurate information how the three areas *microstructure*, *infrastructure* and *business design* must be adjusted before the market is launched. Having in mind that a failure in the introduction phase often leads to an overall failure of the market these tests diminish the likelihood of a failure.[6]

Clearly, the phases are not independent from each other. The suggested process is not conceived as a strict, sequential arrangement of activities. Skipping or replacing phases is rather possible (e.g. the first phase can be skipped if an existing product definition is employed) – an iterative approach likely.

Summarizing, the structuring of this engineering process identified several tasks that has to be performed and an ordering which tasks must take place early in the process or at a later time. In order to assure good design solutions, i.e. an adequate market design with respect to all three dimensions, the development of supporting tools appears to be reasonable. Those tools can firstly incorporate the es-

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[6] After the design process is completed the roll-out can take place. With the roll-out the electronic market places enters its lifecycle in operation. Although the operation process and the design process are not independent of each other, the associated problems are different. The present engineering process focuses on the design activities only.

sential knowledge how to perform those tasks and, secondly, create either documents or programs/ algorithms, which can be used in subsequent phases of the engineering process.

5 The Vision of Computer Aided Market Engineering

Electronic marketplaces differ from traditional markets in the fact that they are completely designed – not just evolving. By the means of appropriate structure the institution 'market' can attain a high degree of market quality. On the other hand an inappropriate design can entail severe distortions in allocation, liquidity or customer-orientation. But what is an appropriate design? Every new marketplace has to answer this question; every incumbent marketplace has to verify whether the current design is still the most adequate one. The present paper proposes a structured approach to market engineering that guides the market designer through this cumbersome design process.[7]

Furthermore, the idea of computer-aided market engineering is deemed promising to further structure the process and is thus motivated. Recall that market engineering is usually a knowledge intensive, inter-personal and time-critical process.

Time-to-market is important particularly for innovative solutions, as the first-mover advantage is essential. However, if early appearance is achieved by incurring severe design failures, the chances of the electronic market are tremendously diminished. Recall that the market quality (in this respect liquidity) is a chicken-and-egg problem: Once a market started with low participation, the chance of catching up is low since negative network effects work against this market. The market engineering process is thus demanding a quick and thorough conception and implementation.

The second argument for computer support of the engineering process concerns the dispersion of design knowledge among different experts. Software engineers usually do not have consolidated knowledge about special products, market microstructures, or business models. Accordingly, the design knowledge inherent to experts should be added to an accessible knowledge base. This base enhanced by easy-to-use tool also gives novices (recall the software engineer example) the possibility to act as an expert.

A third argument concerns the inter-personality of the market engineering process as a whole. As depicted in section3 market engineering is a complex process, which requires the cooperation of different developers (economists, software engineers, managers). Supporting tools provide these developers with a standardized approach. Furthermore, by the means of those tools, communication can be streamlined by using a joint terminology and providing visualization techniques.

In the discipline of software engineering the requirements are similar to those in market engineering: high functionality software applications must be developed in a short period of time. This can be achieved by the means of so-called CASE technologies (Computer-aided software engineering). CASE tools allow automating significant parts of this time-consuming software development life cycle. In analogy to CASE tools, specific development tools for market engineering are also deemed promising to speed up the design process. Furthermore, the quality of the design process can be enhanced by a standardized, tested procedure[8]. The proposed engineering process should thus be supported by a CAME tool suite. The development of these CAME tools is subject to future research.

The engineering process can be conceived as a holistic approach since all important perspectives of market design are included. As illustrated, the conceptual framework of market engineering comprises not only the microstructure perspective but also incorporates the business and infrastructure. By doing so, it can be explained why real markets better work in theory than in practice. The reason stems from

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[7] Practically, it is of interest how exactly the engineering process should optimally look like. Due to the limited scope of this paper the exact configuration of the phases are omitted.

[8] Note that the engineering process is an open process. Knowledge acquired during the engineering process is added to the knowledge base and will be accessible for other projects.

the perspectives of theory. Usually, theory abstracts from the fact that the electronic market is a firm. This omission of the business structure perspectives assumes a benevolent market, which is never the case in the real world.

Literature

Ausubel, L. and P. Cramton (1996). "Demand Reduction and Inefficiency in Multi-Unit Auctions." Working Paper No. 96-07, Department of Economics, University of Maryland.

Ausubel, L. and P. R. Milgrom (2002). "Package Bidding : Vickrey vs Ascending Auctions." Revue Economique **53**(3).

Babin, G., T. Crainic, M. Gendreau, R. Keller, P. G. Kropf and J. Robert (2001). Towards Electronic Market-places: A Progress Report. ICECR-4,, Dallas, TX.

Bain, J. (1968). Industrial Organization. New York, John Wiley & Sons.

Bakos, J. Y. (1991). "A Strategic Analysis of Electronic Marketplaces." MIS Quarterly **15**(3): 295-310.

Bichler, M., J. Kalagnanam, H. S. Lee and J. Lee (2002). Winner Determination Algorithms for Electronic Auctions: A Framework Design. EC-Web, Aix-en-Provence, Springer.

Budimir, M. and C. Holtmann (2001). The Design of Innovative Securities Markets: The Case of Asymmetric Information. e-Finance: Innovative Problemlösungen für Informationssysteme in der Finanzwirtschaft. N. K. a. W. S. Hans Ulrich Buhl. Berlin et al, Springer**:** 175-196.

Budimir, M., C. Holtmann and D. Neumann (2001). "The Design of a Best Execution Market." Revue Bancaire et Financière/Bank en Financiewezen **66**(2-3): 138-146.

Cohen, K. J., S. F. Maier, R. A. Schwartz and D. K. Whitcomb (1985). The Microstructure of Securities Markets. Englewood Cliffs, New Jersey, Prentice-Hall.

Conitzer, V. and T. Sandholm (2002). Complexity of Mechanism Design. 18th Conference on Uncertainty in Artificial Intelligence (UAI), Edmonton, Canada.

Di Noia, C. (1999). The Stock-Exchange Industry: Network Effects, Implicit Mergers, and Corporate Governance. Rome, CONSOB - Commissione Nazionale per le Societa e la Borsa**:** 78.

Domowitz, I. and B. Steil (1999). "Automation, Trading Costs, and the Structure of the Trading Services Industry." Brookings-Wharton Papers on Financial Services: 33-92.

Gomber, P. (2000). Elektronische Handelssysteme - Innovative Konzepte und Technologien. Heidelberg, Physica-Verlag.

Hayek, F. (1945). "The Use of Knowledge in Society." American Economic Review **35**(4): 519-530.

Kauffman, R. J. and E. A. Walden (2001). "Economics and Electronic Commerce: Survey and Directions for Research." International Journal of Electronic Commerce **5**(4): 5-116.

Knight, L. (2000). Triggering the B2B Electronic Commerce Explosion, Gartner Group.

Krishna, V. (2002). Auction Theory. San Diego, CA, Academic Press.

Lee, R. (2000). What is an Exchange? The Automation, Management, and Regulation of Financial Markets. New York, Oxford University Press.

Macey, J. R. and M. O'Hara (1997). "The Law and Economics of Best Execution." Journal of Financial Intermediation **6**(3): 188-223.

Malone, T. W., J. Yates, M. Scott and R. J. Benjamin (1987). "Electronic Markets and Electronic Hierarchies." Communications of the ACM **30**(6): 484-494.

Mason, E. S. (1939). "Price and Production Policies of Large-Scale Enterprise." American Economic Review **29**: 61-74.

Massimb, M. N. and B. D. Phelps (1994). "Electronic Trading, Market Structure and Liquidity." Financial Analyst Journal **50**(January- February): 39-50.

McAfee, R. P. and J. McMillan (1987). "Auctions and Bidding." Journal of Economic Literature **25**: 699-738.

Miles, M. B. and A. M. Huberman (1994). Qualitative Data Analysis. A Source Book of New Methods. Beverly Hills, Sage.

Milgrom, P. R. and R. Weber (1982). "A Theory of Auctions and Competitive Bidding." Econometrica **50**(November): 1089-1122.

Moai Technologies, I. (2000). White Paper: An Introduction to Dynamic Commerce and Negotiated e-Commerce. San Francisco, Moai**:** 1-16.

Neumann, D., C. Holtmann and T. Honekamp (2001). Market Integration and Metamediation: Perspectives for Neutral B2B E-Commerce Hubs. e-Commerce - Netze, Märkte, Technologien. C. Weinhardt and C. Holtmann. Heidelberg, Physica**:** 67-85.

Neumann, D., C. Holtmann, H. Weltzien, C. Lattemann and C. Weinhardt (2002). Towards A Generic E-Market Design. Towards the Knowledge Society: e-Commerce, e-Business and e-Government. J. Monteiro, P. M. C. Swatman and L. V. Tavares. Lisboa, Kluwer Academic Publishers**:** 289-305.

Neumann, D. and C. Weinhardt (2002). Domain-independent eNegotiation Design: Prospects, Methods, and Challenges. 13th International Workshop on Database and Expert Systems Applications (DEXA 2002), Aix-en-Provence, France, IEEE Computer Society.

Nisan, N. and A. Ronen (2001). "Algorithmic Mechanism Design." Games and Economic Behavior **35**: 166-196.

Picot, A., C. Bortenlänger and H. Röhrl (1996). Börsen im Wandel. Frankfurt a.M., Fritz Knapp.

Rassenti, S., V. Smith and R. L. Bulfin (1982). "A combinatorial auction mechanism for airport time slot allocations." Bell Journal of Economics **13**: 402-417.

Röhrl, H. (1996). Börsenwettbewerb: Die Organisation der Bereitstellung von Börsenleistungen. Wiesbaden, Deutscher Universitäts-Verlag.

Roth, A. E. (2000). Game Theory as a Tool for Market Design. Game Practice: Contributions from Applied Game Theory. F. Patrone, I. Garcia-Jurado and S. Tijs. Dordrecht, Kluwer**:** 7-18.

Roth, A. E. (2002). "The Economist as Engineer: Game Theory, Experimental Economics and Computation as Tools of Design Economics." Econometrica **forthcoming**.

Rothkopf, M. H., A. Pekec and R. M. Harstad (1998). "Computationally Manageable Combinatorial Auctions." Management Science **44**: 1131-1147.

Sandholm, T. (2002). "Algorithm for Optimal Winner Determination in Combinatorial Auctions." Artificial Intelligence **135**: 1-54.

Schwartz, R. A. (1995). Global Equity Markets: Technological, Competitive, and Regulatory Challenges. Chicago et al., Leonard N. Stern School of Business.

Spulber, D., F. (1999). Market Microstructure: Intermediaries and the Theory of the Firm. Cambridge, Cambridge University Press.

Stoll, H. R. (1992). "Principles of Trading Market Structure." Journal of Financial Services Research **6**: 75-107.

Tirole, J. (2000). The Theory of Industrial Organization. Cambridge, MA and London, England, The MIT Press.

Varian, H. R. (1995). Economics Mechanism Design for Computerized Agents. USENIX Workshop on Electronic Commerce, New York.

Varian, H. R. (2002). When Economics Shifts From Science to Engineering. New York Times. New York.

Wise, R. and D. Morrison (2000). "Beyond the Exchange - The Future of B2B." Harvard Business Review **78**(6): 86-96.

Wurman, P. (2001). "Dynamic Pricing in the Virtual Marketplace." IEEE Internet Computing **5**(2): 36-42.