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Collective market-making efforts at an engineering conference

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Collective Market-Making Efforts at an Engineering Conference

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Abstract

This paper advances research on institutional work in market constitution processes. I show how purposive, coordinated action is organized under conditions of uncertainty through practices of rendering irreducible uncertainty tolerable. Building on recent developments in institutional theories of organization, market sociology, and the concept of field-configuring events, I analyze collective market-making efforts at a conference on the next generation of lithography technology for manufacturing semiconductors. I use original documents and 76 field interviews in a qualitative analysis to identify and understand the main practices of collective institutional work at the conference, along with the immediate consequences of these practices. My findings show that the overall purpose of the conference was to generate momentum toward commercialization, in spite of remaining uncertainty, through practices of bootstrapping, roadmapping, leader-picking, and issue-bracketing. These are practices of ignoring, denying, displacing, and suspending uncertainty, respectively. I contribute important clarifications of the meaning of purposive action and agency in institutional work and I advance action-theoretical explanations of market constitution processes by identifying activities involved in shaping a market that is still in the making.

Zusammenfassung

Diese Studie trägt zur Erforschung von *Institutional Work* in Marktkonstitutionsprozessen bei. Ich zeige, wie gezieltes, koordiniertes Handeln unter Ungewissheit durch Praktiken organisiert wird, die die Ungewissheit tolerierbar machen. Ausgehend von den jüngsten Erkenntnissen der institutionalistischen Organisationstheorien, der Marktsoziologie und dem Begriff des *Field-Configuring Events* analysiere ich kollektive Bemühungen der Markterschaffung bei einer Konferenz über die nächste Generation von Lithographietechnologie für die Halbleiterproduktion *(Next Generation Lithography)*. Anhand von Originaldokumenten aus dem Feld sowie 76 Interviews führe ich eine qualitative Analyse durch, mit der die wichtigsten Praktiken des kollektiven *Institutional Work* bei der Konferenz und deren unmittelbare Folgen identifiziert und verstanden werden können. Meine Ergebnisse zeigen, dass es in der Konferenz vor allem darum ging, einen gewissen Schwung, das heißt: eine zielgerichtete Kraft zu erzeugen, die die Kommerzialisierung einer neuen Technologie anstoßen soll – und zwar trotz der verbleibenden Ungewissheit. Dies wurde durch Praktiken des Ignorierens, Leugnens, Verschiebens und Aufhebens von Ungewissheit erreicht, die ich mit den englischen Begriffen *bootstrapping, roadmapping, leader-picking* und *issue-bracketing* genauer bezeichne. Die Studie trägt zur weiteren Klärung der Bedeutung von gezieltem Handeln und der Rolle von Akteuren in Institutionalisierungsprozessen bei. Ich bringe handlungstheoretische Begründungen von Marktkonstitutionsprozessen voran, indem ich Praktiken beschreibe, die einen Markt beeinflussen, der sich noch im Entstehungsprozess befindet.

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1 Introduction

The role of organized actors in the constitution of new fields, especially in the creation of new markets through radical innovation, is widely recognized (e.g. Garud/Karnøe 2001; DiMaggio 1988; Fligstein 1997). Yet the practices by which actors are able to coordinate collective action toward the development of a new market in the face of uncertainty are poorly theorized, and even less well known empirically (Wijen/Ansari 2007; Akrich/Callon/Latour 2002). This paper focuses on practices that can be observed at market-configuring events. How do such events work to organize collectives of actors to move in the same direction toward constituting a new market, when there is still uncertainty about the final destination?

The common view is that actors can be motivated to move in the same direction by reducing the uncertainty about the feasibility and desirability of the projected market (e.g. Beckert 1996; Fligstein 2001a; Podolny/Hsu 2003). My study of a pre-competitive event, however, reveals important practices that serve to ignore, deny, displace, and suspend uncertainty just as much as they may increase certainty for the actors. I refer to these practices as bootstrapping, roadmapping, leader-picking, and issue-bracketing. They support collective sense-making, and add to market-making efforts (Garud 2008) as a result. Such mechanisms render uncertainty tolerable, which I argue is vital for coordinated action toward the constitution of new markets in the face of uncertainty.

My study heeds Davis and Marquis's (2005) call for problem-driven, field-level, and mechanism-based research in organization theory. The problem I address is one of the major concerns in the semiconductor industry about constituting markets for "next generation lithography," which is anticipated to have great consequences for modern economies and societies. This new market is an emerging field, and I aim to understand it better by studying the practices that occur at high-profile, field-specific events. These practices reveal mechanisms of dealing with uncertainty that can be theorized beyond the field in question.

The study is grounded in institutional theories of organizations and organizational fields, especially research on "institutional work" (DiMaggio 1988: 13–15; Lawrence/Suddaby 2006) and developments in the sociology of markets, particularly field-based approaches dealing with constitution processes for new markets (Fligstein 2001a). My findings about alternate ways of dealing with uncertainty and generating momentum advance these two related streams. In terms of research design, I build on Zilber's (2007)

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and Garud's (2008) studies of conferences as key events for institutional entrepreneurship, collective sense-making, and field configuration (Lampel/Meyer 2008). I analyze how different practices at conferences are related to the problem of uncertainty. The event I focus on here is the Fifth Sematech Workshop on Next Generation Lithography (Fifth NGL Workshop) in Pasadena, California, on August 28–30, 2001. The conference theme was "Working toward Commercialization," which points explicitly to institutional work on market-making, at least as an objective of the conference.

My contribution to organizational institutionalism and market sociology is threefold: first, I show that the concept of agency needs to be extended to include practices in the face of uncertainty that are projective without a clear vision of the desired outcome, which revises current notions of purposive action in institutional work and entrepreneurial vision in innovation-based market creation. Second, I demonstrate by focusing on empirical practices that markets can be studied before they are established, either when actors articulate their projections and ideas at events, or when actors form a collective around the "issue" of creating new markets and technologies (Hoffman 1999). Third, I apply the currently vague notion of "field-configuring event" to the constitution of markets. Because I am studying a market-configuring event, I can therefore be much more specific about the elements of the field being configured. This greater specificity helps to assess the actual impact of events on a market field.

In the following sections, I first develop the theoretical bases and context for the institutional work, market constitution, and field-configuring events that underpin my study. In the data and methods section, I introduce the larger empirical context in which the Fifth NGL Workshop occurred and specify the data and analytical tools used to extract my findings. The next section presents the market-making efforts at the conference and identifies the practices of institutional work they represent. In the last section, I discuss the theoretical contributions and research implications of my study.

2 Institutional work and market-configuring events

As early as 1988, DiMaggio (1988: 13–15) uses the term "institutional work" to describe actors' efforts to reproduce institutions or create new ones. More recently, research under the label of "institutional work" (Lawrence/Suddaby 2006; Lawrence/Suddaby/Leca 2009) has reinvigorated the search for a better understanding of the role actors play in processes of institutionalization: this research embraces the paradox of embedded agency rather than resolving it (Battilana/D'Aunno 2009; Garud/Hardy/Maguire 2007; Holm 1995). Lawrence and Suddaby (2006: 215) define institutional work as "the purposive action of individuals and organizations aimed at creating, maintaining and disrupting institutions." Accordingly, actors can take many different roles in relation to new and existing institutions. They can work for or against them, play a leading or sup-

portive part, and influence the actions of others and the overall development of a field (Fligstein 2001b).

The proponents of institutional work build on the sociology of practice (e.g. Giddens 1984; Schatzki/Knorr-Cetina/Savigny 2001) and encourage researchers to study institutionalization and deinstitutionalization processes from the inside (see Holm 1995). From the institutional work perspective, agency is a constant but open-ended possibility; analyses focus on social practices that are aimed at influencing institutions and, at the same time, are still reliant on institutional resources (Lawrence/Suddaby 2006). The main question is how much creativity and intelligence goes into these practices, and the degree of success that agency achieves in a given institutional context (Lawrence/Suddaby/Leca 2009).

While this emphasis on practice, work, and "effort" is unique to the study of institutional work (Lawrence/Suddaby/Leca 2009: 14–17), its function is mainly integrative, bringing together among scholars of institutional theory such concepts as the new interest in discourse analysis (Phillips/Lawrence/Hardy 2004; Zilber 2007) and the parallel revival of "institutional entrepreneurship" (e.g. Battilana/Leca/Boxenbaum 2009; Beckert 1999; Garud/Hardy/Maguire 2007; Hardy/Maguire 2008; Lawrence/Phillips 2004). DiMaggio's (1988) justified concern that new institutional theories of organization might lose sight of interest and agency leads him to point out that "[n]ew institutions arise when organized actors with sufficient resources *(institutional entrepreneurs)* see in them an opportunity to realize interests that they value highly" (p. 14). This is a reminder of what Eisenstadt (1964: 384) describes as "innovating elites," comprised of "special 'entrepreneurs'" who give a charismatic "push" (in the Weberian sense) to the crystallization and continuation of new institutional structures (see also Eisenstadt 1980). It is interesting that the foundational texts of the new institutionalism in organization studies do not deny the possibility of what came to be called institutional entrepreneurship; Meyer and Rowan (1977: 348) point out, for example, that "powerful organizations attempt to build their goals and procedures directly into society as institutional rules." However, the foundational texts also imply that an active role is only seen as an option for a minority of powerful and visionary actors.

More recent work on institutional entrepreneurship presents a different picture. Although even DiMaggio (1988: 15) talks about "organized actors" and remarks that they need "the help of subsidiary actors," new research shows more and more clearly that institutional entrepreneurship requires the mobilization of distributed agency. It must also be understood as a collective endeavor (Garud/Karnøe 2003; Greenwood/Suddaby/Hinings 2002; Lawrence/Phillips/Hardy 2002; Lounsbury/Crumley 2007; Maguire/Hardy/Lawrence 2004; Wijen/Ansari 2007), even when a core actor can be clearly identified (e.g. Munir/Phillips 2005) or the process is triggered by an elite (e.g. Greenwood/Suddaby 2006). Although institutional entrepreneurship has been described as rather "heroic," "charismatic," and "powerful" in early works, less positive adjectives such as "messy, manipulative, instrumental, conscious, and devious" (Garud/Jain/Kumaraswamy 2002: 210) may also apply, according to more recent studies.

I adopt the integrative perspective of institutional work in this paper, but I also argue that work in this area needs to go further in at least two respects that are particularly relevant to the constitution of high-tech markets. First, the present meaning of "purposive action" in the definition of institutional work is vague. Lawrence, Suddaby, and Leca (2009: 11–14) discuss different possibilities of treating intentionality from the institutional work perspective, but the research in this area so far has still overlooked an important practical problem: How can purposive action be taken in the face of uncertainty? By uncertainty, I do not mean simply the lack of control over the consequences of action, which a practice perspective already acknowledges, but the lack of a clear objective to pursue. Stark (2009: 1) highlights "the kind of search during which you do not know what you are looking for" and notes that there is a particular type of institutional work with an urge toward innovation or change but without a clear vision of the new or reformed institution to be created (see also Zietsma/McKnight 2009). This purposive but open-ended action is the institutional work of "knowledgeable" actors (see Giddens 1984; Lawrence/Suddaby 2006) in the face of uncertainty; they not only try to reduce it, but also use other practices of dealing with uncertainty such as ignoring, denying, displacing, and suspending it.

As we expand the definition of purposive action, we must also address how coordination among actors is achieved in practice in the face of uncertainty. It is not enough to recognize that institutionalization involves collectives of actors with partly heterogeneous resources and interests (e.g. Zietsma/McKnight 2009). Linking institutional theory with social movement theory is a promising avenue (e.g. Hensmans 2003; Lounsbury/Ventresca/Hirsch 2003; Schneiberg/Lounsbury 2008), but there are many practices of coordinating and organizing institutional work that do not constitute social movements and yet are highly relevant nonetheless. For example, in Greenwood, Suddaby, and Hinings (2002) a regulatory agency is at the hub of a network of professionals and, through organizational mechanisms, the agency plays a central role in defining and redefining institutional logics. The question of how institutional work is practically organized is related to the question of how purposive action is possible in the face of goal uncertainty, because this uncertainty may be significantly reduced for individual actors if there are organizational mechanisms that help them to find out about the goals of other actors, or even to achieve convergence on one out of many possible goals. I therefore argue that institutional work begins with getting organized, even before specifically "creating, maintaining and disrupting institutions" (Lawrence/Suddaby 2006: 215).

The constitution of new markets is particularly instructive in expanding the notion of collective institutional work to include purposive action in the face of high uncertainty, distributed resources, and imminent competition. Actors have a common interest in the creation of the market but also seek to position themselves favorably as competitors in this market (Appleyard/Wang/Liddle/Carruthers 2008). This apparent dilemma can be dealt with in many ways, and the sociology of markets points to the historical and cross-sectional variety of institutional configurations governing empirical markets (Callon 1998a; Fligstein 2001a; Fligstein/Dauter 2007). This variety can be attributed at

least in part to the actions of market actors, whose practices are merely provisionally stable given the competitive and innovative moves by entrepreneurs and the reactions that these moves provoke (Beckert 2009; Santos/Eisenhardt 2009).

Uncertainty is seen as the main problem that needs to be solved in the constitution of markets (Beckert 1996; Podolny/Hsu 2003). Markets as fields (Fligstein 2001a) achieve order through institutionalized rules, norms, and cognitions (Scott 2008). I argue, however, that a market is more than a set of institutions, because it is also made up of actors, products, exchanges, communications, and networks (Möllering 2009). All of these are to some degree institutionalized in "cold" markets (Callon 1998b: 261) but can never be taken completely for granted, precisely because markets are characterized by distributed resources (i.e. the private property of market actors) and competition over the most profitable utilization of resources (i.e. the price mechanism and entrepreneurial innovation).

Both the typical dynamism of markets and the degree of order they sustain can nevertheless be understood as the outcome of collective institutional work – especially in the constitution of new markets – without denying that many activities in markets are not about reflexive market-making, but simply concerned with making a sale or purchase. Fligstein (2001a: 14) complains that too little consideration "has been made of where new markets come from and how existing markets affect the origins, stability, and transformation of other markets." I read this as a call for studying the kind of institutional work that is aimed at making new markets, entails pre-competitive practices (before the market is established), and draws institutional and other resources from already existing markets.

The study of new markets requires a different research strategy than the study of established markets, especially when the new market is still in the making: competitive exchanges are not taking place yet, but are taking shape. I define a "new" market as the interval during which basic characteristics of markets (i.e. discrete, self-interested, and competitive economic exchanges) are newly introduced into a field, or when there is a significant degree of change in one or several of the constitutive elements of an established market (e.g. products, actors, or regulation). In the telecommunications industry, for example, new markets developed because of privatization and liberalization, and new markets also developed when mobile telephony became available.

The institutional work approach offers a solution to the problem of studying something that is still in the making, by focusing initially on purposive action instead of institutional outcomes (Lawrence/Suddaby/Leca 2009). This is also a welcome solution for the study of new markets. The task, then, is to identify and analyze practices of working toward the establishment of a new market. For example, Aldrich and Fiol (1994) suggest eight entrepreneurial strategies to promote the legitimacy of new markets, and most of these strategies have a collective dimension, such as encouraging convergence around a dominant design, mobilizing to take collective action, and organizing collective mar-

keting and lobbying efforts. Research on the constitution of new markets can build on this and study the collective forms of institutional work and the ethnographic details of market-making practices (Callon/Muniesa 2005; Garud/Jain/Kumaraswamy 2002; Huault/Rainelli-Le Montagner 2009).

Recent work on "field-configuring events" (Lampel/Meyer 2008) suggests a very promising method for studying practices involved in the institutionalization of new markets (see Garud 2008; Zilber 2007). Based on an initial idea by Meyer, Gaba, and Colwell (2005), Lampel and Meyer (2008: 1026) define field-configuring events as "temporary social organizations such as tradeshows, professional gatherings, technology contests, and business ceremonies that encapsulate and shape the development of professions, technologies, markets, and industries." The authors specify (p. 1027) that at a field-configuring event, actors from diverse backgrounds assemble in one location for a limited duration; they have opportunities for face-to-face interaction, information exchange, and collective sense-making; they engage in ceremonial and dramaturgical activities; and they generate social and reputational resources that can be deployed elsewhere.

It has been claimed that one methodological advantage of studying field-configuring events is that they allow us to tap into the practices and dynamics behind processes that are difficult to observe otherwise and give us an opportunity to look into "social microcosms that can foreshadow and simulate an unrealized shared vision of a focal technology, market, or industry" (Lampel/Meyer 2008: 1030). This matches the rationale for studying institutional work: an opportunity to observe the condition of uncertainty and distributed agency, and a method of analyzing new markets that are still in the making. At the same time, some caution is warranted, because there is a tautological trap of restricting the term to events that have an effect on field configuration, as well as an analytical danger of attributing too much of the possible post-event changes in the field to an event. From the institutional work perspective, it is clear that purposive action is often ineffective and that the causality between by specific efforts and later changes is difficult to establish (Lawrence/Suddaby 2006). Still, it is instructive to study events that have the potential, or even the explicit aim, of shaping a new market. Clearly, any single event that could be relevant for the development of a new market has to be seen alongside other relevant events before and after. As Lampel and Meyer (2008: 1028) state: "Field configuring events are both the products and the drivers of field evolution." Even in the early days of an emerging field, every event has a history. Researchers adopting this approach do not claim that single, isolated events can create a new market or technological paradigm instantaneously. Rather, the events represent occasions for various field-configuring forces to materialize and be channeled in one way or another as part of a longer process of field evolution. Note that the organizers of such events have certain intentions but lack control over the eventual outcomes of the events (Lampel/Meyer 2008: 1026). In this paper, I am interested in how these events are organized and what specific practices prevail at an event that has the explicit aim of generating momentum for a new market.

There are only a few studies under the label of "field-configuring events" so far, mainly in the 2008 special issue of the *Journal of Management Studies* 45(6) edited by Lampel and Meyer, but there is rich prior work on the role played by events in the development of important technologies and markets (e.g. Anand/Watson 2004; Bijker/Hughes/Pinch 1987; Lampel 2001). Linking directly to work on institutional entrepreneurship, Meyer and colleagues (2005: 467–469) suggest studying conferences as field-configuring events (e.g. practices of organizing networks at nanobusiness conferences). Among the recent published research relating events to field configuration, Garud's (2008) study of how conferences have shaped the development and commercialization of cochlear implants is particularly instructive for the purposes of this paper. Garud highlights three purposes that conferences can serve: the enactment of competing possibilities; the collective engagement in making sense of inconclusive claims and information; and the achievement of (somewhat forced) closure around some issues, at least temporarily. Field-configuring events are occasions full of conflict and disappointment below a surface of consensus and enthusiasm. Another study that I build on in terms of research design is Zilber's (2007) study of an Israeli high-tech conference. She also highlights the collective sense-making purpose of conferences and uses discourse-analytical techniques to identify stories and counter-stories in relation to a field-wide crisis.

Field-configuring events are instances of collective institutional work that can reveal a significant part of the overall organizational pattern of market-making practices in a field. However, Lampel and Meyer's (2008) concept is too broad on its own to apply to studying the configuration of a particular field; it should be emphasized that the events they have in mind are only *potentially* field-configuring, and that we need field-specific criteria to assess the actual effect of events. In my study of a new market, I define products, exchanges, information, actors, networks, and institutions as constitutive elements of markets and analyze how a given event affects these specific elements (see also Möllering 2009). Because the event bears the characteristics described by Lampel and Meyer (2008) and configures *elements* of a new market, it has the potential to be a market-configuring event. The empirical part of my paper will show how practices of bootstrapping, roadmapping, leader-picking and issue-bracketing at events such as this one enable actors to generate the resources to move collectively in the same direction in the face of uncertainty.

3 Data and methods

In this section, I first describe the general empirical setting in which the chosen event occurred and justify the selection of the case as a potentially market-configuring event. I then present my data sources and the methods I used to extract findings about the collective market-shaping efforts at the event.

Empirical setting

The Fifth NGL Workshop, held in Pasadena in August, 2001, is the potentially field-configuring event analyzed here. It was organized by the International Sematech consortium and brought together 183 representatives from 70 organizations active in the field of semiconductor manufacturing, such as chipmakers (20%), equipment and material suppliers (48%), and research and development centers (32%). All of the conference participants came from the northern hemisphere (North America 59%, Asia 26%, Europe 15%, see Sematech 2001: 75). NGL means "next generation lithography," and this label reflects the crucial issue faced by the actors in this field: optical lithography, the dominant technology for making ever more powerful computer chips, has long been expected to reach its physical limit (see Henderson 1995; Sydow/Windeler/Möllering 2004). Once this happens, it will be impossible to further reduce the size of structures on a chip within the current technological system, which employs machines known as steppers. These steppers use light, lenses, and masks to burn the pattern of a chip onto silicon plates known as wafers (see Brown/Linden 2009; Chuma 2006; Henderson 1995). The collective search was on in 2001 for the "next generation" of lithography, or even for some totally different technological principle that would enable chip producers to make chips with circuit features below 100 nanometers (nm; i.e. less than 1% of the width of a human hair). This would ensure the continued improvement of computer chip performance in line with "Moore's Law" (a productivity projection published in Moore 1965); the number of transistors on leading-edge chips doubles about every eighteen months (e.g. Brown/Linden 2009: 9–10). Actors in the field faced the dual uncertainty of technology and timing, because they did not know which technological option would be feasible and at what point NGL tools might be required and available for mass production (Appleyard/Wang/Liddle/Carruthers 2008; Linden/Mowery/Ham Ziedonis 2000).

It is important to note that actors needed a drastically new technology, one that would necessitate changes in all parts of the stepper systems (Brown/Linden 2009: 95–101; Sydow/Windeler/Möllering 2004). This radical technological change meant that the market in which the new manufacturing tools would be bought and sold could be considered a *new* market. Although the next generation lithography market would grow out of prior stepper markets, the constitutive elements of the new market could be fundamentally different – and significantly separate – from the older market (see also e.g. Fligstein 2001a; Leblebici/Salancik/Copay/King 1991). What is interesting empirically is not so much the extent to which a truly separate NGL market has been constituted since the 2001 conference, but the ways in which conference participants sought to promote this possibility and make it happen.

Since my analysis centers on the event in Pasadena at the end of August 2001, I consider the broader developments in the chip manufacturing field in order to put the conference into context (for an overview see Brown/Linden 2009). This was the fifth and last conference in a series of similar consensus-building events, and speakers would make

references to conclusions reached at previous conferences, particularly the one immediately prior (Fourth NGL Workshop, Reston, Virginia, September 25–26, 2000). The NGL Workshops were a core element of Sematech's NGL Program, and the conferences before 2001 followed a very similar format: they included a survey among the participating firms at the end of each conference and were intended to build a global industry consensus on which technological options to pursue (Dao/Mackay/Seidel 2002).

The 2001 conference represents only one of the various activities organized by Sematech – the leading technology development consortium of semiconductor manufacturers (see www.sematech.org/meetings/archives.htm). The consortium had thirteen members in 2001: Agere Systems, AMD, Conexant, Hewlett-Packard, Hynix Semiconductor, IBM, Infineon, Intel, Motorola, Philips, STMicroelectronics, Texas Instruments, and TSMC. Note that the membership was predominantly American, which reflects that Sematech started as a purely US-focused consortium in 1987. Three European members (Infineon, Philips, STMicroelectronics) and two Asian members (Hynix, formerly Hyundai, from South Korea, and TSMC from Taiwan) joined in 1998 when Sematech became "International Sematech," but there were no Japanese members (such as NEC) at the time of the Fifth NGL Workshop (see also Ham/Linden/Appleyard 1998: 151). The conference was designed as an open event, however, and the participants represented suppliers and research institutes as well as chipmakers. Notably, 26% of participants came from Asian organizations.

To understand the dominance of US chipmakers within Sematech, one must be aware of what happened in the global semiconductor market in the 1970s, when US firms were surpassed by their Japanese competitors and the American semiconductor industry was facing long-term foreign dependence (Brown/Linden 2009). The founding of Sematech, with the help of the US government, was an ambitious and urgently needed response (e.g. Ham/Linden/Appleyard 1998; Browning/Shetler 2000). The core element of the US strategy was to allow more research collaboration, and the main instruments to achieve this were the 1984 National Cooperative Research Act, which relaxed existing antitrust laws, and the installation of Sematech as a consortium that would help coordinate the vertical and horizontal collaborations across the US semiconductor industry (Browning/Beyer/Shetler 1995; Ham/Linden/Appleyard 1998). The consortium has become more international over time, but its original purpose and history was still apparent at the 2001 NGL Workshop.

Case selection

I chose to study the Fifth NGL Workshop in Pasadena because, of all the conferences in the field of semiconductor manufacturing held in the 1990s and early 2000s, it was targeted the most clearly at constituting a new market. The event theme was "Working toward Commercialization," and its explicit objective was "developing recommendations

that will focus industry resources on the commercialization of NGL" (see Sematech 2001: 1). At the same time, the conference was very much a technology-making event, with frequent references to the rather neutral aim of "assessing the status of the NGL technologies." I also chose this 2001 conference because after this year NGL development became progressively more specialized and the conferences smaller and more numerous, though there are still some big conferences that cover the whole field (such as the conferences of the Society of Photographic Instrumentation Engineers). The Fifth NGL Workshop was broad enough to bring together stakeholders from all the different technological avenues and focused enough to at least envision a common cause in developing new lithography markets.

More specifically, I selected this event because it displays the typical characteristics of field-configuring events (see Lampel/Meyer 2008: 1027). While I would emphasize that these alone do not qualify the event as having a lasting effect on NGL market constitution, the conference has the potential to do so, based on criteria defined in the literature, and therefore merits further study. Table 1 shows the six characteristics defined by

Table 1 Field-configuring characteristics of the Fifth NGL Workshop

Characteristics of field-configuring events (Lampel/Meyer 2008)	Characteristics of the Fifth NGL Workshop
1. FCEs assemble in one location actors from diverse professional, organizational, and geographical backgrounds.	The conference in a hotel in Pasadena assembled participants from a broad range of engineering disciplines and business functions who represented manufacturers, suppliers, R&D centers, and consortia from North America, Asia, and Europe.
2. FCEs' duration is limited, normally running from a few hours to a few days.	The conference lasted two days plus some pre- and post-conference meetings.
3. FCEs provide unstructured opportunities for face-to-face social interaction.	The conference included three receptions, a poster session, breakfast, lunches and coffee breaks, and the conference dinner; there was time for private dinner arrangements, and informal meetings could be held alongside the conference program.
4. FCEs include ceremonial and dramaturgical activities.	The conference was held at the rather luxurious and glamorous Ritz-Carlton Huntington Hotel, included a closing dinner with survey results as its grand finale, and had a carefully planned agenda featuring the so-called Technical Champions.
5. FCEs are occasions for information exchange and collective sense-making.	The conference program consisted mainly of presentations for exchanging information on progress in NGL technology; the survey exercise at the end gave a collective picture of opinions within the field.
6. FCEs generate social and reputational resources that can be deployed elsewhere and for other purposes.	The conference generated many resources, the most significant one being the Final Report and, more importantly, the survey results distributed after the conference, in the form of presentation slides that would be used to push the case for technological options at later events.

Source: Author's own compilation based on the Final Report (Sematech 2001) and confirmed by interview data.

Lampel and Meyer, along with information on how the Fifth NGL Workshop matches them. My empirical analysis focuses on the practices at the event and immediate consequences.

Data sources

In order to analyze the Fifth NGL Workshop in Pasadena as a potentially market-configuring event and a site of collective market-making efforts, I used original documents and field interviews related to the event as my main data. These are complemented by my knowledge of the semiconductor field more generally, which comes from my own observations, personal discussions, literature and press reviews, collection of company information, and other forms of engaging with the field since 2003.

There are three kinds of original documents that I drew on: first, I collected the messages that were sent and received by the conference participants, as captured in a publicly available Final Report by the Sematech NGL Task Force (Sematech 2001), and all the presentations that were given at the event (see www.sematech.org/meetings/archives/litho/ngl/20010829/). These documents are the most direct record of what happened in Pasadena, and they are interesting precisely because they are not neutral but rhetorically charged – revealing institutional work (Suddaby/Greenwood 2005). Second, I used internet searches to gather any press releases or similar announcements that were issued following the conference, in order to assess how the event was interpreted officially by the field (e.g. in media such as *Business Wire, EE Times, Electronic News,* and *Semiconductor International*). Third, I used the *Lexis Nexis News* archive (English language) and identified the press coverage of the Pasadena event.

My other main source of data is semi-structured interviews. The study reported here grew out of a larger research program on inter-organizational relationships in semiconductor manufacturing that started in 2003 and is sponsored by the Volkswagen Foundation (Grant No. AZ II/80 308, see Sydow/Windeler/Möllering 2004). Because of my ongoing collaboration with colleagues at the Freie Universität Berlin (where I worked on the project from 2003 to 2005) and the Technische Universität Berlin, I could use interviews that were conducted relatively soon after the Pasadena conference, as well as more recent interviews. Altogether, 76 semi-structured interviews with 66 different persons, conducted from 2003 to 2009, were analyzed. The interviews last an average of 60 to 90 minutes each, and the interviewees represent chip manufacturers, suppliers, research centers, consortia, and funding agencies in the US, Europe, and Japan. Some interview partners were interviewed more than once, since we are continuing to follow and analyze the semiconductor field. The ongoing nature of the project also gave us an opportunity to check earlier assessments of certain events, such as the Fifth NGL Workshop, against later interpretations. While only a few of the interviews had direct comments about the Pasadena conference in 2001, many other interviews were useful

in their more general assessment of the field-configuring potential of conferences for semiconductor manufacturing technology markets.

Data analysis

The main method used in this study is a content analysis of the original documents and interview transcripts related to the Fifth NGL Workshop. First, I examined the material to find facts that would give me a general description of the event. I then checked the characteristics that Lampel and Meyer (2008: 1027) specify for field-configuring events against the NGL Workshop in Pasadena (see above). Next, I used the main analysis to identify specific practices of institutional work aimed at market-making that occurred during the conference. This was done initially by extracting any passages from the documents that related to practices or included statements with potential implications for future NGL markets. I would sometimes find very obvious instances of institutional work, such as in the final presentation of the conference and the Sematech press release that was issued two weeks after the event. At other times, interesting statements and reports of relevant activities would be somewhat hidden within technical presentations full of engineering jargon, with small glimpses of the strategies actors pursued to shape the new market. In line with the supposedly pre-competitive nature of the event, an en-

Table 2 Practices of institutional work: Relating data to mechanisms and labels

Practices of institutional work	Underlying mechanisms of dealing with uncertainty	Examples of evidence in interviews and documents
Bootstrapping: self-starting action, concluding without conclusive evidence	Ignoring uncertainty	The survey at the end of the conference turns tentative and biased opinions into a hard, objective, numerical result: "The NGL options have been narrowed to EUVL and EPL" (Final Report).
Roadmapping: assigning dates to events though the future is unknown	Denying uncertainty	Despite its lack of reliability, participants refer to the International Technology Roadmap for Semiconductors: "The ITRS is fake … its timing is not real" (supplier interview).
Leader-picking: making others go ahead, following the key actors	Displacing uncertainty	The conference features Technical Champions, and the main suppliers are purported to lead commercialization: "You have to watch … what the key players are doing" (supplier interview).
Issue-bracketing: putting problems aside, postponing and excluding	Suspending uncertainty	Showstoppers and critical issues are identified as tasks for the future, but the overall message is good progress: "Significant progress is being made … Much more effort is needed" (Final Report).

Table 3 Influence on NGL market constitution: Relating data to findings

Constitutive elements of markets	Market-configuring mechanisms	Examples of evidence in interviews and documents
Products	Innovating	"Technology is not the main concern of our business, it is business. I mean this very, very seriously … technology matters but it is never an end in itself" (supplier interview).
Exchanges	Commodifying	Roadmaps standardize technology "nodes" (i.e. product specifications) and timing, e.g. statements about "production shipment … starting in the 2004-05 timeframe" (Final Report).
Information	Communicating	Conference participants' presentations conveyed in detail the buyers' desired product specifications for the future and the sellers' view of what could actually be delivered (conference presentations).
Actors	Competing	"There is also a marketing aspect playing a role [at conferences]" (research center interview); actors share information, but "we do not want to enable our competitors to copy us" (supplier interview).
Networks	Associating	Besides general networking, "the real talks [at conferences] happen in the back rooms, with customers, with suppliers, and partly also with competitors" (supplier interview).
Institutions	Institutionalizing	A new rule of the game emerges, to "increase international collaboration" (Final Report); this replaces former preferences for firms from established networks or from the same region.

gineering habitus was apparent; the event resembled a scientific convention more than, for example, a trade fair.

I categorized the relevant text passages with ad hoc primary codes. These were later consolidated into more abstract categories that would capture practices of institutional work. Table 2 illustrates how I moved from interview and field data to identifying different mechanisms of dealing with irreducible uncertainty and thus found practices that served to ignore, deny, displace, and suspend uncertainty. I then labeled these practices as bootstrapping, roadmapping, leader-picking, and issue-bracketing, respectively.

Because I wanted to relate the practices of institutional work in the face of irreducible uncertainty to the question of how the event was used to organize collective efforts specifically aimed at making a new *market*, I also used a parallel analytical framework consisting of six categories that captured constitutive elements of markets (products, exchanges, information, actors, networks, and institutions, see Möllering 2009). Table 3 illustrates how I matched the constitutive elements with evidence from our data. In particular, I looked for evidence that the practices at the event not only affected product development (through collective moves toward a technological innovation), but that they also had an impact on the other elements required to establish a new market.

Finally, I made a tentative discourse-analytical assessment of the effectiveness of the Pasadena conference, in terms of its leading the field in a particular direction in spite of remaining uncertainty about the destination. The main purpose of the study, however, was to identify practices of collective institutional work aimed at market-making in an empirical context that was marked by high uncertainty and competition.

4 Findings

Formal structure and power setup of the Fifth NGL Workshop

Since one aim of this study is to understand how collective institutional work is organized, I will first describe the formal structure of the focal event, so that readers can picture it happening in the luxurious Ritz-Carlton Huntington Hotel (now a Langham Hotel) in Pasadena. A structural description also allows a first glimpse into the (unequal) distribution of resources for institutional work available to various conference participants, as well as into the orchestration of the event as intended by its organizers.

The conference agenda (Sematech 2001: 5, 72–76) had a number of noteworthy features. While the first day of the conference (August 28, 2001) was just for pre-registration and an evening reception, the second day was devoted mainly to "Critical Reviews" of the three main technological options to be considered at the conference (for an accessible overview of NGL options see Linden/Mowery/Ham Ziedonis 2000): extreme ultraviolet lithography (EUVL), electron projection lithography (EPL), and ion projection lithography (IPL). These options were presented by their "Technical Champions," i.e. small groups of leading firms collaborating on the development of the respective technologies. The Champions enjoyed a privileged position above other conference participants, but there was also a pecking order among their three teams. EUVL (promoted by the EUV LLC joint venture of AMD, Infineon, Intel, IBM, Micron, and Motorola) was given four hours' presentation and discussion time for its review, whereas EPL (Nikon, IBM, and Selete) had two hours and IPL (ASML, Leica, Infineon, IMS, and TNO) just 75 minutes. EUVL, EPL, and IPL were framed as competing options, but the agenda did not provide a level playing field. A fourth technological option, maskless lithography (ML2), had a separate pre-conference and was sidelined to a 45-minute summary presentation in the main program (Sematech 2001: 72).

The decision to allocate more or less time to various topics and speakers lay with the organizers at Sematech: the NGL Program Manager and NGL Steering Committee. The main options, main Champions and general pecking order were not designated in advance, but they were certainly reinforced as the structure emerged over a series of five workshops. Sematech's main ambition was to narrow the options and concentrate investments made by the industry. It would therefore support the favorites, whichever

they turned out to be: in this case, it was EUVL first and EPL second. This way the organizers linked the Pasadena event back to the prior NGL Workshops and could arrange for the continued reduction of uncertainty.

The last item on the August 29 agenda was a poster session-cum-reception that featured 18 presentations by suppliers on their current NGL projects. Participants could walk around and discuss the exhibits in a relatively relaxed atmosphere. The following day, however (August 30, 2009), there was a series of more formal presentations, with 17 suppliers scheduled. Again, the time allocation is noteworthy: about four and a half hours were devoted to EUVL, two hours to EPL, and practically no time to (potential) IPL suppliers. The suppliers, who as system integrators assemble the main production tools (steppers), had significantly more time, at 30 to 45 minutes, than the suppliers of subsystems or materials (10 to 15 minutes). Also interesting is that the Sematech members – the chipmaking firms themselves (e.g. Intel, AMD, IBM, and Infineon) – did not give individual presentations, appearing only as part of the Technical Champion groups, if at all.

Perhaps the most striking feature of the Fifth NGL Workshop (and of the previous ones since 1997) is that, towards the end of the last day, the agenda included a session of roughly one hour in which conference participants gathered to complete a survey with a comprehensive set of questions on the different technological options, including the summary question: "If *your* company had to choose only one option today, what would your company choose?" (Sematech 2001: 10, 7–46). This was essentially an opinion poll ("takes a pulse," *EE Times*, September 13, 2001) among the 29 chipmakers, 29 suppliers, 12 R&D institutes, and 6 other organizations participating in the conference. A total of 76 surveys was completed, of which 45% were by North American, 30% by Asian, and 25% by European organizations (Sematech 2001: 12). The results of this survey were presented to the participants the same day, at the end of the conference dinner.

The event did not really end on August 30, though, because there was also a meeting the next day of the NGL Task Force (Sematech 2001: 5, 58–70, 76), which had representatives from the 13 International Sematech member companies (i.e. chipmakers), three tool suppliers, two Japanese chipmakers, one from the Japanese consortium Selete, and one from International Sematech itself (i.e. the organization running the consortium). These twenty members of the NGL Task Force were given the task of drawing the overall conclusions from the conference, identifying the main critical issues, and making recommendations. The meeting of the NGL Task force lasted four hours on the morning of August 31, 2001. The Final Report was put together later on by John Canning, the NGL Program Manager at Sematech (see Sematech 2001: 1–3). It detailed a list of eight points of advice, plus sub-points, from the NGL Task Force to Sematech and the industry.

My first overall finding, then, is that the conference was organized as a somewhat unbalanced forum, where the leading proponents for competing technological options could present their latest developments and the proceedings would culminate in a non-

binding vote on where to invest in the future. In the survey at the end of the conference, 51 out of 76 respondents agreed with the statement, "The major outputs from the NGL Workshop(s) fairly and accurately represent the lithography industry consensus" (Sematech 2001: 44). However, only 4 respondents agreed "strongly," while the others merely agreed "somewhat." There was also a significant minority of 19 respondents who answered "neutral" and 6 who disagreed "somewhat" with Sematech's own claim of producing and representing a "global industry consensus" (e.g. Sematech 2001: 5). This is confirmed by the following comment:

> I would say that it is definitely a democratic process in which formally everybody has their say. However, like in politics, those who have the greatest influence and can pick alliances and partners are also those who can push through the most. So, indirectly and unofficially, the firms who make the biggest contributions also have a greater weight. (Interview with a chipmaker)

Even though the formal structure of the event disadvantaged its critics, a very large majority of participants agreed that their firms supported and valued the NGL Workshop (Sematech 2001: 45). We must analyze the practices at the event in greater detail if we are to understand the event's effect on the field.

Practices of dealing with uncertainty and generating momentum for the NGL market

The chief aim of the Fifth NGL Workshop was to sustain and increase the momentum for the commercialization of one (or two) of the new technological options for lithography markets. At the most general level, this would mean repeated reassurance that progress was being made, accompanied by urgent calls for further investment: "Significant progress is being made […] on the critical issues. Much more effort is needed to make these technologies commercial realities" (Sematech 2001: 1). I identified four practices that represent different recurrent activities that would generate momentum toward commercialization at the conference, i.e. different forms of institutional work in the face of uncertainty at this field-configuring event (see Table 2 above). First, I refer to as *bootstrapping* those activities that would enable participants to reach conclusions without conclusive evidence. The second practice, which I call *roadmapping*, was very common at this conference and is another social technology for dealing with uncertainty by assigning dates to desired future states. The third term, *leader-picking*, is the practice of using and reinforcing the momentum of some actors so that other actors will follow them. And the fourth practice, *issue-bracketing*, happened at the conference when certain topics were either excluded from the agenda or highlighted but postponed (read: suspended) until after the conference. These practices are not mutually exclusive and together they capture the collective institutional work at this conference, with an explicit purpose to "focus industry resources for commercialization" (Sematech 2001: 5).

Bootstrapping is most evident in the survey that was conducted at the end of the conference. After dozens of presentations, which detailed the progress that had been made on the different technological options but notably also mentioned the many unresolved issues that still existed, participants could not have had more than a tentative opinion on where lithography should go and would have been very much biased by their own prior investments. By means of the survey, however, these tentative opinions were turned into concrete percentages: survey results suggested that conference-goers had "decided" to go with EUVL because it had won an absolute majority of votes for the method to be used for manufacturing the most advanced generation of future computer chips. It was also "decided" through the survey that the EPL option would continue to be pursued, while all other options appeared to have been abandoned. The following unqualified statement topped a list of results from the Workshop: "1. The NGL options have been narrowed to EUVL and EPL" (Sematech 2001: 1, 6). Interestingly, these two options have come out as survey favorites at every NGL Workshop since 1998 (see Dao/Mackay/Seidel 2002), showing that the conferences and surveys were used to generate, sustain, and, ideally, reinforce momentum in the face of uncertainty.

With the 2001 survey, Sematech could emerge from the swamp of uncertainty once again and advise that the commercialization of EUVL and EPL be accelerated (see Sematech 2001: 2, 6, 77–78). Workshop participants could use the result to justify their own future actions, even though they would know that it was not binding and had been reached in defiance of uncertainty. It is noteworthy that about 10% of the firms in the General Survey (but no one from the NGL Task Force) answered "Do Not Know" in response to the summary question about the single most promising option.

Roadmapping has a strong tradition in the semiconductor field more generally (Schubert 2007) and was used widely during the Fifth NGL Workshop as well. For example, there is an initiative called the International Technology Roadmap for Semiconductors (ITRS) linked to Sematech, which involves expert committees that produce and update on a regular basis detailed charts (i.e. "roadmaps") of which technological solutions should be available when (for a detailed analysis see Schaller 2004). This is a simple but effective technique of making informed guesses about uncertain future states. The coordination effect achieved by roadmapping does not depend on the actual level of consensus about the dates. All actors still have a private opinion and their own internal roadmaps (see also Schubert 2007), but publicly everyone refers to the ITRS, and it is recognized as the most influential roadmap. This means that participants at the Fifth NGL Workshop could make shorthand references to the ITRS and position themselves on this map (e.g. Sematech 2001: 2, 6). Claims such as "the ITRS Roadmap will continue to accelerate" (Sematech 2001: 2) did not undermine the authority of this instrument; indeed, they could even reinforce it. The ITRS is thus influential even though actors hold strong private opinions about it: "The ITRS is fake; it is really fake. Not everything about it is bad, but its timing is not real. All firms have a real roadmap, and the game is always to be faster than the roadmap, and so you make the official roadmap a bit slower" (interview with optics supplier).

Actors in this field are very used to the practice of roadmapping. They will not only mention the ITRS, especially in their own presentations, but they will also frame their own activities in roadmap terms by attaching dates to their objectives. These are not merely attempts at basic planning; roadmapping activities are evidence of how actors struggle with uncertainty and actually deny it, at least for the near future. Linden, Mowery, and Ham Ziedonis (2000: 94) remark that "semiconductor manufacturers and equipment producers have relied on jointly developed technological 'roadmaps' to reduce these uncertainties, but the effectiveness of such roadmaps is itself uncertain."

Actors know this, because they are aware of both the limits of their knowledge and the risk of path dependence that is inherent in following a roadmap in one direction rather than another. They see the "risk of premature convergence" (Linden/Mowery/Ham Ziedonis 2000: 101). The interviewees agreed that "the financial risk of going the wrong way is considerable, especially for small suppliers" (interview with consortium). Even representatives from major customers (chipmakers) conceded that "unfortunately for the suppliers, the risks are much, much higher" (interview with chip manufacturer). The practices at the event in Pasadena were aimed at narrowing the range of options and generating momentum for the option(s) remaining, which could also be seen as a form of collective risk management.

The practice of *leader-picking* was evident at the Fifth NGL Workshop in several ways. All participants collectively were referred to by Sematech as "the world's leading lithography experts" (Sematech 2001: 77). However, they were not all considered equally important. As already mentioned, some chipmakers and their collaborators were labeled as "Technical Champions" and would report on the status of the main technological options. Other participants were members of the NGL Task Force and as such were entitled to make recommendations to Sematech and the industry (Sematech 2001: 5). By giving such privileges to selected participants, the conference organizers were using other methods in addition to the survey to ensure that conference-goers would contest the different technological options at the conference and that the contest would have a recognizable outcome. If the conference had been an unstructured series of presentations, with no public sense-making at the end, momentum could have been lost, and this is why agentic opportunities were distributed unequally on purpose. Certain actors had the chance, but also the responsibility, to take the lead in the face of uncertainty.

Note that as part of the leader-picking practice, the three tool suppliers ASML, Canon, and Nikon were mentioned by name in the Final Report (Sematech 2001: 1, 6) as the actors that were spearheading the commercialization of EUVL and EPL. With a combined market share of 88% of the lithography market (Linden/Mowery/Ham Ziedonis 2000: 106), these firms played an undisputed leading role (see also Chuma 2006). Still, their explicit mention in the report can be read as a message from the chipmakers, which would put these suppliers under increased pressure. It would also mean that all other conference participants (and subsystem suppliers in particular) could follow these three actors and channel their own resources in a complementary direction to the path these

firms were taking. As a subsystem supplier explained: "My feeling is that you have to watch who the key players are and what the key players are doing" (interview with mask supplier).

The final term, *issue-bracketing*, is how I capture the practice of acknowledging the issues that cause uncertainty and then consciously putting them aside for later consideration. This is different from practices that essentially ignore uncertainty (bootstrapping), deny it (roadmapping), or displace it (leader-picking). At the Fifth NGL Workshop, each report on the great progress actors had made in different areas of the overall technological challenge would regularly be followed by subdued yet elaborate disclaimers listing important unresolved issues. These disclaimers were constant reminders that neither EUVL, nor EPL, nor any other NGL option was guaranteed to actually become viable. Yet this did not stop the NGL Task Force, Sematech, or industry leaders from claiming in 2001 that the destination, and certainly the direction, of NGL was becoming ever more clear. Issue-bracketing usually took the form of postponement, when actors suggested that certain issues should be looked into later. It also occurred when actors were discouraged from bringing up "old" issues again that had been "solved" before, e.g. at the previous NGL Workshop (see Sematech 2001: 2). This practice spanned several interconnected events in the NGL Workshop series.

One clear result of the survey that went against the original consensus-building objective of the organizers was included in the Final Report but deemphasized. In response to the question "When should the industry fund only one NGL technology?", more than 50% of respondents answered "Never" instead of picking a specific year (Sematech 2001: 38). This refusal meant that the organizers of this event could not realize one of their main goals and instead had to settle for the parallel pursuit of two options. A sizeable minority of 33% also did not agree that the output of the NGL Workshop was a fair and accurate representation of the industry consensus (Sematech 2001: 44). This limited convergence was bracketed out in summary presentations and press releases later on. Perhaps one of the biggest surprises at the conference was that a new, less advanced option known as 157nm lithography garnered great support and threatened to reduce the momentum of both EUVL and EPL (see *EE Times*, September 13, 2001), but this development was not mentioned in the official conference reports. Finally, some very fundamental challenges to the whole NGL movement were virtually excluded, or very much sidelined, at least in 2001, such as the question of whether Moore's Law really could continue forever (see Brown/Linden 2009).

These four practices of collective institutional work in the face of irreducible uncertainty relate to the main public activities at the Fifth NGL Workshop. Although such events are relatively concentrated empirical settings, they are also venues for highly multiplex interactions and it is impossible to study all occurring practices at once (even when collecting as much field data as possible, e.g. Zilber 2007). A core idea behind the notion of a market-configuring event, however, is that the most important resources created at these events are those that a multitude of actors in the field can draw upon in the

aftermath of the event, such as the result of the NGL survey or the reassessment of the ITRS (Garud 2008; Lampel/Meyer 2008). These are public rather than individual or dyadic resources, and they were created at the Fifth NGL Workshop through bootstrapping, roadmapping, leader-picking, and issue-bracketing. The practices at the conference were purposive: they dealt with uncertainty without really reducing it, aimed to generate momentum, staged a contest, subdued conflict, and discouraged resistance.

The conference's influence on constitutive elements of future NGL markets

Clearly, an NGL market did not quickly arise following the conference. It is debatable whether one can speak of an established EUVL market even eight years later, at the time of writing. I can nonetheless analyze how practices at the Fifth NGL Workshop influenced constitutive elements of the market that was in the making at the time: the products, exchanges, information, actors, networks, and institutions involved (see Table 3 above; for further details see Möllering 2009). I use these elements as the framework of my analysis. The extent of the influence that these practices had on each element in turn indicates that the conference did more than just constitute technology; it also shaped the market. A cautious assessment of its effectiveness as a market-making event will follow my analysis.

Products for future NGL markets were most obviously influenced by the institutional work at the event, because the products were completely dependent on the technological choices discussed in Pasadena. Participants were well aware that the conference was ultimately about products, because "in the end, we don't sell a technology, but some kind of product" (interview with optics supplier). In fact, the projections about future markets affect ongoing technology development: "Whether a technology is realized or not is always a question of economic feasibility, not technological feasibility" (interview with mask supplier). Another supplier stated that "technology is not the main concern of our business, it is business" (interview with optics supplier).

A key aspect of the commercialization of NGL technology is what actors in the field refer to as the Cost of Ownership (see Dao/Mackay/Seidel 2002; Sematech 2001: 1–2, 14, 77). Chipmakers are not only interested in the price of a new stepper, which can be as much as 20 million US dollars for the latest models, but particularly in the costs of running it over a number of years. Many of the technological issues raised at the Fifth NGL Workshop concerned the cost-related question of whether EUVL, EPL, or other options would be suited to mass production in the fab (fabrication plant). Participants were no longer so interested in the engineering-related Proof of Principle: the physical feasibility in the lab (R&D centers). This meant that the strong message from the Fifth NGL Workshop – that the technology options had been narrowed to EUVL and EPL – narrowed the options for further product development.

Exchanges, or the regular sales and purchases of a type of product (NGL technology in this case), are the clearest evidence of whether a market has been established. These were not occurring with NGL in 2001, either before or after the Fifth NGL Workshop, but the conference was a collective effort to influence if and how exchanges would take place in future NGL markets and to explicitly push the field towards commercialization. The roadmapping practice, by supplying information on anticipated exchanges, was particularly instrumental in signaling when the market would be established. For example, the Final Report stated that "production tool shipments [would be] starting in the 2004–05 timeframe" (Sematech 2001: 1). The roadmaps referred to standardized "nodes," i.e. different stages in the advancement of NGL (e.g. the 90nm, 65nm, 45nm, and 32nm nodes). These nodes also helped to commodify the diverse products and solutions that were still in development. The conference represented an opportunity – especially for the chipmakers, the future buyers of NGL – to confirm or revise the product specifications that they expected their suppliers to match in the future. Thus the event influenced not only what the technology would look like, but more generally what kind of exchanges would be made in the market in the future.

Information is a constitutive element of markets because prices and all other coordination requirements in markets, from valuation to logistics, build on communication. Since any NGL market exchanges had yet to take place at the time of the Pasadena conference, the market-relevant information that was communicated revolved around hypothetical or desired product specifications for the future. Specifically, in the survey conducted by Sematech at the conference, almost all respondents agreed with this statement: "The ISMT NGL Consensus-Building Process provides me with the latest information on the individual progress of each NGL technology" (Sematech 2001: 44). Market-configuring events are occasions for information exchange and collective sensemaking, and the Fifth NGL Workshop was no exception.

As customers, the chipmakers were in the role of telling the suppliers what they would like to see (and buy) in the future NGL markets. The suppliers were supposed to respond and indicate how likely it was that they would be able to deliver the desired products within the timeframe envisaged (e.g. Sematech 2001: 30–31). All participants understood that they were not merely talking about how to solve technological problems; they were finding out which solutions would be commercially required and when these would be available (see Sematech 2001: 14). Once again, the practice of roadmapping was integral to paving the way for future NGL markets through information-sharing.

Actors constitute markets because they perform exchanges and communicate information in markets. A defining characteristic of markets is that market actors compete with each other over exchange opportunities (Weber 1978 [1922]: 635–636). The Fifth NGL Workshop was a so-called "pre-competitive" activity, meaning that the participants should act on their common interest in finding technological solutions. This can be read as another variant of the practice of issue-bracketing, whereby the issue of future competition was nominally bracketed out from the conference. In truth, though, the

event held at least the potential to influence competition within the future NGL markets. The practice of leader-picking identified actors who would be likely to participate in such markets and it sent a message to other actors: that they would need to find their own position, relative to those who would be participating in the future.

The presentations given by suppliers can be interpreted as business-to-business marketing at an early stage, because the suppliers would present their own product development in the most favorable light. They would also demonstrate their general competence and commitment by joining in the ritualistic listing of critical, but presumably solvable, issues. The representative of a research center describes this as follows:

> The conferences are not only scientific places, where all the scientists are showing the smallest details of their research. There is also a marketing aspect playing a role, and indeed, companies who have all the benefit to get a certain technology running will never show the bad things of that technology or will trash the bad things of their competitor's technologies.
> (Interview with research center)

A supplier confirmed this:

> One notices that [at conferences] it is common to totally exaggerate, i.e. when somebody presents data, you can always discount them somewhat. Everybody knows this, though, and everybody treats the others in this way, it's the well-worn rules of the game. … One is obliged, however, to present something, even though a competitor is present. So we have to keep each other up to date but without telling so much that a competitor can get direct details.
> (Interview with EUVL source supplier)

These "performances" and strategies of "impression management" (in the sense of Goffman 1959) are about establishing actors in the new market. Another supplier remarked that while he and his colleagues did present important information at conferences, "on the other hand, we do not want to enable our competitors to copy us, if they are still far behind. So it's a balancing act, because they are all competitors in the market" (interview with mask supplier). A participant confirmed that "we as a supplier have to watch our competitors and then see how the customers are looking at this … The conference is important for this" (interview with optics supplier). The general approach is: "we share what we can share, but we do not reveal secrets" (interview with source supplier). Conference participants definitely were using the event in Pasadena to establish themselves as future markets actors and to manage competition early on. Interviewees would point out that "there is very strong competition" (interview with optics supplier) and say that "those people who have the most influence, like Intel, pay attention that competition [between suppliers] is not restricted" (interview with mask supplier). Firms generally valued the ability to choose between at least two suppliers for an NGL component or tool (interviews with Sematech and optics supplier). As Geroski (2003: 97) notes with specific reference to markets in the field of semiconductor manufacturing: "the race starts even before the track has been fully laid out."

Networks as a market-configuring element represent the relationships among the market actors just discussed. The Fifth NGL Workshop was an opportunity to make, maintain, or further develop relationships between potential customers and suppliers, as well as between partners in horizontal alliances. From the interviews we can see that it does matter to the actors in the field that at a conference, "for once everybody is in the same place at the same time" (interview with source supplier). Conferences are an opportunity for networking with business partners: "Conferences are important, because that's the place where you can meet all these specialists" (interview with research center). Networking is not always open, though: "The real talks happen in the back rooms, with customers, with suppliers, and partly also with competitors" (interview with source supplier).

It is important to note that participants are well aware that the supply networks in the new NGL markets would probably look very different from the prior lithography markets. For example, a company that had been supplying Intel successfully for many years would not be able to count on automatically becoming an Intel supplier in the new markets. The new technology development networks that were highly visible at the Fifth NGL Workshop would be at least as important in the new markets as the established supply networks. Consider the Technical Champion for EUVL at the Pasadena event, which was a joint venture called EUV LLC, owned by AMD, Infineon, IBM, Micron, and Motorola (see Linden/Mowery/Ham Ziedonis 2000; Sydow/Windeler/Möllering 2004). This joint venture was dissolved later on when it had achieved its aims, but it created a particular network, with a lasting influence that extended to the structure of the EUVL market-in-the-making.

Institutions as a category capture the development of specific rules of the game for a new market, in this case NGL. The main question here is whether there is any evidence from the Fifth NGL Workshop that new rules were created for NGL that differed from the rules in the older markets for semiconductor manufacturing technology. The market was still in the making at the time of the conference, but I found at least one important institutional change relating to the networks mentioned above. A new rule emerged: old networks would not necessarily be reproduced in the new markets. The main justification for this was that conference-goers would have to work with whoever found a cost-effective solution first, and no one could afford to wait for their old partners to catch up. While old alliances would surely still have an effect after the Pasadena conference, its method of organization and purported openness to the whole industry in particular served to promote the new rule that old networks are not binding.

This is particularly noteworthy with respect to the regional competition between US, Asian, and European firms that was so pronounced in the 1980s. By 2001, the willingness and necessity to work with partners from all triad regions had greatly increased. The Fifth NGL Workshop is evidence of this trend because the US dominance at the event was reduced, though still noticeable. The NGL Task Force issued the specific advice that the industry should "increase international collaboration" (Sematech 2001: 2). Old informal rules about doing business, preferably with firms from one's own country

or region (often supported by formal economic policies by national governments, e.g. on the grounds of national security, see Ham/Linden/Appleyard 1998), would become obsolete in the NGL context. Collaborations between US and Japanese firms would also become more common, for example Nikon and IBM working together on EPL (see also Linden/Mowery/Ham Ziedonis 2000: 105–107).

My analysis has shown that the practices of institutional work at the Fifth NGL Workshop were indeed practices aimed at making a new *market* and not just a new technology. Technology development in the narrower sense and the economic forces behind market constitution in the broader sense are so closely intertwined that any technological progress affects market prospects immediately. This is why it is important to analyze, as I have done, the full range of elements involved in the constitution of a new market: products, exchanges, information, actors, networks, and institutions.

Effectiveness of institutional work at the Fifth NGL Workshop

The effectiveness of the market-making efforts at the Pasadena conference is assessed here not in terms of whether they made a particular new NGL market possible, but on the more short-term issue of whether the resources generated at this potentially market-configuring event were actually used afterwards. The discourse-analytical evidence for this is manifold. First, the Sematech press release based on the Final Report of the Fifth NGL Workshop was adopted with hardly any changes or qualifications by the trade press in this field. Online media in particular reported almost word for word the results of the conference as Sematech had framed them (e.g. *Business Wire*, September 13, 2001), sometimes using headlines that would send an even stronger message than the Sematech press release itself, for example the headline "EUV, EPL Commercialization Pushed at Sematech Workshop" (in *Electronic News*, September 13, 2001). *EE Times* (September 13, 2001) and others highlighted the survey results at the conference and thus reinforced the bootstrapping effect of this activity. Even if we take into account that the journalistic resources of the trade press in this field are limited, it is still the case that the reputational resources generated at the conference were multiplied and amplified by the official reporting on the event. I could not find any sources that challenged the conclusions from the conference. *EE Times* reported that NGL might be "pushed out," i.e. delayed, but this source did not question the longer term convergence on EUVL and EPL. Moreover, I have evidence that the reputational resources generated at the conference were used immediately afterwards by individual participants such as Motorola, who reported that they had announced their own advances in EUVL mask technology at this conference, thus increasing the credibility of their own claims (*PR Newswire* and *EE Times*, August 29, 2001). Suppliers also used resources from the event. For example, the slide on the main result of the 2001 NGL survey appeared in support of the EUVL option as part of a presentation by Schott Lithotech in Germany in November 2001.

Three months after the Fifth NGL Workshop, *Semiconductor International* (December 1, 2001) published a detailed report on NGL development that included many direct references to the conclusions published after the conference. The report repeats the message that the options for commercialization have been narrowed to EUVL and EPL and that the remaining obstacles can be overcome. This confirms the lasting effect of the event in Pasadena. The report includes various quotations from representatives of Sematech, ASML, Canon, DPI, and Nikon that give an impression of the competitive (re)positioning undertaken, especially by tool manufacturers, following the NGL Workshop. We can also see from this report that EUVL has gained more momentum than EPL, with the announcement from John Canning that Sematech "plans to take a very active role in commercializing EUVL" as it continues to support the EUV LLC (*Semiconductor International*, December 1, 2001). Canning indicates that Sematech will also be collaborating with the Japanese consortium Selete to pursue the EPL option, but much less intensely. One supplier, ASML, is also concentrating on EUVL, while the report shows that Nikon has decided to continue working on several options at the same time.

Further evidence of how the resources generated at the Fifth NGL Workshop were used by actors is a paper (Dao/Mackay/Seidel 2002) presented six months after the Pasadena event at a conference on "Emerging Lithographic Technologies," organized by the Society of Photographic Instrumentation Engineers (SPIE) in Santa Clara, California on March 5, 2002. The authors of this paper are Sematech representatives. They relay the results of the Fifth NGL Workshop to the extended SPIE audience, reinforce the message that the options had been narrowed to EUVL and EPL, and report that Sematech's resources will be invested mainly in EUVL activities. It is also telling that, in this paper, the authors state that one purpose of the NGL Workshops has been to "educate" participants and the community (Dao/Mackay/Seidel 2002: 29, 30), confirming the institutional-work purposes of the events (on educating as a practice of institutional work see Lawrence/Suddaby 2006: 227–228).

Public criticism of the results of the Fifth NGL Workshop and of Sematech's NGL Program more generally was rare. It took some time before more explicit comments were heard, such as the following words by Phil Ware of Canon USA in *Semiconductor International* (January 1, 2004):

> Have we been able to trust the consensus of experts that come out of workshops? Apparently not. The series of NGL Workshops (from 1997 to 2001) that winnowed down options for suppliers to focus on chose EPL and EUVL, not 193nm immersion. At any point in the past, expert opinions have always been too pessimistic toward the extension of optical lithography and too optimistic for NGL solutions.

In a way, this criticism actually confirms that a consensus was reached in 2001 and that momentum for EUVL was generated by excessive optimism in the face of uncertainty. Underneath the public consensus at the time, many conference participants must also have felt that the resources generated at the event could be used against them. This

group would have included the proponents of the "losing" technological options, as well as the organizations that were neither NGL Task Force members nor Technical Champions. A weak sign of resistance from the disadvantaged side is expressed in the NGL Task Force's call for "a neutral, detailed report on the business picture/perspective" (Sematech 2001: 2), which can be read as an acknowledgement of the Task Force's own lack of neutrality and of the economic implications for firms when technological options are narrowed.

The interviews about the Pasadena conference and other similar events do confirm the picture gleaned from publicly available media, but they also put it into perspective. First of all, interviewees were always aware of the conclusions reached at the conference in question, even if they had not been participants themselves, and would also say that no one could ignore the messages that such events send. Survey results at conferences are taken seriously, irrespective of how they came about, because actors know that the whole field will refer to these results. Nevertheless, the experts from the field who were interviewed also saw through the bootstrapping and other practices aimed at rendering uncertainty unproblematic; they would recognize that the conference conclusions were in no way binding on anyone, and they would point out that the key players were always a few steps ahead of what was officially discussed at such events. Taking these qualifications into account, I conclude that the Fifth NGL Workshop received considerable attention and informed future decisions of actors in the field to a degree that made it effective as a market-configuring event, at least in the short term. We can only guess, however, at how much of the current situation in NGL markets in 2010 can be traced back specifically to the event in 2001.

5 Discussion

My study focused on the Fifth NGL Workshop in Pasadena in 2001 and generated a number of important findings on how this conference was a market-configuring event, what practices of institutional work occurred at the event, and how the event served to organize collective efforts at shaping a new market that was still in the making.

A special feature of the empirical setting was that although actors in the field faced very high technological and economic uncertainty, they would commit to participating in activities that were designed to generate momentum in a particular direction, even though the final destination could not be known. I have thus looked at an occasion for institutional work where the "purposive action" that the concept of institutional work implies combined an unclear purpose with a very clear urge to move forward. This required actors to find ways of making uncertainty tolerable by ignoring, denying, displacing, and suspending it beyond their attempts to reduce it. In these actions, I identified the practices of bootstrapping, roadmapping, leader-picking, and issue-bracketing,

respectively. These practices played an important role at the event I analyzed, but they were not newly created at this event or unique to this event. They were carried over from prior events and from activities outside of the bigger events, and they were mobilized to deal with uncertainty at the event that is the object of this study.

The four practices are an important theoretical contribution to research on agency and institutions. In particular, these practices of dealing with irreducible uncertainty need to be added to the catalogue of practices of institutional work presented in Lawrence and Suddaby (2006). Prior research on institutional work has tended to emphasize actors' knowledge about the institutional work in which they are engaging. The practices I have highlighted here are indeed evidence of reflexivity, but more importantly they show that "institutional workers" often do not know where they are going, and that their practices can have the purpose of ignoring, denying, displacing, or suspending uncertainty. This is still institutional work, because it can serve to create, maintain, or destroy institutions; it also points to a purposeful but open-ended form of agency in institutional work.

Others have discussed the "social skill" (Fligstein 1997, 2001b), "entrepreneurial strategies" (Aldrich/Fiol 1994), "art of interessement" (Akrich/Callon/Latour 2002), and "projective capacity" (Emirbayer/Mische 1998) of those engaging in institutional work. However, these authors also tend to overestimate agency – notwithstanding the many qualifiers to the contrary that they would point out – because they presume that actors who use certain tactics, strategies, or imaginative powers have a vision of a desirable future in mind. The effectiveness of agency is even presented as depending on such a clear vision, but this requirement is not always fulfilled (see also Stark 2009; Zietsma/McKnight 2009). The practices of bootstrapping, roadmapping, leader-picking, and issue-bracketing I identified can enable agency precisely when the destination is not yet known. Note that the organizers of the event I analyzed had the clear objective of narrowing the technological options, but only a preliminary vision of which option would be the favorite and how much the industry was willing to converge on one option. I conclude from this that agency is not inhibited by the lack of a clear projection of the future, instead drawing on specific practices when the future is highly uncertain to the actors.

My study analyzed a market-configuring event and built on similar studies that have looked at conferences (Garud 2008; Zilber 2007; Meyer/Gaba/Colwell 2005). It produced new insights on the collective nature of institutional work (Wijen/Ansari 2007), especially on how actors organize collective institutional work related to new markets. Conferences like the Fifth NGL Workshop are obviously no accidental gatherings of random actors. They are very well-prepared events, planned long in advance, with a binding agenda and – at least in the case I studied – significant organizational resources (i.e. Sematech) behind them and performances by participants that have been carefully planned. Further research on field-configuring events could be meaningfully enriched, in my opinion, by drawing on Goffman's dramaturgical perspective and analyzing in detail elements such as the front-stage and back-stage activities, the relationship between

performers and audiences, and the strategies of impression management (e.g. Goffman 1959). Field-configuring events involve "dramaturgical activities" by definition (Lampel/Meyer 2008: 1027), but the connection to Goffman has not yet been explored.

The conference revealed how some of the institutional work in the semiconductor manufacturing field is organized. Actors were attributed status according to their respective places in the supply chain, their geographical origins, and their membership in task forces, consortia, or project groups. The technology survey at the end of the conference was particularly noteworthy: on the one hand, the survey was inclusive, because everyone was allowed to vote, but it also served to produce an exclusive result that, if enacted after the conference, would take the collective in one direction rather than another. These techniques embodied the common rhetoric at the conference (see Suddaby/Greenwood 2005), which fluctuated between the neutral language of "status review" and frequent urges to "reach consensus" (e.g. Sematech 2001: 1–2, 5). Future research can take my study as a starting point to identify further organizational devices that are used in practices of institutional work. With this analysis, I contribute to the stream of research that seeks to explain the emergence of markets and fields by studying organizational mechanisms in action (e.g. Davis/Marquis 2005).

I have drawn on the concepts of institutional work and field-configuring events primarily in order to gain a better understanding of the constitution of new markets that are still in the making. My study took into account that new markets tend to evolve from older markets (see Geroski 2003; Fligstein 2001a); the vast majority of participants in the Fifth NGL Workshop are evidently not completely new players but already active in prior lithography markets. Their experience meant that my study yielded novel insights on how the participants of a market characterized by strong competition are able to collectively envision new markets, markets that they themselves perceive will constitute a significant break from the old markets. It is a great practical challenge in empirical work on new markets to study the period before which these markets are actually established (Garud 2008; Santos/Eisenhardt 2009). It is also a theoretical challenge to capture how markets both emerge by themselves and at the same time are shaped by purposive action (Aspers 2009; Möllering 2009). With this study I have demonstrated that analyzing market-configuring events is a very insightful method of accounting for collective agency in new markets without denying the influence of outside forces in processes of market constitution, forces that obviously take more time than a two-day conference. Future research can follow this lead and study how market constitution involves very practical activities (see also recently Huault/Rainelli-Le Montagner 2009; Santos/Eisenhardt 2009).

While this study was focused deliberately on the last conference in the series of Sematech NGL Workshops, an extension of this initial work could first analyze all five events in detail and trace any developments in the four practices over time. Allowing for some variation on the specific techniques employed (such as the survey at the end of the conferences), researchers could also study how often the practices identified here appear at

other conferences and, more generally, at other field-configuring events characterized by variable levels of collective uncertainty.

For managers and others involved in new markets, especially those taking part in events such as the conference I studied, my findings offer "sensitizing concepts" (Blumer 1954: 7) that will enable actors in the field to recognize when uncertainty is an issue and to understand that many practices do not reduce uncertainty, but rather make it tolerable. I have labeled these practices bootstrapping, roadmapping, leader-picking, and issue-bracketing. Actors need to decide in practice, depending on their position and interests, whether they can use these practices to their advantage or must work against them in order to prevent disadvantages in a market-making process. I make no normative claim about these practices, but I argue that they demand our attention.

Overall, my study points to a pragmatist view of market-making (e.g. Whitford 2002). I highlight that actors attempt to influence the evolution of new markets not only when they have a clear vision of the kind of market they expect to see in the future, but also and especially when there is uncertainty about the destination combined with pressure not to stand still. Actors can try to build their interests into the new market – whatever it will look like – under these conditions of uncertainty, but they also risk that the market may develop in an unfavorable way that they cannot reverse or control later on. For example, the Sematech survey at the Fifth NGL Workshop most likely generated more momentum toward the commercialization of EUVL, but at the same time probably made it harder to move back to another option, should any of the critical issues of EUVL turn out to be irresolvable.

My study identified practices that market actors use to organize their complementary efforts into shaping a new market when there is uncertainty about the viability and shape of this market and the competitive position of relevant actors. I have contributed original insight into practices of collective institutional work that generate momentum by ignoring, denying, displacing, and suspending uncertainty. Actors who engage in these practices do not do so naïvely: they are well aware of what their agentic powers will permit, and they have a pragmatic interest in constituting a market.

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