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from the UK chemicals industry**

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Reconciling Visions and Realities of Virtual Working: findings from the UK Chemicals industry

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Abstract

The emergence of advanced technologies such as Grid computing will, some suggest, allow the final realisation of visions of virtual organisations. This will, according to its advocates, have entirely positive impacts, creating communities of experts, increasing flexibility, reducing the need for travel and making communications more efficient by crossing boundaries of time and space. Such predictions about future patterns of virtual working are, unfortunately, rarely grounded in real working practices, and often neglect to account for both the rich and varied interpretations that may exist of what constitutes virtual working and the constraints and concerns of those who would do it.

This chapter gives attention to the consequences of different views over what virtuality might mean in practice and, in particular, considers virtuality in relation to customer and supplier relationships in a competitive and commercial context. The discussion is based upon a three year study that investigated contrasting visions of what was technically feasible and might be organisationally desirable in the UK Chemicals industry. Through interviews with managers and staff of companies both large and small that research provided insights into the different meanings that organisations attribute to the virtuality of work and to the acceptability of potential implementations of a middleware technology. It was found that interpretations of virtuality amongst the potential users and participants were strongly influenced by established work practices and by previous experiences of relationships-at-a-distance with suppliers and customers. There was a sharp contrast with the enthusiastic visions of virtual working that were already being encapsulated in the middleware by the technical developers; visions of internet-only interaction were perceived as rigid, alienating from well-established ways of working with suppliers and customers and unworkable.

In this chapter we shall capture these differences by making a distinction amongst competing interpretations of virtuality and we suggest the centrality of issues of trust, security, the importance of the local context, and an understanding how the virtual is embedded in the non-virtual.

Introduction

Virtuality, the virtual world and the virtual organisations are terms that are frequently, loosely and sometimes too narrowly used to describe the complex interactions occurring where physical presence is impossible, restricted or deemed unnecessary and so presence is provided by advanced information and communications technologies (ICTs).

Virtuality or places that humans have no actual ability for physical presence have been always areas of interest as Nguyen & Alexander (1996) explain:

“Despite the stubborn resistance of our limited physical bodies, we have long tried to explore, and set up as real, domains beyond our immediate senses. As a civilization, we have learned to live with many virtual realities. Think of the molecules and atoms of our physical and chemical structure. Think of the virtual reality of this pulsating universe measured in light years and sprinkled with black holes and supernovas. We have learned to find compelling the virtual reality of other people’s suffering across oceans and time zones. Our TV screens display everyday the contemporaneity of all possible human experience.” pp. 100-101

However, despite our familiarity with technologies such television, when we explore the concept of virtuality in a specific context then the boundaries between the virtual and the real are not so clear; many authors have tried in vain to discover organisations that fit any pure definition of the ‘virtual organisation’. This is disappointing since virtual organizations, enabled through extensive use of new electronic technologies, are often justified on the basis of improving the efficiency and profitability of business operations. Efficiency arguments are supported by reductions in paper work and the need for travel. Effectiveness, it is argued, will be achieved by promoting possibilities that were difficult if not impossible before. For example, virtual teams composed of experts from around the world, may be engaged continuously in a project while remaining in their home countries and never meeting in person. Why then are actual virtual organizations so elusive?

We suggest firstly that the consequences of virtual working are complex, having contradictory implications and different meanings across individuals in differing or even similar organizational contexts. The very same things that promise efficiency may inhibit acceptance; the distantiation in time and place that allows the virtual team from around the world to work together brings also a loss of the personal that engenders loss of trust and an unwillingness to work together. Thus visions of the virtual organisation are difficult to bring into existence. Second, we suggest that advocates of the virtual organisation often fail to recognise that those they would convert to their vision are already working virtually to a great extent, and understand intuitively that working virtually must be integrated into existing organisational practices and take account of practical constraints.

In this chapter we introduce and discuss the findings from a large, UK e-science research project.. The GOLD project (Morris et al., 2004) built upon earlier e-science successes but was unusual in being focussed upon taking Grid computing beyond its use by scientists and academics and to explore its use for commercial ends. The intention was to focus upon the development, production and marketing of speciality, high profit margin chemicals. In this industry sector an economic case could be made that ‘new ways of working based around dynamic virtual organisational structures’ were needed.

The GOLD project was inter-disciplinary with the research team consisting of computer scientists who were investigating the development of computer middleware, chemists and chemical engineers looking at required R&D and manufacturing processes. The authors were involved as part of an investigation into the chemical companies' requirements and to raise awareness of the social implications of the use of any developed technologies. From this emerged findings that confirm some previous work on virtuality but also emphasise the importance of existing practices and norms in determining what visions of virtuality might be possible.

In the initial stages of the project the meaning of virtuality was socially constructed amongst the project team, and heavily influenced by the technical team's view of what the technology would allow.. These views of virtuality, and of how the chemical companies might form virtual organisations relied upon the literature concerning virtual organisations and were formed in isolation from any knowledge of existing work practices and attitudes towards technology in the UK chemicals sector. And in some cases the agenda was driven by what seemed most interesting to research. For example, at the start of the project there was an interest in enabling high security communication between anonymous parties. As the authors discussed those visions of virtual organisations and interactions amongst companies with the industrial partners they were able to feedback to the technical teams a greater understanding of what might actually be acceptable, leading to changes in emphasis and intent. It was clear, for example, that there would never be any need for communication amongst anonymous participants and security requirements within the sector were lower than had been imagined or hoped-for. Thus, the visions of virtuality that the technology would support were radically different at the end of the project from those at the start.

Virtuality: Meaning and 'real' implications

There are extensive and numerous definitions of the terms 'virtual' and 'virtuality', ranging from purely technical interpretations of the term to the more socially orientated. For example Schultze & Orlikowski (2001) discuss existing perceptions of virtuality by using the 'metaphorical' elements in the definitions of virtual organisations as: platforms, spaces, bits, communities and networks. They point out the linguistic ambiguity of each metaphor and the consequences it entails for researchers to adopt a metaphor over another. Despite the increased hype in recent years on the emergence of virtuality, there are current accounts which urge to examine the range of intended and unintended consequences of virtual work. Watson–Manheim *et al.* (2005), for example, reflect on the concepts of continuity and discontinuity in virtual work environments and suggest that the implications from virtual technologies both facilitate and hinder people in day-to-work practices. Woolgar condenses the learning from the ESRC project named 'Virtual Society?' to produce insightful accounts on the nature of virtuality grounded, by and large, on empirical findings (Woolgar, 2002). Woolgar (2002) captures the essence of these studies by identifying what he defines as 'five rules of virtuality', explaining that these rules are not produced to be followed in any deterministic sense but, quoting Garfinkel, as 'aids to the sluggish imagination' (p.14):. Those rules are used here as a framework against which to present some of the findings of the GOLD study.

The uptake and use of the new technologies depend crucially on local social context

Woolgar (2002) refers to the adaptability of virtual technologies beyond their technical dimension and their relevance to the social context in which they are implemented. Technical capability is one aspect in the implementation of virtual technologies but not the only one and cannot explain the use or non-use of such technologies. A series of examples are discussed which put a cautionary note on the universalistic nature of current arguments about the use of virtual technologies, see (Wyatt et al., 2002, Liff et al., 2002). This message was strongly supported by the GOLD research, where, in the UK Chemical industry, the particular and the local proved to be of prime importance.

For example, the need for accountability over Health and Safety issues, even where the manufacturing takes place thousands of miles away, is done by another company working under different local laws, regulations and expectations, is essential. As one manager told the researchers, he would never trust what his partners told him about safety in a manufacturing plant unless he had looked them in the eye and seen the plant for himself. No virtual presence or other form of interaction could substitute.

The fears and risks associated with new technologies are unevenly socially distributed

Empirical findings from the financial sector have indicated that narratives about new technology can be in the form of future shock stories or ‘emperor’s new clothes’ stories (Knights et al., 2002). Woolgar (Woolgar, 2002) describes this as “... *the transformative power of expectations about, and performance of, technological artefacts in social action.*” (p.16), such that perceptions about new technologies rely heavily upon the interpretation of social actors

Our own research gave little insight into whether differences might exist between social classes because the social differentiation between actors was narrow. All the participants in the GOLD research were of the professional managerial class, well informed and educated; in addition, their training as chemists and chemical engineers was common despite their varied national roots. Furthermore they were experienced within an industry that has and continues to undergo aggressive reshaping globally, so that they knew, sometimes had already felt, the transformative effects of technological change. .

What the GOLD study did find was that some expected differences did not occur. An example of this was that the technical teams had, on learning that the managers made relatively little and unsophisticated use of IT come to the false conclusion that they were technologically backward; this would perhaps lead to difficulties in their understanding virtuality and what might be achieved through the technology.

In fact, the GOLD study found that the managers had very little difficulty at all in understanding working at a distance with parties they had no social interaction with; this is what they routinely do as their job and had done for many years. Those managers simply wanted to know if the technology might allow them to do it more easily and better.

Virtual technologies supplement rather than substitute for real activities.

Woolgar (2002), aiming to criticise the extensive claims of substitution made by virtuality enthusiasts, provides evidence indicating that ‘old’ non-virtual practices often co-exist with new, virtual practices. Furthermore, there is the emergence of new interactions that are the result of this novel mix between traditional and virtual, for example ‘I’ve just sent you an e-mail’ discussions in the workplace (p.17). The empirical

findings that this rule is grounded on are from domains such as those of education and social support where virtual activities supplement rather than substitute existing learning and social support activities (Crook and Light, 2002, Nettleton et al., 2002).

The GOLD research, taking place in a very different setting, suggests that substitution could take place. For example, one interesting issue lies in the communication of intellectual property and commercially valuable process information. Currently, non-disclosure agreements are required before details of manufacturing procedures are discussed with potential partners and the documents themselves are hand-delivered. There was though no reluctance to adopt secure electronic transmission if every access to the material and every stage of the transmission were scrupulously audited and if new facilities such as 'your-eyes-only' emailing could be introduced. With such safeguards then substitution could occur.

The more virtual the more real.

Woolgar (2002) suggests that virtual technologies frequently have subsequent 'real' consequences on day-to-day practices, echoing previous concerns on the transformative claims of virtual technologies regarding the need of travelling and face-to-face interactions e.g. (Moss and Townsend, 2000). The emergence of teleworking, for example, increased the need of travel since teleworkers, assisted by advanced communications technologies, were able to contact more customers and thus increase the need for face-to-face visits. Other examples include the increase for phone calls and letter writing (Nettleton et al., 2002) and the increase of informal contact versus the formal perception that e-mail communications engender (Brown and Lightfoot, 2002).

We found no support for this assertion in our research, possibly because of the particular nature of the speciality chemicals business; with the specialised equipment needed for handling sometimes dangerous production processes the number of companies able to produce a particular product is necessarily small. New and virtual ways of working will, in this industry, alter the forms of interaction amongst existing companies but are unlikely to generate an increase in the number of active parties or increased face-to face-contacts.

The more global the more local.

Drawing on the empirical work, including that of (Hughes et al., 2002) Woolgar (Woolgar, 2002) suggests that it is frequently local efforts and existing ways of working that make new technologies work at a global level. In the context of a retail bank Hughes *et al* (2002) discovered that, contrary to existing arguments, instead of needing new skills and novel working practices to become a global or virtual organisation, actors make great efforts to 'fit' new technologies into the existing day-to-day work practices.

This was strongly confirmed by our discussions with chemicals companies and their representatives. There was an overwhelming consensus that given the tight margins and somewhat precarious survival of many firms there could be no gambling on new IT driven initiatives; only where it could be seen that new methods of working would give commercial benefits at low risk would the technology to support such new ways of working be considered. And where benefits could be most easily seen was in the small, local tasks that required to be done, such as the secure communication of sensitive documents and contracts. Suggestions of 'broadcast tender invitations' and other changes to the macro level ways of conducting business were dismissed immediately.

Changing interpretations of the virtual

One of the most interesting results of the GOLD study was the insight gained into how greater understanding of how the managers in the S&F chemicals industry operated in and understood their world led to changes in the GOLD team's visions of what virtual working in that industry might be like.

It has been said that it is very hard to remember what we once did not know, and in most research projects the knowledge of how appreciations of 'the problem' change is lost. In the GOLD project though the authors were careful to record wherever possible the way in which the team's perceptions of requirements and of what virtuality might mean changed over the course of the project. In some cases the differences between ideas early in the project and later were quite marked, and the eventually created technical artefacts were of a different kind.

Following some explanation of the GOLD project, it is to these changing visions of virtual working that we shall turn our attention.

The GOLD project

The GOLD project was an EPSRC funded e-science project that aimed to develop Grid middleware as the enabling technology for dealing with trust, security, lifecycle and information management in highly dynamic Virtual Organisations (VOs). It could therefore be seen as aiming to create technologies that would virtualise the non-virtual

The potential application domain for such technology-facilitated, inter-organisational working is wide, for example in construction, electronics, and the military sectors. The chosen area for the GOLD project was the production of speciality and fine (S&F) chemicals, these being chemicals produced in small quantities but having a high cost. In this sector the secrets of success lie in finding new but practical ways of manufacture, rapidly meeting unpredictable demand and adhering to very strict quality and delivery requirements; trust and security impose very stringent requirements and the sector could be seen as a critical case.

There were also good reasons to believe that the S&F chemicals industry would benefit from new and agile ways of working. This is a sector where the UK has only a modest \$9-12bn share of a \$250bn global market. The nature of the products means that much legal paperwork has to be completed for every inter-organisational collaboration and Health and Safety authorities, customs, even the police have to be aware of the movement of products between partners.

The traditional strengths for companies in this industry have been Intellectual Property (IP) protectable knowledge, a skilled workforce, plant efficiency, and good reputation. In recent years, however, the cheap labour and facilities in new economies have been used to reduce overall price to market, so that production skill and efficiency have become less important as factors for success. There is therefore increased pressure upon all to innovate to maintain their competitive advantage through *business intensification*: the ability to commercialise innovations more quickly than competitors. Previous attempts at virtual working claimed very significant cost savings of 92%, with time to market reduced by 66%. (Wright and Bramfitt, 1999, Wright, 2004). However, the experiment

was not scaleable. The information necessary to coordinate, manage and control outsourced activities in remote locations proved too large in volume and the necessity for ad hoc reconfigurations in response to external events and the evolving state of each project was beyond the capability of existing software platforms. Grid technologies were seen as the way to render this problem more tractable, offering sufficient and readily accessible processing power to participants, wherever located; the way is thus opened to transparent global interorganisational working, with outsourced R&D labs, safety assessments, chemical analysis, data analysis, pilot studies, manufacturing, marketing and distribution. However, moving to such new ways of working would have considerable implications for an industry where health and safety records and intellectual property rights play such a large role.

An interdisciplinary approach

Within the GOLD project were three main groups, working on six work packages. The groups were:

- The technical team of computer scientists and security experts who were creating the middleware and demonstrating its functionality. This work was the core of the GOLD project and would be the primary measure of success or failure of the whole project.
- A smaller group, called here the Chemical Team, were concerned with the application of the middleware to chemicals production, demonstrating the usefulness of e-science outside the academic community to which applications had, until now, been directed.
- A third and smallest group, the Business Team, were concerned with investigating the real-world opportunities and constraints of using the technology in a commercial setting. This group, based at the Management School at Lancaster University and to which the authors belonged, would feed back to the technical and chemicals teams relevant information gained from the S&F chemicals industry.

The work of the Technical and Chemicals teams has been reported in the relevant disciplinary journals and it is the findings of this latter group that are reported here. Those findings stem from interviews undertaken with twenty three organisations in the speciality and fine chemicals sector. Access was gained either through direct contact or through a respected professional association. At least one of the Business Team was present at every interview; in some interviews members of the Technical and Chemicals teams were also present. Interviewees varied from chemists, engineers on site to R&D, Operations, and/or IT managers and CEOs. The aim of the interviews was to understand the way in which business was conducted, the day-to-day activities of participants and discuss how virtuality might be implemented in a particular real-world setting. Interviews lasted between one and a half and three hours, were recorded with permission of the interviewees and later transcribed. The qualitative data analysis software Atlas ti was used to organise the themes emerging from the interviews.

Imagining the virtual

At the start of the research there was amongst the technical team a strong desire to pin-down and define exactly what was meant by a 'virtual organisation' and how such an

organizational form would operate in the chemicals industry. After all, they argued, how can we produce software to support it if we do not know what it is?

There followed several weeks of researching what had been reported in the literature, seminars, visits to knowledgeable academics and group discussions. Emerging from this came a vision of a virtual organization that could be most relevant to the chemicals industry and which the to-be-developed technology might facilitate. This was of the 'highly dynamic virtual organisation' formed swiftly and dissolved equally rapidly in which companies might co-operate on a production project even whilst being competitors in other contracts.

Such dynamic virtual organisations would operate within a 'common', secure virtual space, within which customers and suppliers of chemicals could log on, check prices of chemicals and initiate B-2-B collaborations. After the end of such collaborations the virtual organisation would be terminated. During the relatively short life of such collaborations, information concerning patents, formulas, intellectual property rights etc would be freely exchanged in a technically 'secured and trusted' way.

The role of managers in the new, virtual way working would be to monitor and control the operation of each virtual collaboration. Workflow management facilities could assist, since it was seen that every collaboration would follow the same set of pre-defined activities.

This then was the vision of the virtual that the GOLD team saw as being enabled by the new computing and communications technologies they were constructing. It was a credible vision well supported by the literature of virtual organisations and by real-world electronic business-to-business markets in other industries. While the technical teams carried out the preliminary work in creating the technology, the Business Team began their work of validating the vision and refining its fit to industry concerns. As the this strand of the research unrolled and the results were fed back to the technical and chemicals teams then the original vision of virtual working and the supporting technology were to change.

Validating the vision

The GOLD project had though from its outset been intended to be of practical benefit and so the feasibility of all of the above was to be tested against the requirements of industry. Firstly, because this was seen as a novel application of a novel technology conventional requirements engineering methods could not be used. Instead a set of required business activities was identified through use of soft systems modelling (Checkland, 1981, Lewis, 1994, Checkland and Poulter, 2006) . It was believed that even though virtual working was not presently happening there must be real-world equivalents of these activities already happening, albeit done in a non-virtual way. Understanding how these activities were presently done would illuminate what would be required of the new applications that the middleware would support. Second, it would be necessary to explore exactly how chemicals companies operated with customers and suppliers and what functionality they would most value. From this we might design Use-Cases that would help define the detailed functionality of any eventual technologies. For both of these a series of interviews were undertaken over a two year period.

Perceptions of work practices versus actual practices

In this section we contrast two views of work practices and possible virtual forms of those practices. The first view presents the assumptions made by the GOLD project. It was upon these assumptions and the vision of a virtual organisation allowed by those assumptions, that the middleware to assist virtual working was being created. The second point of view encapsulates the interviewees' descriptions of working practices, their ways of interacting with customers and suppliers and their understanding of virtuality. Table 1 summarises the key points of the discussion

	GOLD team	Managers and professionals in S &F chemicals industry
Pricing	Prices are public knowledge, key determinant of choice of partners	'Big Secret' of the industry, each price is negotiated and specific. <i>Set down initially verbally, only later in confidential contracts</i>
Trust	Trust was open to technical solutions of controlled communications and audit Trust invoked at discrete, temporary transaction level	Trust is at personal level, between individuals. Contracts are formal arrangements of relationship that does not happen without trust contractual penalties will never be needed. Requiring long term established relationships
Management	Managers seen as monitoring and controlling the operation of a virtual organisation, which could be workflow modelled. Business interactions and activities required in development and production repeatable and can be defined in advance.	Managers seen as attenuators of change. Major role to establish and judge trusting business relationships. Each relationship, project seen as idiosyncratically unique ICT seen as having no inherent attraction but merely as possible facilitators to existing and continuing requirements.
Locality	Being local is no necessity , an irrelevancy necessity in a virtual context	Locality of facilitating services paramount important
Travel	Virtual presence lead s to reduced need for travel	Essential to travel especially when nurturing new collaborators

Table 1: Differing interpretations of elements of virtuality

How do chemicals organisations really collaborate?

The GOLD study revealed that the ways in which chemicals organisations dealt with their customers and suppliers to be deeply rooted in experiential and professional knowledge of the managers in each organisation. Their perceptions of virtuality and plausible future patterns for work were closely related to context specific characteristics of collaboration; the strongest of these in the S&F chemicals area were price, trust, the role of managers, locality and need for travel. Each is briefly discussed below.

Price

Assumptions were made by the GOLD designers that speciality and fine chemicals had a price, and that companies might advertise publicly the price they were willing to pay or the price for which they were willing to sell. Based on that assumption the early thinking of the GOLD team centred around the notion of a virtual organization dynamically formed as the result of price bids. That is to say, a party would require partners to supply services or chemical raw materials for the production of a speciality product. That need would be advertised and the companies replying with the lowest priced bids would become partners in a short-term virtual company. The early ideas extended this to the idea that the advertisement of the need for partners might be done globally through a specialised electronic marketplace. This meant that the early thinking about the technical architecture and about security requirements was centred around that vision of what a virtual organisation might look like.

The interviews with managers soon revealed a far more complex process happening in the pricing of chemicals. As a commercial manager explained:

“ Price is the big secret of the industry. Many things indicate the final price of a chemical: who is the customer; what they want the chemical for’ how much profit they will make. You do not go round telling people how much you paid for your raw materials or how you are selling your products for. You are losing credibility in this way and get a bad reputation.”

This was a revelation; This was a global industry where the majority of the products were custom-made. The ‘ideal’ of a purely economical basis for virtual collaboration with customers and suppliers was simplistic and naïve.

Trust

A further misdirection lay in the technical team’s understanding of trust. The literature of virtual organizations had identified trust as important but the word was used for a considerable time before it was realized that subtly different interpretations were being used within GOLD, and by the managers in the S&F chemicals industry.

Within the GOLD researchers there were differing meanings attached to trust by the computer scientists, security experts and the business team. For the technical teams trust had its roots in the technical considerations of communication theory, which emphasizes the extent to which an individual may believe that a received message comes from the claimed sender, is the same message as was sent and was not intercepted.

Trustworthiness was seen as a property of the technology.

For the business team of GOLD, trust was a perceived relationship between co-operating parties Under this view then I might have every confidence in your message , that the message I receive is the one you sent, that no one intercepted and even that it is factually

true. But even then, I may not trust why you sent it. The GOLD team therefore early on began to differentiate between ‘trust’ and ‘business trust’.

The interviews with managers revealed further differences in the understanding of trust. Trust, as explained by many managers, in the everyday operations had largely a social rather than a technical dimension. Trust was repeatedly described as a relationship based on long-term knowledge of other individuals within the industry and personal judgements on the professional capabilities of others to perform. One CEO tried to explain the process he follows to trust others:

“... I think if you know somebody a lot and you have an experiential relationship you can look at your experience and decide how many times has that person disappointed you. I think there is another level of trust when you are looking forward and people normally need to be able to codify the information you are giving them in their own matrix. So, I come along and say we need to work on this and this will make loads money. Firstly, you will be thinking the issue of being credible in believing in this idea and secondly it is sharing the benefits of the credible, what evidence do I have for that? So I think there are a lot of value judgments that happen that are either made, or that are chucked away and destroyed because they are not credible nothing to do with the purchase. Too good to be true or completely not understandable... Then it does not start. It is a complex issue. “

And, the words of the Vice-President of a multi-national petrochemicals organisation emphasised the importance of knowledge and trust in specific individuals, a

“In this industry, you deal with individuals. You have a long-term relationship that takes a long time to build; ten years at least I will say. We do not follow companies, we follow individuals. That means, if a trusted person moves from one organisation to another we follow the person not the company.”

Such a basis for collaboration was a long way from the purely economic criteria for collaboration that underlay the GOLD team’s early vision of a virtual organization, where the rational economic manager would promiscuously rearrange relationships with whoever at that moment offered the most economic returns.

Managers and managing

The role of management was also very different from that which the GOLD team expected in a virtual environment; though it was some time before this was realised. Even two years into the project there was still discussion of workflow management being a core activity that the GOLD middleware would facilitate. Reliance on such software assumes that there is a given and pre-defined set of interactions to be carried out, with well defined exchanges of information and identifiable triggers and signals for when an activity can legitimately commence. The instantiation of this process and information model can then be monitored by software and alerts produced when there is deviation from an expected sequence or, say, one process has finished but the next has not begun. Managers in the S&F chemicals industries certainly did monitor progress and institute corrective actions. One manager expressed a robust view of what was required:

“And over the years, the one thing that you find out is that nothing happens unless you are persistently kicking arse and shaking people. And the whole world is the same. Our success, I suppose, is that because we get so frustrated at lack of action that we go out there (China) and kick arse. So we are pushing every day because unless you do...”

However, all the managers saw their role as unpredictable and different in almost every situation. Managers described that the majority of their time was spent on negotiations, face-to-face communication and making decisions based on their experience and personal judgement. This was perceived to be their job and the source of whether they were a good manager or not. Asking managers to have the role of monitoring and controlling the operation of a virtual organisation was alien in the context of chemicals organisation, and this dissonance between their experienced world and the vision behind some interpretations of virtual working could cause comments such as that given by one CEO that:

“Using new software to implement new ways of working is very stressful and you never get the job done. There is nothing relevant to the chemicals industry and we find the language alienating. New technologies will slow us down.”

Locality

The importance placed on locality was expected to diminish in virtual collaborations, but managers reported that, even with the more global working practices, locality was still seen as important. This was especially true in relation to facilitating services; in such things as legal disputes or dealing with local regulations it was important to work with local experts. It was not foreseen this would be any less true in future.

The creation and dissolution of contracts and contractual obligations was an area that, the GOLD team's vision foresaw as easily benefiting from new methods. Boilerplate contracts could be rapidly created, automatically tailored to the circumstances and then authorised virtually in order to speed up the process of creating new partnerships and operating arrangements. However, for the managers interviewed no assurances that there would be safeguards and auditability could convince them that they might ever work this way.

Travel

Travel was viewed as an essential part of their job. Despite the global nature of their organisations, managers repeatedly stressed the importance of meeting the people who they were dealing with, especially in cases of first time collaboration. This was justified partly upon trust and partly by technical need.

Trust, we were told, was built upon face-to-face experience of the other party; once established then as stated by one manager other things might follow:

“..For our key raw materials and key customers it all depends on face to face communication and building a relationship. Both with suppliers and customers. At some point you are trying to establish the personal contact and once you establish that you can try to do it via telephone, e-mail, do video-conferencing etc.”

Even where trust was established travel was required because many of the collaborations that these companies were involved in centred around some unique, innovative

production processes and there was the necessity to explain or interpret the underlying science or development process.

Conclusions

We have given in this chapter an overview of what was discovered when the GOLD project attempted to test out visions of virtuality against practice. The discussion is grounded in a single and somewhat specific context, that of the manufacture of fine and speciality chemicals and as such we cannot claim generality across different industrial sectors. The work does though provide support for previous authors' conclusions as demonstrated in respect to Woolgar's 'rules' of virtuality. In particular it supports that understanding virtuality in contemporary organisations requires understanding of the business contexts and norms of those organisations. Beyond this it illustrates how those contexts and norms lead towards differing visions of the virtual. In the GOLD project the two groups, researchers and managers, were separated not merely by differing knowledge (though this was the case too) but also by different assumptions about how persons and organisations interacted now and might interact in the future. The lesson is not that good developments require good requirements analysis; software engineering is built upon that truth. Instead, the lesson is that in situations such as that of the GOLD project the requirements do not exist; they are emergent properties of the dialogue between the parties. As such they will be born partly from past practice and partly from visions of what is technically feasible and what is practically feasible.

This is most significant for considering future developments in the F&S Chemicals industry when coupled with another finding from the GOLD project, namely that virtual working is more readily acceptable than might be supposed. For the managers in the project the concepts themselves were not novel; through telephone, fax and simple email they have worked globally for the last thirty years, frequently working with partners with limited contact and in different time zones. They could readily judge the potential usefulness or otherwise of technical artefacts enabled the GOLD middleware.

It would seem therefore that the route to novel virtual working practices, perhaps to virtual organisations becoming commonplace in the F&S chemicals production, may lie not through immediate adoption. Already several attempts to establish B2B electronic markets had failed. Instead it seems that where some new facility (be it secure document transmission, automatic audit trailing of messaging or whatever else the GOLD middleware enables) is useful it would be adopted. Gradually and over time this accretion of changed practices might move the industry towards something resembling the visions of virtuality in the literature. For the managers this would be no sea-change but merely an extension of current practice.

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