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Accounting, simultaneity and relative completeness: The sales and operations planning forecast and the enactment of the 'demand chain'

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ABSTRACT

This study adds to the literature on accounting incompleteness and instability an understanding of how accounting acts upon an object that is practised as a multiple. It explores how accounting, in the form of a sales and operations planning (S&OP) forecast, helps discover the objections attached to the various enactments of an object multiple, namely a 'demand chain' - a lateral ordering of the firm's production and products from customers backward to suppliers - and translate these objections into decision mechanisms. The paper finds a process of accumulation of accountings that contributes to the enactment of the 'demand chain' multiple. In this process, accounting becomes both performative and provocative. As a source of performativity, accounting is *relatively complete* because it turns each emerging objection into a specific decision model, enacting the 'demand chain' in a certain way. As a force of provocation, accounting stimulates new objections to emerge against what accounting reveals about the 'demand chain'; this adds new accountings onto existing ones, all of which exist *simultaneously*.

1. Introduction

> '… factories put sales' forecast aside as they speak a different language. Sales always consider the volume sold to customers, but the factories always think in terms of shipment from either warehouses or factories to customers, and shipment from factories to factories' (Product Line Planning Manager A – Industrial Division, EuroTech)

The multiplicity of an object – what Law and Singleton (2005) and Mol (2002) refer to as an *object multiple* – adds complications to inscription work (Latour, 1987; Robson, 1992; Robson & Bottausci, 2018). The opening quotation illustrates the relationship between accounting – in the form of a forecast – and the multiplicity of a demand chain. The forecast, a central part of target setting (Frow, Marginson, & Ogden, 2010; Hansen, 2012; Merchant, 2006; Merchant & Manzoni, 1989) and budgeting (Ezzamel, Robson, & Stapleton, 2012; Marginson & Ogden, 2005; Miller & O'Leary, 2007; Preston, Cooper, & Coombs, 1992), here enacts the multiplicity of the demand chain – a lateral ordering of the firm's production and products from customers backward to suppliers – through a concern about internal *versus* external customers. The *demand chain multiple* is practised in different ways and raises the question: how may accounting for multiplicity exist? This is a different question from that asked by studies exploring the complications of inscription work related to incompleteness (Ahrens & Chapman, 2004, 2007; Busco & Quattrone, 2015, 2018; Jordan & Messner, 2012; Jørgensen & Messner, 2010; Millo & MacKenzie, 2009) and instability (Andon, Baxter, & Chua, 2007; Chua, 1995; Dambrin & Robson, 2011; Quattrone & Hopper, 2001; Revellino & Mouritsen, 2015). Those streams of research focus on managers' and institutions' efforts to make do with absences – as accounting provides only limited understanding of complex organisational realities (Ahrens & Chapman, 2004, 2007; Chapman, 1997; Jørgensen & Messner, 2010) – by stimulating dialogue (Busco & Quattrone, 2015, 2018; Quattrone, 2009, 2015) via mobilising institutions (Dambrin & Robson, 2011), politics (Briers & Chua, 2001; Chua, 1995), and other forms of resources (Ahrens & Chapman, 2007; Jørgensen & Messner, 2010); and by experimenting with different accounting devices (Andon et al., 2007; Chua & Mahama, 2007; Skærbæk & Tryggestad, 2010). These studies focus on the ways in which complementing work is made 'highly compatible' with incomplete accounting (Jørgensen & Messner, 2010, p. 188).

Our study brings a different focus to absence through a concern

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with multiplicity. When an object multiple is enacted as a variety of durable but different practices, absences may take many forms (Law & Singleton, 2005; Mol, 2002), each of which may challenge the way it is represented by accounting. This sets it apart from the research on incompleteness and instability because contextualising accounting with complementary resources may not relate to the *many* different types of absences that come into tension with accounting's representation(s) of the object. In such a situation, relating the distribution of absences to the multiple enactments of an object multiple via mediations of accounting is worth exploring. This motivates the research question of this study: *How does accounting act on a demand chain that is practised as a multiple?*

Our case study of EuroTech (pseudonym) examines how a forecast interacts with the challenges of lateral coordination between sales, factories, suppliers, and customers in managing demand chain. There are tensions in the demand chain between, for instance, sales and production, as shown in the opening quote, in response to a market-based sales and operations planning (S&OP) forecast. 'Volumes sold' is a sales activity while 'shipment' is a procurement and production activity; the practice of the demand chain in sales differs from that in production and the demand chain is enacted as an object multiple (Law & Singleton, 2005; Mol, 2002). Thus, a general forecast may not have a stable relation to the demand chain and may not coordinate diverse entities across it; it creates tensions. Its purpose to coordinate laterally interdependent organisational functions (Atkinson, 2009; Tohamy, 2008; Vollman & Cordon, 1998; Vollman, Cordon, & Heikkila, 2000) is at risk when the demand chain is practised differently in relation to the market, customers, products, production, capacity, and suppliers.

This paper adds to the literature on inscription work by analysing how managers find and organise frictions and objections (Latour, 1999b) generated from the multiplicity of an object. Here accounting actively enacts – via discovering and coordinating the differences in practising – an object multiple. The analysis is centred on the ways in which a forecast both provokes objections to its inscription and transforms such objections into decision-making activities. This is relevant because the challenge of acting upon an object multiple involves discovering and distributing objections via mediations of accounting across its multiple enactments.

To explore how forecasting acts on the multiplicity of the demand chain, the paper is organised as follows. The next section discusses the literature on accounting's precarious relation with practices vis-à-vis incompleteness and instability, followed by a discussion of the implications of accounting's engagement with material absences on the enactment of objects multiple. Then it develops the theoretical approach, based on modes of existence, that informs the analysis. The paper goes on to describe the method used. The findings are presented in seven empirical episodes, followed by discussion of the study's contributions and implications.

2. Accounting's precarious relation with practices

2.1. Incompleteness and instability

Research into the relationship between accounting and managerial practices has established that accounting rarely creates comfort. This happens because accounting is not a machine simply supplying answers to questions, but rather a machine that brings to the fore worries, tensions and conflicts (Burchell, Clubb, Hopwood, Huges, & Nahapiet, 1980); 'Accounting information – even if available in detailed form – provides only for a limited understanding and handling of the complexity of organisational life (Chapman, 1997)' (Jordan & Messner, 2012, p. 545). In other words, it creates, rather than resolves, managerial struggles. Therefore, it is important to 'study the complexities of the evolving dynamic processes of accounting *in action*' (Hopwood, 1976, p. 3) where 'both a fluidity and a specificity have been introduced into our understanding of accounting' (Hopwood, 1987, p. 231).

One sign of accounting-created struggle is the tension of incompleteness. Managers, in a pragmatic sense, may feel that accounting should provide a precise guide for decision making and action, but 'accounting information usually does not capture all the dimensions of performance considered relevant for an organisation or a manager' (Jordan & Messner, 2012, p. 546). 'Managers therefore tend not to rely 'blindly' on such information. They rather seek to contextualise or complement it by drawing upon other inscriptions or forms of knowledge' (Jordan & Messner, 2012, p. 545). This complementing work around accounting has interested researchers contemplating what is absent from accounting (Ahrens & Chapman, 2004, 2007; Busco, Quattrone, & Riccaboni, 2007; Jordan & Messner, 2012; Vaivio, 1999), and this literature examines, for example, how accounting is complemented by strategising (Jørgensen & Messner, 2010), by relating to strategic guidelines and operational activities (Ahrens & Chapman, 2007), and by capitalising on intimacy to customers (Vaivio, 1999). These interventions may help make the absences from accounting representation less worrying by a dialogical process that generates sensible and even creative 'in-tensions' (Busco & Quattrone, 2015, 2018; Quattrone, 2017). Complementing work stimulates 'doubts' and 'debates' that create *more* opportunities for decision making.

Another tension is instability. When accounting calculations are corrupted or flawed they require additional justifications. Dambrin and Robson (2011) show how institutionalisation and bricolage of many inscriptions make it possible to accept the consequences of even 'flawed' calculations so that, for example, bonus payment systems may endure in spite of calculative flaws. Frandsen's (2009) study of the origins of accounting relates the difficulties of tracing costs to the disease of psoriasis in a hospital. This problem of absent (hospital) realities is also central to Chua's (1995) study of what she calls 'flawed approximations' of Diagnosis-Related Group (DRG) costs that seemingly had little other presence than political compromises. The reality of 'hospital business' faded away while a reality of 'political business' gained prominence. In another study, Briers and Chua (2001) attend to the lack of decision coherence on costing, finding it was resolved, not by approaching the realities of production of aluminium, but by reconciling them with managerial intuitions, alternative business, and system insufficiencies. The problem of arriving at realities is about the instability of the inscription building process on the one side, and reluctance on the other to make the realities of production a strong argument. A similar problem with instability of inscription work is presented by Andon et al.'s (2007) analysis of the development of performance measures. Here, lack of coherence of performance management is attributed to a relational drift, which is accommodated through a series of experimentations around accounting aimed at connecting accounting to otherwise absent realities of 'performance'.

Generally, accounting produces tensions because of things absent in its representation. This absence provokes complementing work, such as alternative practices, bricolage, politics, and experiments. That is, managers seek to 'fill in the gaps' by adding contexts to accounting. Accounting helps to perform a space of absences (Quattrone, 2017; Quattrone & Hopper, 2006). It proposes a course of action based on managers' ability to be provoked or motivated by its message (Busco & Quattrone, 2015, 2018) and allows them 'to be somewhat relaxed about the representational qualities of accounting information' (Jordan & Messner, 2012, p. 545).

Yet, this requires that it is possible to retain a sense of 'relaxation' (Jordan & Messner, 2012) toward absences via contextualisation. However, when multiplicity is brought to the fore, relaxation is difficult because complementing and contextualising may not

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accommodate the interactions and objections between the *many* different absences of an object multiple (Law & Singleton, 2005; Mol, 2002) and accounting's rendering of them. The present study considers an alternative, where accounting actively helps discover *what* absences are material and responds to the frictions brought by these absences. This alternative requires an approach that allows an exploration of how accounting helps to enact an object's multiplicity through engagement with material absences.

2.2. Materiality of absent realities

Some accounting research does focus on the role of material objects. For example, Chua and Mahama (2007) study how 'buyer–supplier relations' responded to a new accounting technique, re-opened discussion about relations with a supplier and changed accounting to suit a new set of relations. Likewise, Skærbæk and Tryggestad's (2010) study of accounting and corporate strategy details a history of problems, in response to which a series of new accounting devices were constructed to deal with emerging concerns and issues requiring new accounting calculations. The frictions became strategic challenges that rendered existing strategic propositions outdated, requiring new calculations for capital expenditure. These contributions offer accounts of how accounting adapts to other objects but pay less attention to the ambiguity of objects, to their fluidity (de Laet & Mol, 2000) and multiplicity (Law & Singleton, 2005; Mol, 2002). Here, the various enactments of an object may challenge each other, questioning accounting's capacity to establish faith in the way that decision mechanisms can hold together different absent−presences (ibid.) within an object multiple.

Mol (2002) and Law and Singleton (2005) elaborate the notion of an object multiple in their studies of atherosclerosis and alcohol liver disease respectively. Each of these diseases is enacted as multiple *practices*. For instance, alcohol liver disease is a lethal condition that calls for abstinence in the hospital; it is a problem calling for regulation in the substance abuse centre; it is something that is at least better than recreational drugs in GP's surgery; and it is an effect of accumulation of other social problems in community-based social care (Law & Singleton, 2005). Therefore, 'enactments' of an object multiple 'take place in the *practices* of getting to know those realities' (Law & Singleton, 2005, p. 334), as each 'produces their object in question' (ibid., p. 336; see also Mol, 2002). Central to this ontology multiple is a set of absent–presences (Knox, O'Doherty, Vurdubakis, & Westrup, 2015; Petani & Mengis, 2016), for example, the presence of the treatment of the disease in the hospital requires absence of alcohol. Therefore, the presence of the disease is 'generated in juxtaposition with realities that are necessarily absent, even though they bring versions of those realities to presence' (Law & Singleton, 2005, p. 345).

Multiplicity becomes a problem when some enactments challenge others. This is highlighted by a community-based psychiatrist discussing alcohol liver disease: 'it is not just a question of being substance-free. It has to do with improving other aspects of life … enjoy health and a social life' (Law & Singleton, 2005, p. 345). Practising the disease in the hospital is challenged by practising the disease in social care. There are interactions and objections between material absences: alcohol, as a material absence in the hospital, is in tension with the absence of 'other aspects of life' in social care. Therefore, multiple enactments raise a challenge of coordination. Enacted realities are not independent; these are not parallel worlds but different − sometimes competing − realities of an object multiple.

The tension related to material absences has been addressed by Giovannoni and Quattrone (2018), who understand the problem of coordinating absences as an inevitable consequence derived from the impossibility of full representation. In their study of the construction of Siena Cathedral from 1259 to 1357, Giovannoni and Quattrone (2018) relate the incompleteness of the cathedral to the impossibility of filling the void between contested readings of its representations. This tension, which relates to inter-institutional disagreements, differs from Singleton and Law's concern with alcohol liver disease, where tensions are not negotiated. Tensions emerge because the object is multiple rather than because a single object is open to opposition as to what it is and should be; tensions exist because there are *many* (absent) practices − enactments − within an object rather than because the object leaves *a* lacuna for managers to fill debates. To understand how accounting acts upon multiplicity, it is therefore compelling to position accounting *next to* the *many* material absences that make the object multiple.

One way to study accounting when confronted with multiplicity is to follow its participation in discovering and organising the tensions and frictions − or to use Latour's (1999b) term, objections − arising from multiplicity. As a situated *practice* (Ahrens & Chapman, 2007), accounting may help enact an object's multiplicity. However, this requires the interactions between accounting and the multiplicity of an object to be taken literally. In this regard, Latour's (2007) distinction between modes of subsistence and reference is helpful: Here both accounting and objects move and sometimes these movements intersect. These intersections produce objections and reformulations of what accounting accounts for.

3. Subsistence and reference as modes of existence

Studying relationships between accounting and the demand chain as a multiple requires observation of episodes where the multiplicity of the demand chain is enacted through absent−presences and what accounting reveals about them. To help gain access to material absences, Bruno Latour's distinction between modes of subsistence and of reference is a relevant methodological tool. He claims that realities are enacted when knowledge of objects intersects with subsistence of objects, both of which have histories (Latour, 2007).

Latour's (2007) study of the evolution of horses featured in the Natural History Museum in New York offers an illustration. He revisits the confusion attributed to the distinction between the history of objects and the history of knowledge about objects (history of science). The classic theory states that the history of horse lineage forms 'a simple evolutionary sequence: from small to large bodies, from many to fewer toes and from short to tall teeth' (Latour, 2007, p. 4). A more recent theory, however, indicates that horses' evolutionary path is more complicated, based on the recent discovery and study by palaeontologists of fossils: Some horses are smaller than their ancestors and some still have three toes instead of one. Evolution apparently takes a bushy rather than linear path. The museum's curators used the phrase 'we now know' to indicate the advancement of knowledge. The puzzle of how scientists gained more knowledge about horse lineage made Latour re-contemplate the *distinction* between objects and knowledge of those objects. To Latour, the curator's careful presentation of a more complicated version of knowledge of horse evolution and their genuine statement of 'we don't know for sure' (Latour, 2007, p. 4) does not confuse visitors and force scientists to 'abandon all hopes to know something objectively'; 'Quite the opposite' (p. 6). Knowledge about horse evolution becomes more objective. In contrast to the classic representational scheme where knowledge and objects sit at opposite poles, Latour (2007) opts for an alternative methodology. In his 'continuous scheme', there is no knowing subject, 'representation', or 'idea'. Nor is there a bridge between the object and the knowing subject. Instead there is a

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history of subsistence of objects (e.g., fossils) and a history of reference of the subsistence (e.g., scientists' statements about horse lineage). Knowledge is acquired when these two histories intersect, which they do multiple times. According to Latour (2007), 'the main problem of knowledge is to deploy the continuous chain of experience to multiply the crossing points at which it will be possible to retroactively decide whether we had been right or wrong about a given state of affairs' (p. 16).

In Latour's proposal, horses existed in a reproductive form many years ago in the wild. It is impossible to observe how these ancient horses lived and evolved, but they leave fossils as instantiations, as items of subsistence. When these fossils are 'unearthed, transported into crates, cleaned up, labelled, classified, reconstructed, mounted, published in journals', that is, 'once palaeontologists have crossed path with the ancient horses' (Latour, 2007, p. 24), a knowledge of horse lineage is produced (p. 8). At each *crossing point*, modes of subsistence and reference intersect and interact, and a facet of an object is enacted. Latour's (2007) point is that neither the mode of subsistence nor the mode of reference is immutable over time. The challenge is to find more crossing points.

The notion of *crossing points* is relevant for this study as in which we consider the relation between an object such as the demand chain (or ancient horses), a series of items of subsistence such as product, customers, sales, and market (or fossils) and understanding these through forecasts (or the non-linear theory of the horse lineage). Like the galloping wild horses, the demand chain is inaccessible in its entirety due to the impossibility of full representation (Giovannoni & Quattrone, 2018). It exists for managers in episodes, as will be narrated later, manifested by tensions around supply shortage, composition of the market, product and customer variations, planning rhythms and so on, all of which add materialities and realities to the demand chain, thus enacting its multiplicity. Crossings between subsistence and accounting are access points to episodes in the enactment of the demand chain, which 'take place in the practices of getting to know those realities' (Law & Singleton, 2005, p. 334); accounting in the form of forecasting helped managers 'get to know' the 'realities' of the demand chain (Law & Singleton, 2005). This methodology does not describe all possible realities but only those enacted at crossing points; however, it does help researchers identify intersections, which become empirical observation points to access the demand chain multiple.

4. Methodology: studying accounting and enactments of the demand chain multiple

4.1. The S&OP process at EuroTech

The field study was conducted at a large European high-tech manufacturing company, EuroTech. Its product range comprised five platforms including bearings, seals, lubrication systems, mechatronics, and services. Its customers were from a wide range of industries including agriculture, automotive, construction, electric power tools, home appliance, oil and gas, industrial pumps, green energy, and so on. There were three divisions: the automotive division (AD), industrial division (ID), and service division (SD), each of which served distinctive groups of customers, and business volumes varied. Each division's products were part of the five platforms mentioned above but the products manufactured and sold varied. Each division had a manufacturing organisation and a sales organisation. In coordinating these three divisions, Group Purchasing supervised material sourcing and Group Demand Chain oversaw planning across the demand chain. Fig. 1 illustrates EuroTech's structure.

In 2007, Group Demand Chain (GDC) realised that EuroTech had declined a substantial number of customer orders, missing out on significant revenue that would have been generated had factories had sufficient capacity. Inventory was a notable absence. In order to balance demand and supply, GDC decided to implement a Sales and Operations Planning (S&OP) process with ID as a pilot site and aiming to transform the company into a demand driven organisation. The S&OP process proposed that sales calculate a market-driven S&OP sales forecast to be used by factories for their product line planning activities. However, many objections from the demand chain made this proposal difficult and challenged the proposed seamless lateral coordination in a variety of ways. Though challenged, the forecast was trusted by the GDC for its capacity to enable lateral coordination of the demand chain. Of interest to the research is how the forecast added to the multiple enactments of the demand chain.

4.2. Data collection

Most of the empirical data was collected from documents, interviews, and observations of meetings pertaining to or held by actors relevant to the S&OP sales forecast. One of the researchers entered the field in June 2010 when GDC was rolling out the pilot S&OP process in some of the product groups in ID. Upon completing the field research in December 2011, the pilot S&OP process was still under construction. This researcher was present in the company interviewing and observing during the period from June 2010 to December 2010. After this point in time he did a number of follow up interviews when new concerns emerged, up to December 2011.

The empirical field involved the company's headquarters and adjacent factories. The researcher conducted 41 semi-structured interviews (including six telephone interviews due to inability to conduct face to face interviews) with 16 managers across functional groups during the period June to December 2010 and thereafter intermittently to December 2011. Each interview lasted between 0.5 and 3 hours with an average length of around 70 minutes and all were tape recorded and transcribed. The researcher either participated in, or conducted interviews with participants of, the pilot S&OP product group planning (PGP)[1] meetings. Each meeting took around 2 hours and was tape recorded and transcribed. A vast range of internal materials was studied including S&OP charters, 6 Sigma charters, business cycle forecasts, financial forecasts, an S&OP instruction manual, data in the pipeline and in the Demand Solutions, factory daily planning inscriptions, factory stock levels, safety stock levels, shipment histories, and meeting minutes. As the S&OP process was implemented in ID, most of our data is collected from interviewees, meetings, and documents within ID and GDC. Table 1 shows the summary of the empirical data collected.

4.3. Data analysis

The organisation and analysis of data focused on crossing points – episodes where the demand chain via intersections between subsistence and references gained more properties. Empirical evidence was organised by crossing points between items of subsistence (mode of subsistence) and forecasts (mode of reference), which helped to articulate the demand chain as a multiple. Each crossing point concerned a particular problem such as 'supply shortage', 'composition of the market', 'product and customer variations', and so on; each denoted a tension due to the intersection between reference and subsistence.

This procedure focuses on the emergence of the demand chain

[1] A Product Group Planning (PGP) meeting raises concerns about planning issues for a number of different product lines.

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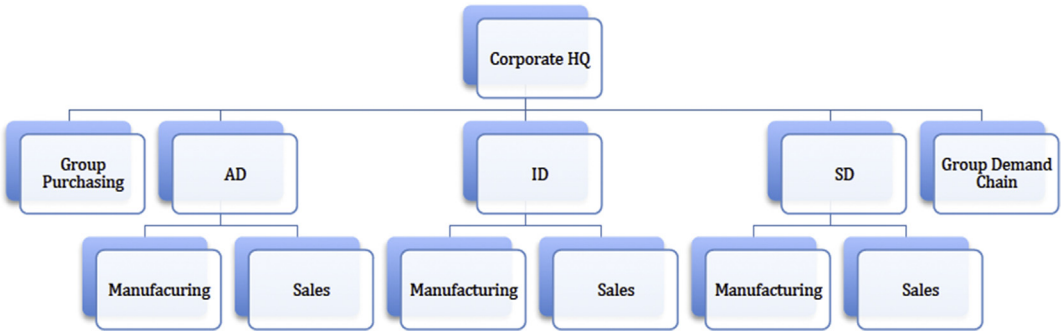

Fig. 1. Organisational structure of EuroTech.

Table 1
Summary of interviews, meetings and documents relevant for the study.

Interviews		
Positions	Face to face	Telephone
Sales Manager of Bearings and Units – ID	1	0
Demand Chain Manager for large bearings – ID	5	2
Manager on Manufacturing & Supply – ID	5	1
S&OP Manager – GDC	4	0
Business Process Analyst A – ID	1	0
Business Process Analyst B – ID	3	0
Business Process Analyst C – ID	2	1
Regional Sales Director – ID	1	0
Sales Manager – ID	2	0
Product Line Planning Manager A – ID	1	0
Product Line Planning Manager B – ID	2	2
S&OP Product Line Planning (PLP) Manager – GDC	3	0
S&OP Supplier Capacity Planning (SCP) Manager – GDC	2	0
Forecasting Manager – SD	1	0
Purchasing Manager – ID	1	0
Director of Demand Chain – GDC	1	0
Total	**35**	**6**
Meetings		Attendance
Pilot S&OP meeting Sept. 2010		1
Pilot S&OP meeting Feb. 2011		1
Total		**2**
Internal documents		
S&OP charter		
6 Sigma charter		
Business cycle forecasts (the F18 curve)		
ABC analysis		
Financial forecasts		
S&OP instruction manual		
Pipeline		
Demand solution		
Factory daily plans		
Factory plan, stock levels & safety target levels		
Shipment histories		
Meeting minutes		

as an object multiple. It does not guarantee that all practices have been discovered and that the research has found all crossing points. Yet, this is not a constraint. The theoretical reason for this is that the study emphasises how accounting actively enacts and responds to multiplicity. The methodological reason is that following crossing points that organise the forecasting work in the firm helps to anchor data collection. This makes it possible to consider who should be respondents and where to go and to observe (next). Therefore, there is an interaction between the material absences of the demand chain and *follow ups* of data collection. This means that our theorisation is always in conversation with the literature, analysis of collected data, and collection of new data.

5. Intersections between modes of subsistence and reference on the demand chain

The following analysis of crossing points shows first how the development of the S&OP forecasting mechanism was both conditioned by and enacted the discovery of items of subsistence of the demand chain. It also shows how it translated objections from subsistence into accounting in the form of decision mechanisms for coordinating the multiplicity of the demand chain.

5.1. Crossing point 1: supply shortage

When asked why the S&OP process was proposed, many

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managers pointed to availability failure, for instance:

> We have poor figures on more or less all channels … this is the actual situation when it comes to deliveries right now, so that is not a good picture now … I just give you a hint on our availability. Here (pointing at a computer screen) you see the H channels that we have, you see who the planner is, here we have the availability on the stock items, 81% for the H2, 9, 35, 51, 53 and so on. (Purchasing Manager – ID)

> We have a factory in India now, which has availability failure of 50%. I mean it's just ridiculous. I mean it doesn't matter because the sales guys don't talk to customers anymore. (Business Process Analyst B – ID)

When subsistence such as 'empty' inventories and 'lost' customers emerged, the demand chain was understood as availability. These items of subsistence proposed the firm as 'not being able to predict increasing demand early enough' (S&OP Manager). This imbalance between demand and supply was also connected with another subsistence in product delivery, as explained by the S&OP Manager:

> In EuroTech we produce, for example, a bearing which is mainly for car customers (customers to the automotive division), but there is always a certain part which goes to either service division or industrial division. So, it's very rare that a product only goes to one segment. Factories produce both for particular customers (for a particular division) and for (all) EuroTech customer segments. That's why it's so important to get the whole demand right for all our customers … We had different solutions, pieces here, pieces there.

This quotation attributes the issue of complex delivery to the lack of coordination along the demand chain. Each component could be delivered to customers who ordered from all three divisions in EuroTech. This delivery complexity escalated because of the platform concept as explained by the S&OP PLP Manager – GDC,

> There are five different platforms (product groups). We have bearing units, which is the largest one. There are also seals, lubrication systems, mechatronics and services … The main purpose is to combine as many of these platforms as possible. The more we can combine these solutions, or platforms, the better it is for us and for the customers; and it also gives more value to us and customers.

As the quotation explains, EuroTech delivered not only one product to multiple customer segments but also combinations of product groups (platforms) to one individual customer. For instance, it could sell a combination of bearings and mechatronics to one customer as something managers called 'a solution'. This delivery complexity was an item of subsistence of the demand chain that put a burden on lateral information, communication, and action flow. The early quotation from the S&OP manager, 'we had different solutions, pieces here, pieces there', was further explained by the S&OP SCP Manager – GDC,

> All this information (forecasts) has been flowing to the factories, but never in a unique, organised structure. Factories are of course planning their production and capacity again with a different methodology (to that of sales). And on the supplier side, of course all factories are communicating their supply needs. Yet, there has never been a consolidation of these requirements. Each factory has been going to their own suppliers, (but) our purchasing organisation didn't have a detailed organised updating of the information of the demand of different components, materials and so on … there wasn't anything structured already in place.

The presence of many calculating agencies exacerbated delivery problems. Sales predicted market demand, factories anticipated production runs and batches, and the purchasing organisation struggled to make contracts with suppliers; each developed their own model of planning and communication and the three functions faced different product and customer priorities. The multiplicity of calculating agencies increased the complexity and the unpredictability of the demand chain. These various items of subsistence identified these complex availability problems as due to a lack of general coordination between operations (supply) and sales (demand). To manage this coordination concern, a reference was produced to balance demand and supply: 'we want to compare our capacity to our (S&OP) sales forecast three years from now so that we can increase our capacity' (Product Line Planning Manager A – ID).

To re-capture lost customers the S&OP sales forecast was proposed as a market-driven unconstrained forecast. Business Process Analyst A – ID said that this 'pure customer demand' would enable 'decisions and actions before everything is a big mess'. Or as proposed by Product Line Planning Manager B – ID:

> I'm really positive towards this S&OP forecast because we (product line planning in factories) will have to communicate with sales. I'm sure it will improve cooperation between sales and manufacturing, but it will probably take some time … We actually had one case when we had one final variant where the sales side says we are going to sell 2000 per month and we (the factory) had only shipped 1000 per month, and we only had orders for 1000 per month. Then we ask them (sales), OK, we had only sold 1000 pieces per month, you say we are going to sell 2000 pieces per month, either you have to place more orders, or to decrease the forecast.

Aiming to address the tension between demand (customers) and supply (inventory and delivery) EuroTech proposed an unconstrained market-based S&OP sales forecast for the upcoming 36 months as a solution. Its purpose was to integrate sales, production, and suppliers to reach a consensus production plan so that EuroTech would increase investment in capacity if predicted market demand exceeded current capacity. A consensus plan would potentially bring every party's information, action, and communication flow into one frame where product delivery could be well organised, empty inventories reduced, lost customers re-captured, and availability increased. A customer friendly supply would create proximity (Corvellec, Ek, Zapata, & Zapata Campos, 2018) between all these items of subsistence.

5.2. Crossing point 2: composition of the market

However, with this market-oriented solution, an objection from the demand chain emerged. Forecasting of the market had to be made at the 'different levels' (Forecasting Manager – SD) because, for example, 'business with a huge automotive client (of AD) and (a client purchasing) smaller bearings (from ID and SD) are certainly different'. Therefore, the many types of products offered and the divisional structure of EuroTech made forecasting of the market difficult.

The unconstrained market-based forecast (the reference)

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created at crossing point 1 was not able to relate the heterogeneity of customers to the market. This absence emerged in the intersection between the forecast proposed at crossing point 1 and two competing sets of subsistence of the demand chain at crossing point 2. One set of subsistence, proposed by GDC, suggested the market as made of customers. Thus, the market would be aggregated from either the lower customer item level, such as a particular bearing sold to a particular customer, or the higher product line level, such as a particular size of bearings that could be used by many customers. A customer item and a product line would be two possible 'primary keys' for the forecast, the importance of which is illustrated in the following quotation by the S&OP Manager and summarised by Table 2:

> Automotive Division (AD) had only a few big customers, large organisations, each of whom ordered a large number of products. They prided themselves of sound supply chain management (SCM) and expressed certainty about future business volume. Here, the primary key could be set at the lower customer item level. In Industrial (ID) and Service Divisions (SD), in contrast, the order book for customers had a short time horizon, if any. They had a large number of smaller customers and customer relationship management consisted of personal relationships between salespersons and customers, and customer demand was understood as unpredictable. In this situation, the primary key was set at the higher product line level.

In spite of their differences, AD and ID/SD proposed a common strategy to forecasting based on a primary key as anticipation of individual customers' business volume, which would then aggregate up to regional sales volume.

Such a bottom-up forecast relied on existing customers' past behaviour to anticipate their future demand. This approach, however, revealed another subsistence of the demand chain: The difference between what customers said and what they did, as suggested by the Sales Manager of Bearings and Units – ID during a pilot S&OP product group planning (PGP) meeting,

> The thing about the detailed bottom-up forecast is … our strength in sales so that we can ask the customers about their plans, and we can get more details. But of course each customer is a little bit inaccurate … They (salespeople) can only ask the customers who tell what they think.

The tension was built on the contested inscriptions of the market between GDC and sales. Sales questioned GDC's assumption that past experience about customers would be able to predict their future dealings with EuroTech; for sales, a business cycle forecast (BCF), which started from macroeconomic trends, would better account for the market. This would be a top-down forecast based on macroeconomic indicators, not on what individual customers might say. The manager explained the merits of a BCF against GDC's proposition of an S&OP sales forecast in the same meeting:

> Normally, we (EuroTech) have a better understanding of what trends and thus the future will be than some of the customers that we asked, so what is needed is to apply a certain top-down logic to say, OK, where is the general trend, can we anticipate things because customers don't know yet … you cannot only work on the detailed bottom-up forecast because the truth is not there to be caught …

The quotation indicates two competing sets of subsistence: Customers' own voices versus economic conditions. The competition was conditioned by the difference between what the customers said and did. When intersecting with the unconstrained market-driven forecast developed at crossing point 1, each claimed a different type of knowledge for governing the demand chain: The bottom-up method took advantage of relations with customers, and the top-down approach took advantage of macroeconomic knowledge developed by a central business planning unit in EuroTech. The question became: Who would be a better spokesperson for the market – individual customers or general market conditions?

The items of subsistence of the demand chain at crossing point 2 comprised customers' voices, deviation between what customers said and did regarding future business volume, and general economic trends. They were absent at crossing point 1, but they were materialised because of an objection to the market-driven forecast generated at crossing point 1. The intersection of subsistence and reference presented a new tension to the managers: Specific knowledge of customers would not be compatible with general knowledge of market trend. This raised a new concern about coordination: How were customers linked to the market? What was the composition of the market?

There was thus a movement from inventory planning, logistics, and calculative practices to customer relations, customers' SCM, order books, divisions inside EuroTech, and general economic outlook; a movement from enacting the demand chain as a tension between demand and supply to that of enacting it as a composition of the 'market'. The unconstrained forecast was only a comforting reference at crossing point 1, and it spun into two possible modes of reference, which generated competing interventions at crossing point 2.

The bottom-up approach was eventually preferred not only on its potential merits but also because of historical ignorance of the availability issues of its alternative, the business cycle model, even though sales had more local knowledge of what customers said and did than GDC. This, however, did not mean that the BCF exited the demand chain. The bottom-up S&OP forecast did not replace the top-down BCF, rather the latter continued operating for its central planning purpose. Also, the BCF did gain some prominence in product line planning in factories, as cautiously mentioned by the Demand Chain Manager of Large Bearings – ID,

Table 2
Properties of actors in divisions that created two different primary keys.

Actors	Automotive Division (AD)	Industrial (ID) and Service Divisions (SD)
Business characteristics	Large volume of products sold to few number of customers	Low volume of products sold to a large number of customers
Order Book	Long and reliable	Short and unreliable
Degree of certainty of future customer volume	High	Low
Primary Key (mode of reference)	(lowest) Customer item level	(higher) Product line level

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> We plan by looking at the last 12 months and the biggest weight is the last 3 months … then we see, based on the business development (the BCF), what they say where the business is going, then we put on some percentage because, for example, now we are coming to an upturn of the business.

This started developing accounting as simultaneity (Latour, 2005) instead of as progression or succession: enactment of the demand chain at this crossing point did not substitute the enactment at crossing point 1. In addition to BCF, the reference of a 36-month unconstrained forecast was still in operation to ensure comparability of all forecasts in sales and operations planning. At the series of pilot S&OP PGP meetings, all forecasts were adapted to a time horizon of 36 months. The BCF, used to inform product line planning as indicated in the above quote, was already an unconstrained forecast estimating market trends. Therefore, the reference created at crossing point 1, an unconstrained forecast for the upcoming 36 months, operated simultaneously in GDC, sales, factories, and the central planning unit; the additional model of relating different customers to the market became useful for the *calculation* of an S&OP forecast for coordinating the demand chain. All co-existed and were *added* to the demand chain making it more multiple.

5.3. Crossing point 3: product and customer variations

At crossing point 2, individual customers were taken seriously; the bottom-up reference was established. However, this also created an additional objection from the demand chain, which the Manager of Manufacturing & Supply – ID referred to as the amount of forecasting work created because of the '*sheer number* of different products' sold to 'very different groups of customers in each division' (AD, ID and SD).

Forecasting actors – salespersons, sales managers and sales directors – were unable to calculate forecasts for the whole variety of customer-items and product lines manually because of limited time. Instead, part of this work was delegated to a software instrument called *Demand Solutions*. This software compared historical forecasts and actual sales for the last 12 months and predicted sales for the upcoming 36 months. The S&OP Manager spent an afternoon demonstrating *Demand Solutions* to the researcher, explaining how it created different inscriptions that linked customers to products through different divisions of labour.

The use of *Demand Solutions*, however, was not without obstacles, as highlighted by the S&OP Manager,

> If we take out total automotive business worldwide (AD), we are talking about 5,000 records in combination with final customers … If we take the same (primary) key for the SD in Europe, we have 3 millions of these records – items and final customers (He was scrolling down the screen to show the massive size of the records. Then he clicked on one item.) On that (product) line, you will have something like this, very erratic sales patterns, 5 pieces here, 20 pieces there. Here for a lot of months, nothing (has been sold), so what the system (computerised) forecast creates will be very bad.

The number of customer records, the differences between customers belonging to different divisions, and erratic sales patterns made it difficult for Demand Solutions to generate a sensible bottom-up forecast developed at crossing point 2. When meeting, and objecting to, such a customer-oriented (bottom-up) forecast, the demand chain revealed items of subsistence, as shown below, such as product volume, product growth, product novelty, product value, and customer heterogeneity. For some products, the variation in the historical performance of products was substantial. On managing this kind of variation, the S&OP manager pointed out,

> We give all those cases a certain tag, so for example, if we only have order book, but no history, which means this is a new item, we give a pre-warning as we never sold that item to any customers. Now we (also) have the order book, so for sales persons, it's good for them to get these pre-warnings.

Product novelty was an item of subsistence that required sales people to manually forecast items that had no history in the computer but only appeared in the order book.

There were yet other items of subsistence as explained by the S&OP manager as he flipped to another *Demand Solutions* screen,

> Or you have a strongly growing item, or your order book is much bigger than your forecast … Here we have a decision tree which says in this case the sales per month is above certain amount of money, so it is an important item, and we filter out items that are strongly growing, of course it's a question of how you define a growing item. We have two definitions, one is year over year, so last 12 months should be 50% above the year before, and the last quarter needs to be 100% over the quarter the year before … Here is the situation where we have last 12 months, before certain period of time, it was nothing. We have according to that definition a growing record. … And combine that with those filtered events, then you have a very powerful tool …

Product growth was another item of subsistence. Again, human actors would have to forecast items with growth that exceeded a certain threshold manually. To this, a Forecasting Manager – SD later added that 'we are also presenting average sales value and those items with high value will be forecasted manually'. This revealed a fifth item of subsistence in the form of product value.

Customers' voices were heterogeneous because when the bottom-up customer-based forecast intersected with items of subsistence such as product novelty, product growth, product value, and so on, different types of forecasting models were proposed. Each prioritised certain customers and products; each related customers to products in a unique way. In an attempt at making heterogeneity a little less prevalent, a reference was created that ranked products on revenue into A, B, C, D, and E items (those contributing 30%, 30%, 20%, 15%, and 5% to total revenue respectively). Human forecasting agents could influence A, B, and C products by forecasting them manually. While A, B, and C products contributed to 80% of turnover, they were related to only 3% of customers. Therefore, the reference constituted a hierarchy in which products and customers were prioritised in the demand chain.

This crossing point enacted yet another materiality of the demand chain in relation to the tension of exacerbating forecasting complexity due to (too many) types of customers and (too many) variations in products in the three divisions of EuroTech. Items of subsistence such as product volumes, growth, novelty, value, and customer heterogeneity emerged and objected to the bottom-up forecasting approach constructed at crossing point 2. This tension presented a coordination concern for managers: How do we relate different types of customers to the 'sheer' variations of products? The different visualisations in *Demand Solutions,* from order book to the ABCDE system, helped bundle customers and products differently. For instance, sales people planned for large customers ordering a few big items, as well as new products and products with high value and growth. Other customers and products were

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managed through the software. These practices took place simultaneously.

5.4. Crossing point 4: average customers

As a consequence of handling product and customer variations, the forecast became very detailed at crossing point 3, and this raised an objection from GDC, namely that (too) many details did not produce a set of smooth monthly numbers preferable for medium to long term capacity planning in factories, as exemplified by the Business Process Analyst B – ID,

> You don't want the (forecasting) system to be that easy picking up the specific situations. We look for investment in the next three years. You can smooth the forecast, (say) your forecast is not going up by 10% but only by 5%.

The model created at crossing point 3 raised a dilemma about the link between investment in production and calculation of customer needs. If a forecast was too 'precise', each monthly forecast would be unique. This made customers erratic, which became a barrier to medium to long term capacity planning in production, as proposed by GDC. Capacity planning did not ask questions about specific customers but about general operations: 'do we need to invest in the (production) channel?', 'do we need to invest in the machine?' or 'do we need to build up a shift?', as explained by the Business Process Analyst B – ID. Such questions were not attached to the S&OP forecast. Therefore, fluctuating monthly bottom-up forecasts, which created erratic customers, were in tension with the subsistence of medium to long term production and machinery investments. This presented a new concern for managers: How do we relate production to sales? To address this concern, a model relying on average customers was proposed as follows by the Business Process Analyst C – ID,

> … if you have a strange history, we have for example for large bearings, we had a situation a couple of years ago where you can wait for 1.5 years for your orders, which means you get no supply, no sales, no sales, no sales, and then suddenly there is a production, and you produce all sales in one order, 20 large bearings in July, then there is a long period of no sales, no sales. Then of course we use that input to plan the forecast, but it is not really good. So in those kinds of cases, it is very valuable to adjust the history to smooth out what the real one (history) is.

This means that 'adjusted', 'smooth' forecasts were preferred to 'real' ones. An average customer would be preferable to an actual customer for medium to long term capacity management. The S&OP Manager explained:

> I believe when we talk about forecasting accuracy, it may be more important to select the formula with lowest mean error compared to the lowest absolute error because that one (mean error) will select the formula which produces smooth (monthly) forecasts.

Rather than 'adjusting' and 'smoothing' the detailed representations of the customer-products relations modelled at crossing point 3, GDC opted for smoothing the fluctuating monthly forecasts by looking for calculative space other than *Demand Solutions*. The S&OP Manager referred to formulae embedded in *Demand Solutions* to assist sales finding average customers. *Demand Solutions* could generate 21 different forecasts; in principle, the forecast to be selected would have to be the one, it was argued, that would generate the smallest variance compared with actuals. This was termed 'error' by managers. Yet, error existed in many forms, two of which were relevant here. The so-called absolute error – the absolute difference between actual and forecasted sales – was calculated on raw data. If actual sales were 100 and forecasted sales were 70, the absolute error would be 30. This calculation was automatically built into *Demand Solutions* and therefore the system would, by default, choose the formula that would generate monthly sales forecasts for the next 36 months with the smallest absolute error for the previous 12 months. However, as indicated in the above quotation, absolute error did not produce 'smooth' monthly forecasts. Instead, 'mean error' did. Mean error was the average of a set of absolute errors. So, if there were absolute errors of 30, 10, and 35, the mean error would be 25. This measure would produce a set of smoothed forecasts, which were suggested as more in line with S&OP's time horizon for capacity management. Thus, erratic customers were translated into average customers. This required forecasting managers to override *Demand Solutions*, which calculated forecasts using the absolute error. To do so, managers 'exported (historical) data from *Demand Solutions* to their own excel spreadsheets' where 'mean error' could be generated.

This further multiplied the number of simultaneous forecasts. The forecast created at crossing point 3 was not replaced. It still functioned as a mechanism to relate customers to products. It existed in *Demand Solutions* to which sales, GDC, and production all had access. The 'smoothing' work was addressed by creating an additional space outside the software. This simultaneity resolved the tension between precision in predicting customer wants and generality in capacity planning.

5.5. Crossing point 5: planning rhythms

Factories, on the other hand, had problems with the 'smooth' forecast because their planning horizon was short term product line planning where 'precision' was a calculative must. This became apparent when Product Line Planning Manager B – ID complained that 'availability for every material family now' was more important than that 'in three years' time'. There was a tension between operational product line planning in factories and medium to long term capacity planning proposed by GDC and quantified through smooth forecasts. Average customers were at odds with product line planning. This tension first emerged with an item of subsistence called 'material families' (product batches) as explained by the S&OP PLP Manager B – GDC in relation to factories' planning priorities as follows:

> If we produce the material family first we have to look at the order book, so customers can get what they order. So, this is the first priority, and the next one is the practical distance from the safety stock. If the distance from the safety stock is below certain level for a particular material family, we need produce this material family first. So we look at which material family has the worst situation.

This shows that, for factories, the first step was to use the order book to determine which material family to produce first so that factories would have inventories available to fulfil these customer orders. The next step was to compare the stock level with the safety stock level for each material family. If the gap between the two for a particular material family exceeded a certain level, then that material family was to be produced first. When explaining the importance of a material family, the Product Line Planning Manager A – ID provided the following illustration,

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> We have material families. Typically, it's the size of the bearings. If it's one size, it means you use one type of outer ring and one type of inner ring. Then you can have different variations with different balls and different cages as well as other variations. There is also a decision (called an M decision) linked to that. Here you have the main variant. Then when you have all the material, this is the type we want to produce and when this comes to the factory, you can turn it in different ways, you can have balls in the inner ring … you make some variations in the turning. This is what we call the turning variant (called a D decision). Then we have final variants. You can have difference in clearance, the clearance between the rings (called an E decision). M is (the decision) for (producing) the main variant, or the material family. D is (the decision for producing) the turning variant. E is (the decision for producing) the final variant.

A material family was a batch of bearings of the same size of outer and inner rings. Factories made M decisions about which material family to produce first. In each material family they decided which turning variant to produce (D decisions). Finally, E decisions concerned the final variant factories were to produce. This is why the M, D, and E decisions were called a set of product hierarchy decisions in EuroTech. D and E decisions were postponed as much as possible because the demand chain would be more just-in-time when the time gap between factories making E decisions and customers placing an order was smaller. These product hierarchy decisions were introduced to mediate the relation between availability and flexibility, as explained by the S&OP PLP Manager B – GDC,

> So what they do is that they keep the full quantity open as long as possible for all possible variants. Then the order comes in and then we have total availability. Let's say if we have 5 days' lead time on the material (an M decision), and then you can take this (D) decision in 15 days, and then when you are closer to the actual production date you know more about whether it's gonna be a tapered ball a cylindrical ball because things may change. You have increased the flexibility.

Here the mode of subsistence of the demand chain in factories emerged as the product hierarchy, work-in-progress inventories (D and E decisions in each material family), and product batches (M decisions), all aiming at flexibility and availability. At stake was the rhythm of product hierarchy decisions about the priority of product batches and the extent of postponing work-in-progress inventories till a time when it was clear what customers would order.

M, D, and E decisions were required *daily*, as pointed out by the Product Line Planning Manager A – ID,

> Daily planning! I would say the objective or the goal of the daily planning (is) to maintain free availability. Free availability means you should have the right products on stock all the time. So we can serve the market … Also the daily (planning) means you should book the dispatch order every day, you should order material every day, yes, you have made your M decision on what to produce, so we do this, we have a loop of tasks that we do them each day … Here the core task for the supply chain manager is to daily or rather continuously maintain free availability. Every second is important. We need to have free availability per product at every moment.

In other words, objecting items of subsistence here – the product hierarchy, work-in-progress inventories, and product batches – were to be managed *daily*. The intersection between these items of subsistence of the demand chain and the reference developed at crossing point 4, the 'smooth' forecast used to enact the demand chain as medium to long term capacity planning, revealed the tension on planning rhythms between factories and GDC; average customers were at odds with daily product line planning. It raised a concern about coordination of the demand chain to managers: How do we organise the planning rhythm in production? Daily availability was top of the factories' product line planning agenda whilst the average customer was related to their medium to long term capacity planning. This average customer reference met objections from items of subsistence such as product batches and work-in-progress inventories, which were enacted 'daily', even 'every moment' as highlighted by the quotation. Here, the temporal and spatial organisation of postponement, where a product was put together as late as possible to fulfil a customer order quickly, organised production sequences. Daily product line planning strived for optimisation within capacity constraints. This optimisation was achieved through references in factories such as order book, safety stock, and factory forecasts. However, these did not replace the 'smooth' sales forecast generated at crossing point 4. The smooth sales forecast retained its status in relation to medium to long term availability. The decision model for medium to long term capacity planning of the demand chain in GDC and sales co-existed with the model for daily product line planning of the demand chain in factories.

5.6. Crossing point 6: capacity constraints

Crossing point 5 emphasised daily optimisation of product line planning within capacity constraints and challenged the S&OP assumption that a forecast should be unconstrained. As the Manager of Manufacturing & Supply – ID exclaimed, 'factories did not consider (using) the (S&OP sales) forecast because they always had constraints'. Production wanted to dominate sales because availability to existing customers was always important, but the market kept growing and new customers joined. Excess and potential customers emerged as items of subsistence that objected to the factory planning models. When the S&OP process related sales to operations planning, customers would be in excess for production, and decisions would have to be made to exclude a certain demand from the S&OP process. Therefore, a tension emerged in which sales wanted to include excess and potential customers in the demand chain whilst factories would only relate production to existing customers. This tension created a new coordination concern for managers: How do we relate (unconstrained) sales to (constrained) production? The response was to repair the S&OP sales forecast, as highlighted by the Manager of Manufacturing & Supply – ID,

> That is decided, yes, beyond 12 months, that forecasts need to be unconstrained, but within 12 months, it may have to be constrained if we have any constraints. The ideal is that in 12 months, we should be able to fix those constraints with our own manufacturing (and) with all possible supplies, and then between 1 and 3 years, everything is available, and we should just produce what they (sales) forecast.

Another reference, the adjusted S&OP sales forecast, which would only 'un-constrain' the forecast after 12 months, was understood to be tolerable, so that certain excess customers would be re-considered after 12 months.

This heightened attention not only to 'own manufacturing' but also to 'all possible supplies', produced another item of subsistence in the form of an inter-factory production network. Factories with excess capacity would increase their shipment to support other factories with capacity constraints. The meeting minutes following

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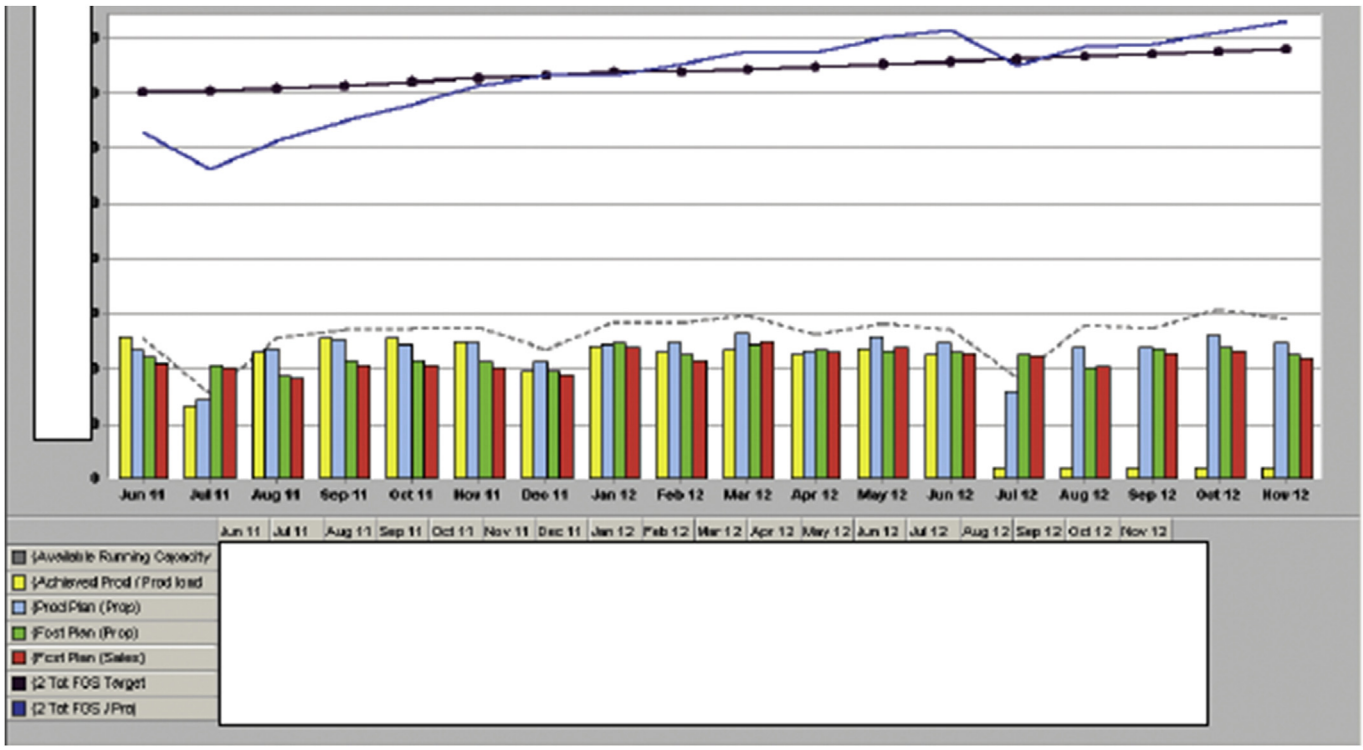

Fig. 2. Presentation of S&OP and factory forecasts – Pilot S&OP meeting June 2011 (green bars represent the monthly factory forecasts and red bars represent the monthly S&OP sales forecasts; certain information is erased to preserve anonymity of the organisation.). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the above first PGP S&OP meeting provided a list of actions, for example, '(i)n Factory A,[2] Channel xx to run 6 days for 24 hours'. Product Line Planning Manager B – ID corroborated that this Factory A was indeed 'supporting inventories to channels in other factories with capacity constraints'.

The reference, the adjusted S&OP sales forecast, produced decision activities to mitigate short-term capacity constraints. Excess customers, while turned away then, could still be served later. The tension between current and excess customers was addressed by a forecast that created simultaneity of both daily product line planning in factories, which concerned existing customers, and medium to long term capacity planning in GDC and sales, which concerned excess (potential) customers. The factory network provided a way to connect the two.

5.7. Crossing point 7: internal customers

The implementation of the adjusted S&OP sales forecast impacted capacity. According to the minutes on the pilot S&OP meeting in May 2011,

> Both adjusted sales forecasts, around xxx euros, and factories forecasts, around yyy euros, were higher than the levels of January 2011 because of the efforts put in place to increase shifts and manpower … Factory M was running all available hours (24/7), started in Feb. 2011; Factory N was running overtime for all channels on longer shifts; in Factory O, temporary extra night shifts were added.

The factory network and 'all possible suppliers', as exemplified above, were ways to make factories' planning systems flexible but this also attracted yet another objection from the demand chain. As the Product Line Planning Manager B – ID explained, 'factory A supported inventories to others, but the (adjusted) S&OP forecast did not include this shipment'. The S&OP sales forecast focused only on the end-customer in the market. This was why from May 2011 factories struggled with product line planning because they understood the adjusted S&OP forecasts as too low. Fig. 2 provides an illustration. It was one of the many PowerPoint slides shown in the June 2011 pilot S&OP meeting that visualised the difference between unconstrained (adjusted) sales and constrained factory forecasts. For most figures discussed in the meeting, the unconstrained sales forecasts were lower than the constrained factory forecasts because of their exclusion of shipments.

According to the Product Line Planning Manager A – ID,

> More or less all factories now realise that their forecasts refer to the shipment out of factories. During this period (February 2011 to May 2011), there was a huge increase in stock in regional warehouses for example the Singapore warehouse and a number of factory warehouses. As a consequence, factories put sales forecast aside as they speak a different language. Sales always consider the volume sold to customers, but the factories always think in terms of shipment from either warehouses or factories to customers, and shipment from factories to factories.

While sales anticipated total volume delivered to external customers, factories planned for total volume of shipments out of factories. For factories, the reference was the shipment volume and, therefore, in addition to external customers, shipments within inter-factory networks and to warehouses also counted. For sales, the reference was only sales volume to external customers. Suddenly it was also clear why for most months the S&OP sales

[2] The actual locations of the factories are concealed for the purpose of anonymity.

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forecasts were lower than the factory forecasts. Product Line Planning Manager B – ID pointed this out when describing the supporting work provided by Factory A, 'forecasts (in Factory A) were higher than sales (forecasts). Sales simply didn't take this into consideration'. He also confirmed that there was 'increase of shipment from Factory B to the regional warehouses', which sales still 'overlooked'.

Also, the lead-time required to transport products between factories and warehouses in different geographical regions impacted forecasts, as explained by the S&OP PLP Manager – GDC,

> In general, we have four geographical areas, North America, South America, Europe and Asia. The rule is that there is no lead time between the shipping factory and the 'receiver' if they are in the same geographical area. When they are in different areas, there is a 1–2 months lead-time.

The demand chain at this crossing point thus revealed items of subsistence such as internal customers, including factories and warehouses, and the lead-time used to transport products between different continents. This tension between internal shipments and external sales was translated into a lead-time adjusted shipment based (LTASB) forecast. The Product Line Planning Manager B – ID gave a numerical example to illustrate how an existing (adjusted) S&OP sales forecast was transformed into a LTASB forecast considering the impact of the lead-time.

Fig. 3 illustrates that, for instance in the first column, if the sales forecast predicted the volume sold to external customers as 105 and considering there was a lead-time of two months of shipment from a European to an Asian warehouse, the European factory needed to ship six extra units today in order for the Asian warehouse to have availability in two months' time. The forecast therefore had to be 111. In columns where the LTASB forecasts was lower than the S&OP sales forecasts, for instance, in the fourth month the adjusted S&OP sales forecast was 107 whilst the LTASB forecast was 106, the explanation from the product line planning manager was that the shipment forecast had to be reduced because some shipments were already forecasted two months earlier when (in the third month) the shipment forecast was increased to 118 from the S&OP forecast (111).

Challenging the adjusted S&OP sales forecast, inter-factory networks, internal customers, and the lead-time of transportation presented a tension whereby internal customers were not included by sales. This tension raised another coordination concern in relation to what full capacity was. Here, a 'shipment' mode of forecasting for the demand chain was produced. This was not a substitution of the adjusted S&OP sales forecast because the model that allowed factories to submit a constrained forecast under capacity shortage was still in operation; so was the internal factory network. The *additions* were internal customers and lead-time adjustments. References about the internal factory network, existing and excess customers, warehouses, and lead-time coexisted. In this sense, the LTASB was another addition to the adjusted S&OP sales forecast.

The empirical analysis ends here, but it does not mean that the unfolding of the demand chain multiple is necessarily complete. As shown in the seven crossing points outlined here, adding a new time and space requires a new crossing point between subsistence and reference. At the end of the fieldwork, it was not apparent to managers what new objections were attracted to the LTASB forecast, but this did not guarantee their absences.

6. Accounting, simultaneity, and relative completeness in the dynamic enactment of the demand chain

6.1. The enactment of the demand chain multiple

The empirical analysis is a detailed account of the development of forecasts as a moving engagement with subsistence of an object (Latour, 2007). The object, the demand chain, never shows itself in its entirety, but it is enacted as a multiple around coordination problems created by intersections between forecasting mechanisms and items of subsistence attracted to them. In this account, a forecast never represents the market but helps enact multiple differentiated practices linking products, production, capacity, customers, and market. The forecast provokes new subsistence because when it proposes a decision model for coordination, other items of subsistence of the demand chain materialise as new objections. Moving forecasts' engagement with moving instantiations of subsistence of the demand chain is summarised in Table 3.

Table 3 recounts the empirical story – accounting's role in enacting the demand chain – as a set of crossings with subsistence (objections) and (established) references (decision models for coordination): An objection intersects with an established forecasting model, which presents a coordination tension and specifies a coordination concern to managers; each coordination concern breeds a new forecasting model; each model attracts and intersects with a new objection from the demand chain, increasing its multiplicity. This is a dynamic account of the enactments as discoveries and coordinations of the demand chain multiple.

Latour's (2007) distinction between modes of reference and subsistence works differently in the case of the demand chain from his example of the horses in the museum. Firstly, the demand chain may be more complex than horses in the field. The enactments of the demand chain exist concurrently rather than in a history separated by thousands of years. This shows that coordination mechanisms never neatly substitute each other. This is why the multiplicity of the demand chain is about *simultaneity* (as accumulation) rather than a story that progressively unfolds as convoluted, as is the case for horse evolution (Latour, 2007). There is continuity in the enactments of the demand chain multiple as enduring coordination concerns, but this continuity is a process that unfolds additional times and spaces rather than replaces existing ones. Secondly, subsistence exists both as activities and as inscriptions. Subsistence is often made visible through inscription work (Robson, 1992; Robson & Bottausci, 2018); the world has to be made present, or presented, somehow, often by visual means (Latour, 1999a). The difference between accounting and subsistence is that accounting produces a transformation that organises subsistence. It adds to subsistence a decision mode that proposes how subsistence be handled. Accounting transforms subsistence into decisions and actions upon subsistence. For each accounting, there is an air of *completeness* because a decision model is juxtaposed next to a specified set of subsistence. Crossings between accounting and subsistence set a condition for this, turning objecting subsistence into a specific tension of the demand chain and a particular

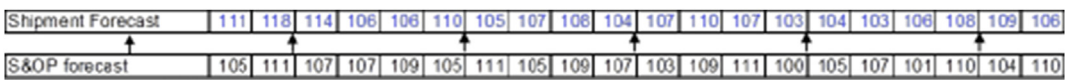

Fig. 3. A numerical example of LTASB forecasts transformed from the adjusted S&OP sales forecasts.

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Table 3
A summary of crossing points that enact the 'demand chain'.

Crossing points	Supply shortage	Composition of the market	Product and customer variations	Average customers	Planning Rhythms	Capacity constraints	Internal customers
Subsistence – objections	Empty inventories; lost customers; complex delivery; multiple calculative agents	Customers' own voice; difference between what customers said and did; general market trend	Product volumes, growth, novelty, value; customer heterogeneity	Medium to long term production and machinery needs	Material families; product hierarchy; intermediary stocks	Excess customers in the market	Inter-factory network; internal customers; lead time of transporting products across continents
Tension of coordination/related coordination concerns	Customers not served by operations /How do we link supply to demand?	Particularity of customers not compatible with generality of market trend/How do we link customers to the market?	Too many types of customers and too many types of products make forecasting complex. /How do we relate customers to products?	Investments plans hampered by erratic customer requirements /How do we relate production to sales?	Average customers at odds with daily product line planning/How do we organise the planning rhythm in production?	Current customers drive out potential customers./How do we relate sales to production?	Internal customers not included by sales/What is full capacity?
References – coordination models	36 months uncon strained market-based sales forecast	36 month market-based bottom-up forecast	A, B, C, D, E products contributing 30%, 30%, 20%, 15% and 5% to revenue (annual)	36 months unconstrained market-based sales forecast based on minimised mean error from the previous 12 months	Factory forecast (daily); Order book; bill of materials; capacity constraints	Constrained 12 months sales forecast; unconstrained 12 −36 months market-based sales forecast	Constrained 12 months shipment forecast; unconstrained 12−36 months market-based shipment forecast

coordination concern (refer to the row of 'Tension of coordination/ related coordination concerns' in Table 3), transforming coordination tensions into decision models.

This completeness is relative because the demand chain is enacted as multiple managerial tensions. Accounting translates subsistence into individual, and scattered, decision problems. The general question of coordination is therefore delegated to a set of only weakly coupled situations, each of which is *internally* coherent. Multiplicity happens because, while the scattered situations may be coherent, the demand chain is not – it keeps espousing new subsistence to leap in between situations. For instance, while serving the purpose of medium to long term capacity planning, the 'smooth' forecast was opposed by product line planners because it did not consider the realistic customer. The 'smooth' forecast creates comfort in one situation but turbulence elsewhere. This dynamic is a consequence of accounting being both performative and provocative. As a source of performativity it turns each objection into a *relevant* tension and a *specific* decision model, making the demand chain function in a certain way. As a force of provocation it helps new objections to emerge against what accounting reveals about the demand chain, adding new accounting models to existing ones. This process may be 'generative' (Busco & Quattrone, 2015, 2018) but its resolution is hardly the result of managerial creativity and political compromise (Giovannoni & Quattrone, 2018). Rather it is the accumulation of decision models that discover and organise coordination problems because of continuously emerging crossing points.

The finding that forecasts both add and organise coordination problems suggests nuanced insights about forecasting and demand chain management generally (Vollman & Cordon, 1998; Vollman et al., 2000) and S&OP processes specifically (Grimson & Pyke, 2007; Lapide, 2005; Shapiro, 1998) in relation to lateral coordination of interdependent organisational functions (Atkinson, 2009; Tohamy, 2008). It is important to maintain the general idea that the market guides sales and production planning activities, but managers engage with many things that mediate relations between production and market. These various realities enact their own relation with customers, production, products, capacity, and so on. The translations shown in Table 3 illustrate that none of these realities exists passively. In effect there are multiple forecasts, each of which takes one particular concern into consideration. The effect of this delegation is both to deal with the present concern and often also to produce other concerns, as they draw attention to other subsistence. Therefore, the coordination problem is enduring, but simultaneously complete forecasts enable managers to settle each situated tension relatively *independently* of others.

6.2. Accounting and simultaneity

It takes efforts to make delegation tolerable and operational. The first effort is to understand time as simultaneity (Latour, 2005), instead of as succession. Simultaneity relativises distinctions such as short term and long term, and translates such temporal relativity into spatial co-existence. Various long terms, medium terms, and short terms are enacted and differentiated along the demand chain as different tensions (refer to Table 3) that make the orientation of the time–space coordinates of the forecast variable. The passage of temporalities is therefore not primarily a matter of progression. They are all contemporary and simultaneous in the enactment of the demand chain. This shows that lateral coordination, which the forecast is expected to bring, is an effect of spatial and temporal work (Corvellec et al., 2018).

As shown, simultaneity means that accountings accumulate and cohabit. Each may function in its own setting and it neither substitutes (Andon et al., 2007; Chua & Mahama, 2007) nor competes (Mouritsen, Hansen, & Hansen, 2009) with other accounting(s). The success of one accounting does not depend on the failure of another. This is related to the multiplicity of the demand chain, wherein all enactments 'become contemporary' (Latour, 2005, p. 30). Simultaneity happens because each crossing point develops a specific time–space relationship between market, sales, factories, customers, products, and capacity, all of which co-exist in relation to the demand chain. The generic market forecast – BCF – does not fade away; it is present in both product line planning and central planning. The adjusted S&OP forecast was not replaced by the LTASB forecast. Shipments were added to sales when there were an internal-factory network and regional warehouses.

Simultaneity requires *additions* of decision mechanisms. This helps coordination because each time–space relation resolves a particular tension as a forecast is mobilised as a source of handling worrying subsistence. Each crossing point discovers a new objection that presents another coordination tension and concern somewhere else, which is then turned into an additional solution. Simultaneity has many orders, many ways of making the demand chain work. A forecast helps to perform the discovery of emerging subsistence because each produces concerns for others, and the success of coordination turns out to be the degree to which concerns are tolerable.

This adds to accounting research that sees accounting instruments as providing coherence in action at a distance (Miller & Power, 2013; Robson, 1992). The study proposes that while one tension may be organised by a centre of calculation, other streams of activities that are difficult to bring into this centre are dealt with by other centres. There are actions on simultaneous various distances. Existing research also proposes that accountings may compete in political games for influence (Edwards, Ezzamel, Robson, & Taylor, 1995; Mouritsen, 1999; Mouritsen et al., 2009; Preston et al., 1992), and then, as shown by this study, to a certain degree it is also possible that different accountings can be tolerable when they perform parallel activities to those of others (crossing points). Therefore, it is 'pertinent to trace continual changes in loci of control' (Quattrone & Hopper, 2005, p. 760) to emphasise not only the changes in controls but also their multiplicity. While a forecast attracts objections, the accumulation of forecasts increases the number of enactments of the demand chain. Objections are made tolerable through the simultaneity of accountings. This is what simultaneity does: it performs *many streams* of decision activities.

6.3. Accounting and relative completeness

The second effort to make delegation tolerable is to create completeness of accounting in each situated enactment of the object. The demand chain multiple is realised by many crossing points, each of which specifies a particular cumbersome subsistence, a manageable tension, a decision model and resources required for handling such a worrying situation. Completeness, therefore, translates subsistence into articulated decision procedures that handle subsistence; it juxtaposes reference and subsistence. This completeness functions until another (absent) subsistence emerges and objects to an existing decision model. In this sense, accounting helps to *complete* the demand chain by providing each of its situated enactments with a decision mechanism.

This sense of completeness is present in Corvellec et al. (2018), who arrives at a similar conclusion when studying how accounting invoices produce proximity between economy and environment. Such 'distance' work produced by accounting is complete since users at many levels from individual residents through to local governments formed a coalition between the two otherwise

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opposite entities, money and environment. Money and environment were made the same thing through an accounting invoice that calculated the cost of not being environmental. Similar things happened at each crossing point at EuroTech. Here, a relation is formed between subsistence and accounting, which are brought closer to each other. Compared with Corvellec et al. (2018), the case of EuroTech illustrates that delegation also breeds additional objections that point to yet other coordination concerns. As shown in the empirical analysis, complete accounting is relative in the sense that sealing off of one time–space may provoke resistance from other time–spaces because any particular decision mechanism is relevant only to *a* particular situation; it does not stop other objections. For instance, at crossing point 4, while sales and GDC were satisfied with their average customers, factories did not want to bear the burden of the average customer disrupting their daily line product planning at crossing point 5. Coordination is, therefore, an enduring process to discover tensions and to produce situated decision models.

Relative completeness provides some nuances to insights contributed by the literature on accounting incompleteness and instability (e.g., Ahrens & Chapman, 2004; Busco & Quattrone, 2015, 2018; Chua, 1995; Dambrin & Robson, 2011; Jørgensen & Messner, 2010). This literature suggests complementing work around accounting, for instance, strategising, institutions, politics, dialogues, and so on, to make the incompleteness of accounting less straining. It is based on the premise that managers have, or develop, a reservoir of extra knowledge about the absent realities they can apply to contextualise incomplete and unstable accounting so that accounting and other accounts, such as 'strategic and operational arguments' become 'highly compatible' (Jørgensen & Messner, 2010, p. 188). The problems facing mangers at EuroTech are different. They insist that the forecast helps enact a world of moving things and knowledge. Instead of relying on managers' sense making (e.g. Ahrens & Chapman, 2004, 2007; Jordan & Messner, 2012; Jørgensen & Messner, 2010) or creativity (eg. Busco & Quattrone, 2015, 2018; Giovannoni & Quattrone, 2018) that invites *other* things to help move accounting along, they propose that accounting be actively bent towards objections and decisions; they require that accounting keep adding objections and decision mechanisms upon objections; it is these *additions* that re-organise the many and variable relations that shape an object multiple.

7. Conclusion

The case of EuroTech's sales and operations planning (S&OP) process explains how accounting, in the form of a forecasting procedure, produces decision mechanisms, which in turn create managerial attention to an object, the demand chain. Over time, accounting gains properties, partly because the multiplicity of the object in question reveals new subsistence and partly because accounting provokes new subsistence to appear. In this account, accounting plays an active part in the enactment of the demand chain multiple and its coordination. The study follows the inter-related movements of subsistence of the demand chain and of forecasting, and it finds, firstly, that there is a movement from accounting *of* to accounting *for* the object. The power of accounting here is not merely an observation that accounting is constitutive, but how it becomes both performative and provocative; not only that it makes territories visible, but how visibility becomes a resource for decision making and for discovery of new subsistence that will require new decision models. This happens because of the concerns with lateral coordination. There is a movement from time as succession to time as simultaneity. This happens because there is accumulation of accountings, each of which helps enact its own reality of the demand chain. Each can operate more or less independently of each other. Yet each provokes objections, which in turn makes present other absent subsistence and adds to the multiplicity of the demand chain.

Secondly, there is a movement from accounting incompleteness and instability to relative completeness; from contextualising one incomplete accounting with complementing work to many complete accountings, each of which has a strong sense of formation and is an 'engine' of change. This happens because there is emphasis on accounting for *a* situation, which requires a specific decision model. It is about the condition under which one is able to rely on accounting. This completeness is also *relative* because it only functions in a particular situation. It is an important mechanism to make multiplicity tolerable and acceptable. Tolerability is achieved through accumulation of simultaneous accountings, and acceptability is realised via provision of relatively complete accountings. Absence becomes material when it constructs specificity and discontinuity. Specificity requires juxtaposition – proximity – between enacted realities and accounting (completeness) whilst discontinuity requires separability – organisation – of different enactments (simultaneity). This is neither a compromise nor a sacrifice because different decision rules cohabit in their various enactments of the object multiple.

Understanding accounting in performing simultaneity and relative completeness has implications. When multiple calculations create *a*centre of discretion (Andon et al., 2007; Quattrone & Hopper, 2001, 2005), simultaneity and relative completeness ensure that multiplication and organisation of the *'a'*s are tolerable. Here, *a*centre of *discretion* is translated into *co*-centres of *actions.* Future research may consider further exploring the dynamic relations between the performativity of accounting and multiplicity of objects because there may exist other relations between accounting, managerial actions, and enactments of an object multiple.

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