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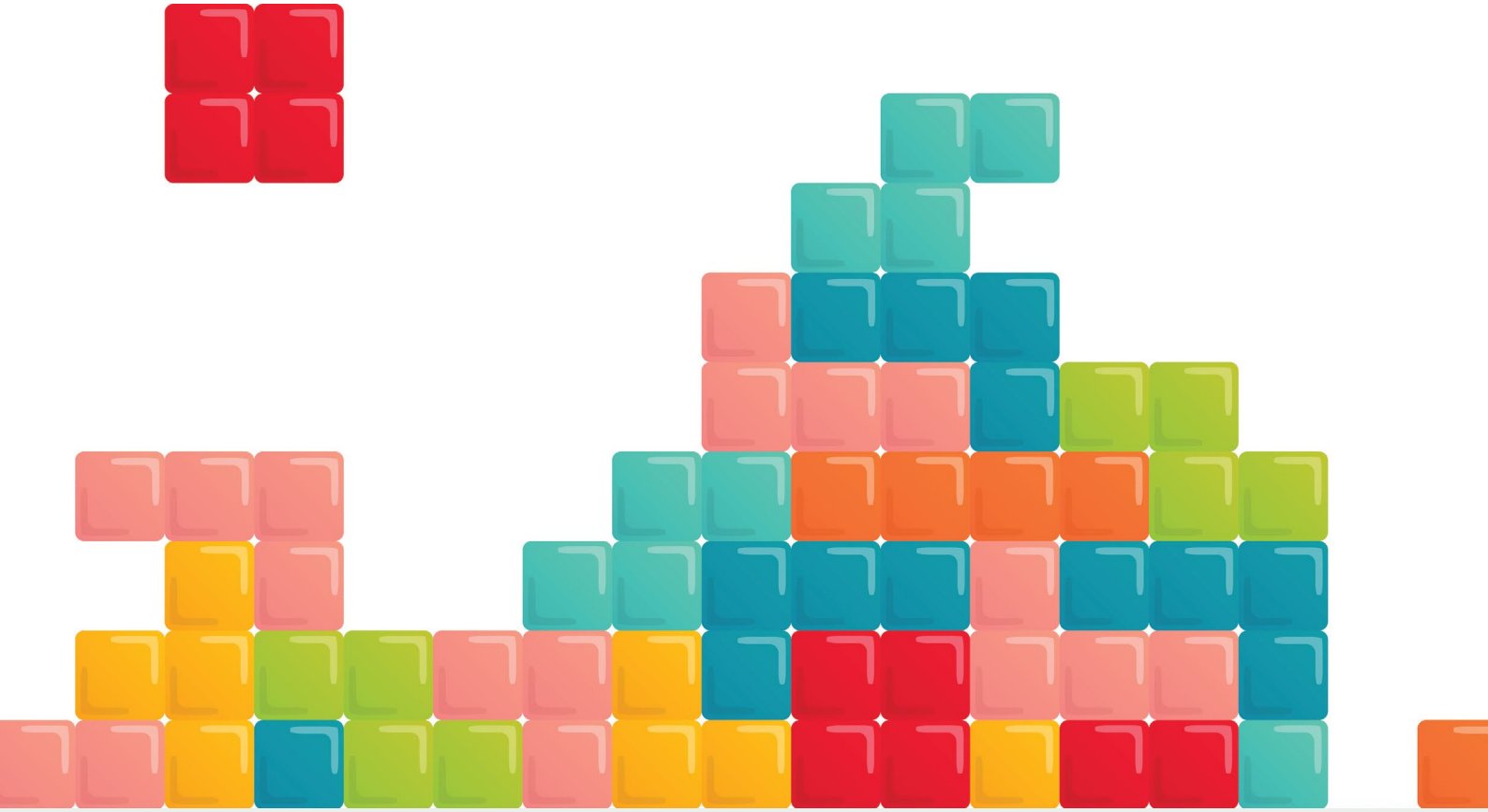
Innovative Decontamination Solutions



Collaborative innovation from the perspective of decontamination of surgical instruments

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Introduction

Innovation, by definition is a commercial implementation of a new idea – be it a product, process, entire technology or service. In a broader sense, it is a driving force standing behind development and progress following the idea - generating research, both academic and commercial.

Decontamination starts with surgical instruments and is all about surgical instruments – making sure they are safe to use during every surgery. Decontamination of surgical instruments is a complex task where various disciplines of science and engineering intersect. Developments in medicine and the world of surgical techniques provide overarching direction but effective decontamination needs to combine insights from many other fields of science like microbiology, chemistry and engineering.

Because of the growing levels of research specialisation, as well as complexity of issues, the true progress will require a collective effort – collaboration. It is not only about instruments becoming more complex. Our knowledge and understanding of infection processes, discoveries of previously unknown threats like prions and drug resistant microorganisms force the need for collaborative innovation.

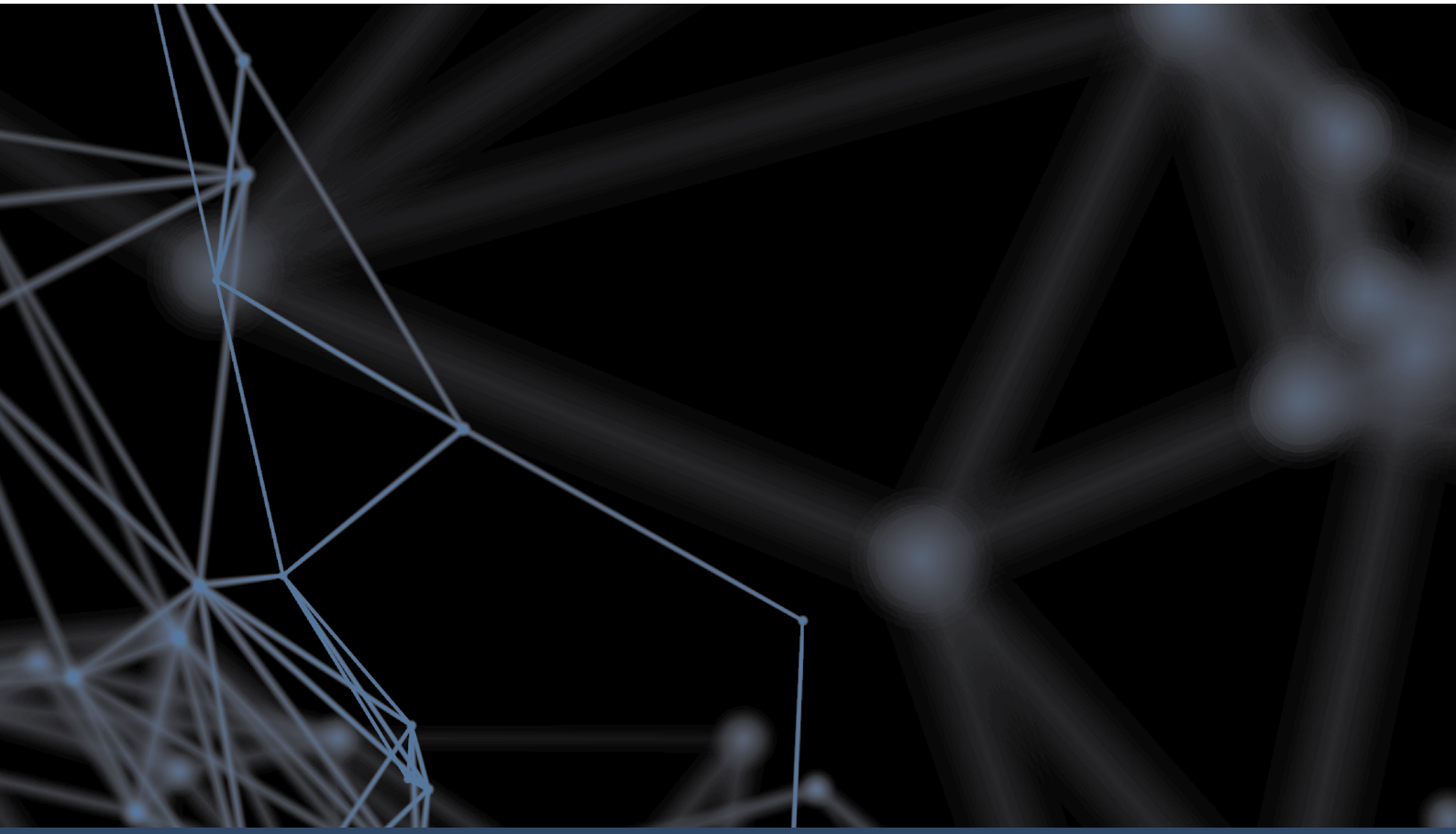
This is especially important at this intersection of disciplines and critical for surgical instrument manufacturers who can deploy it towards better products, proactive troubleshooting and solution finding. With the understanding of the intricacy of the entire mechanism surgical instruments manufacturers become natural hubs of information exchange between medicine, engineering and science.

Part 1 – Networks and Networking in Decontamination

Networks and networking seem to be the words in fashion when professional and business relations are considered. A shift is happening in the way we work, we search and gather information and also in the way we make our decisions.

Technology allows us to communicate everywhere with everyone, the boundary between what we do offline and online is more blurred by the day so this change must also – unequivocally – alter our behaviours.

Whether we like it or not - we are networked. Networking is widely misunderstood as random business card swapping at events with bad food and meaningless conversations. However, the strength of one's network is not measured by the quantity of business cards one holds, but reliable connections that – when needed – provide relevant and reliable information. One has got to understand the intricacies of networks first and learn how they work, to be able to effectively explore them and exploit. This is an attempt to translate the network theory based on the literature on the subject and results of my own research on networks in the Decontamination Sector to practical understanding and ability to make the most of these benefits that networks present.



Networks, what are they?

From theoretical perspective Malerba and Vonortas (2009:6) define networks as multidimensional concepts that cut across different types of actors, different types of scientific, technology and knowledge realms, and may touch on R&D, production and marketing. This is quite a comprehensive definition that not only shows the relative size of the phenomenon, but it grasps its complexity as well. What is missing here is the social dimension of networks that Gulati (1998:295) explains as a set of individuals linked by a set of social relationships of a specified type – social network. Networks therefore are free forms that may consist of sub-networks and at the same time be parts of even bigger ones. If that was not complex enough, they can be governed by different mechanisms, involve different actors and pursue different goals. I always look at them as circles of friends and colleagues one is surrounded with – they are all different, they are parts of bigger structures, they intersect and evolve in time.

Networking is a set of activities individuals perform within networks. Nohria cites one of the venture capitalists who claims that "the information one gets is only as good as where one sits and whom one knows". Therefore, networking can be seen as "actively building new and maintaining old social relations with a view of creating a vantage position in the flow of information" (Nohria 1992:244). So if one assumes that we communicate with others purely to obtain new and important to us information it does put us in the vantage position when we obtain it. We become a source others require.

Connections can be categorised based on the strength of bonds and the functions they play. Networks are environments where social capital and network resources operate mechanisms of trust and credibility. Networks thus become sources of information, knowledge and in consequence opportunities.

Inside your network – Strong and Weak Ties

Networks consist of various actors (individuals, firms, organisations) with different goals and different motivations for participation. Granovetter (1973:1362) introduces classification of network relations into strong, weak and absent ties. He argues that the stronger the tie between actors, the more common connections they have (Granovetter 1973:1362) which should not be a surprise as the longer one interacts with someone the more likely it is that their circles of contact will interact as well. Furthermore, strength of ties distinguishes between roles individuals play within networks. Strong ties tend to exchange information of greater complexity and higher quality, such as specific technical or scientific knowledge. Weak ties, on the other hand create strategic connections that provide access to other networks, information and resources.

Participation in the networks is usually associated with the search for information. Firms exploit networks to increase efficiency of its current resources, competencies and strategy. Additionally, firms may explore networks for opportunities and innovations in order to gain the competitive edge (Vonortas 2009:37). This can be easily transposed to individuals who learn, gather experience, browse for better job offers, better houses or cars and make strategic connections that give them overall advantage – the mechanism is very similar.

There is yet another element I wanted to introduce to the discussion on networks – Network Brokerage. It is about exposure to variation of opinions and behaviours provided by building connections across different networks (Burt 2010:4). Brokerage is directly responsible for diversity, progress and innovation. Imagine a small network of microbiologists where one of them gains access to engineering R&D. This person becomes a broker that if used well can open doors to many new opportunities. Network brokers create bridges across networks. They are usually regarded as weak strategic ties. Rich diversity of connections becomes an indispensable source of opportunities (Granovetter 1973:1378).

Social Capital and Network Resources

According to Bourdieu social capital can be described as "the sum of resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of relationships of mutual acquaintances and recognitions" (Bourdieu 1992:19). Social capital is therefore based on social relations, Granovetter's ties, and is rooted in social networks. In NHS structures social capital may be shared between individuals and their functions. This happens when particular person who one might have a contact to represents a particular position within the NHS.

Social capital is the property of relations between individuals (Gulati et al. 2000:210). Organisations tend to turn individual relations into network resources through multiplying relations between individuals – creating multilevel relationships. However, relationships between firms and organisations may still exist as relations of individuals.

Trust in theory

When relations are analysed, trust is identified as the primary building material. Barney and Hansen (1994) distinguished between the trust that is an attribute of the relation and trustworthiness an attribute of an individual involved in the relationship. Trust "alleviates the fear that one's exchange partner will act opportunistically" (Bradach and Eccles 1989:104).

Trust is an attribute that is directly related to the evolution of relationships and networks because trust relations evolve from social interactions (Granovetter 1985). Position in the network, as well as the strength of ties, may stimulate trust (Krackhardt 1992).

Similarly, common values (vision or culture) cement relationships and increase the level of trust (Ouchi 1980:138). Trust becomes an antecedent of cooperation (Gambetta 1995) as through the past performance and referrals, one builds credibility over time (Townsend 2012: 49).

Networks change in time

Ramos argues that every firm (and organisation) is a network (2012:14) that exist in the net of relationships (2012:15). There is an emerging trend of change within organisations from the hierarchical system built on "overabundance of demand and limited supply" towards customer oriented structure. Power is not based on status but the role individual plays in providing value to the customer, one in possession of the scarce resource – money (Ramos 2012:17).

In Decontamination Sector the customer is sometimes difficult to identify; from the sterile services point of view the customer may be the patient but from the firms' supplying sterile services the customers may be the hospitals, distributors, healthcare trusts, etc. With such complexity, it is essential to understand the structure of one's network.

Enterprising exploration

Networks create conditions for innovation but require flexibility and attention to constantly changing environment. Participation in the network will provide sufficient feedback about changes and opportunities but one needs to be in a position to capture it. For this reason, actors participate in networking meetings to seek information – exploration mode. Firms look for direct business opportunities while individuals may seek vantage positions. Utilising their own experience and sharing knowledge through the law of reciprocity (Meisner 2012) allows the network to seek higher levels of efficiency.

Meisner (2012) advises to build assets in your network – these assets are trust and credibility that are based on past performance. These assets in turn produce referrals. In time weak ties become strong and a natural switch to exploitation mode occurs. That is when network provides rich content and maximises the probability of success.

This mode switching may occur cyclically over time, as goals and ventures change. It can also be observed that in time the position in the network changes. Exploration mode starts on the outskirts of the network. Gradually trust is built and as progression towards the centre happens the shift towards exploitation takes place.

Networks evolve and with them functions of weak and strong ties. In decontamination networks the rate of change is affected by the omnipresent NHS, which due to its size and complexity is not prone to dynamic change. Additionally, actors in the NHS structure are assigned to static functions and their network positions are fixed.

Opportunities – where exactly are they?

Burt (1992) explained informational benefits of participation in networks through access, timing and referrals. Access in case of firms relates to the access to information about potential partners, their assets, capabilities and level of trustworthiness. This information comes from current and past alliances of potential partners who share the same network (Gulati 1998:297).

Individuals will see it as access to information about potential opportunities that would be coming from peers and colleagues. Timing refers to the availability of the above information at the right time, critical from the perspective of the efficiency of the network and competitive advantage of involved parties.

Referrals provide information, from indirect sources, about firms and individuals, based on their past performance with members of the same network. Referrals also include information on the market (Vonortas 2009:31), solutions of interest, jobs and even little things like special offers, etc.

Firms and individuals with strong capability of collaboration take advantage of access, timing and referrals to increase efficiency, reduce amount of redundant resources and allow for effective use of opportunities – basis for collaborative innovation.

Gravity of collective knowledge

Central position in the network enhances quality of referrals and information. In networks focused on collaboration information responsible for competitive advantage is widely available and enables innovation (Powell et al. 1996). Position can be used strategically in the search for information.

Furthermore, position of bottle neck resource holder grants power in terms of information distribution. That allows for the control over the knowledge that circulates within the network and control over the damage that knowledge spill-overs create. Like in the case when a secret leaks within a circle of friends – one is confident it will not get exploited. At the same time collaboration capability within the network benefits from the accumulation of collective knowledge (Breschi and Malerba 2005).

Trust and Uncertainty

Information is usually sought to reduce uncertainty (Granovetter 1985, Gulati 1998:295). Firms will look to reduce the risk of investments or strategic decisions while individuals will seek stabilisation, job security and financial independence. Networks provide a mechanism through which risks can be shared – thus reduced for individual actors. Shared research reduces cost for firms while shared transport, for instance, reduces commuting expenses.

Trust plays a vital role in this mechanism, as in both cases research would be shared only with the company that is trusted not to use the result against the other and it is also far more likely one will share a ride with someone trustworthy.

Trust also reduces transaction, contract and operational costs (Gulati et al. 2000:209) thanks to mitigation of anticipated moral hazards, as well as elevated confidence that ones' vulnerabilities will not be exploited (Barney and Hansen 1994). It simply means we are much more likely to cooperate with someone we trust, who is not going to use our weaknesses against us.

Trust and Collaboration

Networks enhance and allow to learn collaboration. As trust and credibility levels rise, so does individual competency to work together (Malerba 2009:18, Gulati 1999:403).

Trust is directly related to reputation within the network and cost of its loss prevents opportunistic behaviours (Gulati et al. 2000:209, Mitra 2012:72). It is, therefore, safer to operate within networked environment with established trust relations. Trust grows naturally within self-evolving networks, however in cases where network is largely built on existing structures with different regulatory mechanism in place like in case of NHS trust mechanism may be very difficult to implement.

Decontamination Network's Specificity

Trust was found to be at a very low level when networking for opportunities in Decontamination Sector was researched (de Sternberg Stojalowski, 2013). This phenomenon was surprising to me and I did not initially assume the problem to be so severe.

Trust is absent because of the omnipresent and overwhelming fear of opportunistic behaviours. Individuals as well as firms hold to their intellectual property tightly and through secrecy try to prevent negative effect of information spill-overs. Without trustworthiness there is also no possibility of mitigating for such occurrences.

The lack of trust turns to a vicious circle of maintaining only functional or transactional relationships that further inhibit its network governing capability. Functional relationships are formed when one party exist in the relationship because of their function in the network like in the case of NHS employees. Transactional relationships emerge on the basis of exchange of goods or services.

Both of these do not require trust to function. Similarly certain functions may occupy a central position in the network but it will not result in rich information transfer. As decontamination network is not self-evolving but built around NHS structure it is hard to predict what governing mechanisms play the most significant roles.

Trust is being gradually introduced by small networks that collaborate and form trust based relationships. They engage with the functional structures of NHS and the rest of non-trust based network. A prime example are consultants who provide services for or on behalf of NHS but are at the same time involved in trust founded networks of solution providers. In this case position in the network and credibility are not necessarily connected with trust.

Interestingly one could distinguish different types of trust relations. On one hand, an individual can be trusted as the source of knowledge or know-how but not necessarily in a business related issues and vice versa (de Sternberg Stojalowski 2013).

The bigger risk

Lack of trust has got one more, vastly detrimental effect – it directly inhibits innovation. Firms and individuals are not focused on exploitation of network resources and capabilities. Network actors do not learn how to collaborate and as a result entire sector suffers from stagnation. Decontamination is without a doubt a research heavy discipline and at the scarcity of funding inability to share resources and risks it will only increase the inertia.

I would go as far as claiming that in the grand scheme of things the risk of maintaining the status quo is far greater than the risk of breaking the mould and start implementing trust based networks that will engage different parties in collaborative innovation.

This discussion on trustworthiness is considered through individual behaviour, but it can be extrapolated to the organisational level, provided individual goals are aligned with organisational strategy.

Interestingly, my research also revealed that opportunities networks offer are not immediately apparent in decontamination environment. It is mostly because looking for opportunities inside of a network is not practised. Limited amount of trust between network members also contribute to this factor as naturally solutions to problems are not sought through the network but are being reinvented by individual parties. Firms fear their ideas and concepts will leak out and get "stolen", while individuals fear the exposure of their problems and ostracism. The recent emergence of online discussion forums like LinkedIn groups is definitely a step forward, however problematics are either discussed in too small networks or discussions are not explaining the problem to the core because of the fears mentioned earlier on.

Unutilised resources

Research revealed that networks provide access to key opinion leaders, experts and resources. (de Sternberg Stojalowski 2013). That would suggest that networks in Decontamination Sector mostly consist of weak ties who explore networks for information. Yet again limited trust prevents strengthening of ties and creating dense networks with rich content information exchange.

Informational benefits framework introduced by Burt (2010) applied to Decontamination Sector highlight the problem with lack of referrals. Referrals are very rare because lack of trust introduces fear of reputation loss. This causes the trust mechanism to be locked in a vicious circle of cause and effect. Lack of trust causes cascading effect of mechanisms that affect willingness to collaborate which in turn takes the opportunity of sharing risk and costs of development away (de Sternberg Stojalowski 2013).

The peculiarities of Decontamination Sector force implementation of different networking strategies and ability to manage social capital become the basis on which opportunities are seized. Understanding of processes and network characteristics is essential to first identify and then exploit opportunities.

Summary

Within the context of collaborative innovation the capability of using networks to find opportunities, organise resources and gain access to information and knowledge is of paramount importance. This capability is equally important to firm, organisations and individuals – it is only the goals that differ.

Lack of trust within decontamination network presents a natural barrier for effective use of it and directly hinders collaboration and entire sector's ability to innovate. Taking into consideration the amount of important problems the amount of academic research that is conducted to solve them is minimal not to mention the research that actually gets commercialised. Trusted networks would help sharing the cost and risk of research and allow companies to commercialise the output. Sterile services personnel would provide adequate feedback about problems and issues that become opportunities for those who can provide solutions. Such collaborative infrastructures have the potential to innovate decontamination sciences.

Gladly such networks emerge in the sector and collaborative innovations gradually enter the market. There is a great need for knowledge and information sharing if decontamination is to keep up with the advancement in medical technology.

In the next part, I will introduce the concept of a lead user, an essential ingredient in successful collaborative product development.

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Part 2 – Lead user concept

In the first part of the series introducing collaborative innovation to the medical devices decontamination environment, I have explored networks and networking as the framework that allows to implement the collective effort.

Users sit at the end of the value chain of the intended use of equipment, processes and systems that are developed. They share the joys and pains of entire sector's development and despite the fact the industry came a long way from the boiling pans and flamed instruments, there is still much to be done. In fact, we have to grow accustomed to the fact that we will never be "done" in a literal sense as technology and science continuously break frontiers and nature evolves as well posing new, previously unknown threats. The only choice that remains is to embrace the change and innovate together with the overarching trends.

This chapter looks at the innovation process from the perspective of the end-user within the context of interconnectivity that comes from networks and technology. Von Hippel's (who inspired this article) Lead User concept is investigated and adapted into the decontamination setting. The aim is to understand the gains and benefits that can be drawn from user involvement in innovation and development processes.

Innovation concept

Like networks and networking, innovation is nowadays a word that trends discussions in technology, development and business. Innovation is a commercial implementation of a new idea (product, service, process) or a concept that includes introduction of a known solution to a new environment be it industry or market (Mitra 2012:2). It is important to point out that, in many fields, innovation in techniques is at least as important as equipment innovation (von Hippel 2005). Overall, what is important in this discussion is the emphasis on implementation – ideas alone are not innovations.

Implementation of ideas is in the centre of interest of his article as well. It is the most time consuming and laborious part of the process but one that gives a tangible result – one that allows the idea to be evaluated against. Being able to learn from implementation means the idea can be measured, rethought, transformed and implemented once again with a higher probability of success.

Lead user concept

Together with the technological and scientific advancement came the need for further specialisation of equipment, processes and services. That is certainly the direction decontamination sciences follow. It is easy to identify when we look at the variety and complexity of solutions that were recently introduced – from a range of low temperature disinfecting and sterilising methods through solutions for cleaning of robotic instruments to process indicators and accessories that improve decontamination techniques.

Within this multitude of solutions that is constantly evolving there is another significant trend – specialisation of solutions. It is no longer possible to develop universal technologies. It is no longer practical to develop solutions without taking the specificity of use into consideration.

This also means that often provided solutions must be adapted in order to perform, interestingly often not exactly as intended but as required. This goes in line with von Hippel's suggestion that frequency with which user firms and individuals alter products (upgrade or redesign) to suit their needs range from 10% to nearly 40% in fields studied to date (von Hippel 2005:19). Firms, therefore, must rely heavily on the access to the specific information which make developed solutions relevant. The question is how to best access that information.

Von Hippel (1986) introduced the concept of a "lead user" as an antidote to ineffective market research in the pursuit for novel products. In traditional approach market research user-evaluators are "poorly situated with regard to the difficult problem-solving tasks associated with assessing unfamiliar product and process needs" (von Hippel 1986:792), because of the tendency that "the more recently objects or problem-solving strategies have been used in a familiar way the more difficult subjects find it to employ them in a novel way" (Adamson and Taylor 1954).

Von Hippel suggested engaging "lead users", user-evaluators of a "novel or enhanced product, process or service defined as those who display two characteristics with respect to it:

- Lead users face needs that will be general in a market place – but face them months or years before the bulk of that marketplace encounters them and:

- Lead users are positioned to benefit significantly by obtaining a solution to those needs" (Von Hippel 1986:796).

Considering the two important characteristics, it is worth to mention that the "ahead on an important market trend" variable is based on the assumption that innovations coming from the emerging trend on the market will have the greatest potential and will be commercially most attractive (von Hippel 2005:22). Market requirements change as a result of trends that emerge in them and beyond them.

One of the trends that can be easily identified is increasing complexity of advanced surgical instruments (i.e. robotic tools, endoscopes) that combine various novel solutions and this way create a need for more sophisticated reprocessing equipment, processes or in some cases entirely new decontamination technologies. On top of that there is a need for transparency, repeatable efficacy, performance and traceability of processes – plenty to choose from.

The second characteristic was derived from studies on industrial product and process innovations by Schmookler and Mansfield that showed a positive correlation between the benefit from an innovation and individual's or collective's engagement in obtaining this solution – whether purchased or developed

(Schmookler 1966; Mansfield 1968). It is particularly important in decontamination setting as motivation towards obtaining solutions, apart from operations point of view, comes from the sense of responsibility to deliver instruments that are safe to use.

Urban and von Hippel (1988) devise particular methodology for end-user engagement. The first step is identification of new markets or evolutionary trends within existing markets that will carry potential for a novel product. The second step is identification of lead user group based on its characteristics (Urban and von Hippel 1988:570). Third step involves physical involvement of lead users in concept generation through creative group sessions where lead users take an active part in the solution development process. Fourth step validates the concept on the group of evaluators who do not meet the lead user criteria.

This methodology is presented from the point of view of firms looking to commercially gain from end-user's participation in development. Moreover, there is strong evidence that the concept of lead user benefits both high and low tech organisations (Herstatt and von Hippel 1991). Competences that constitute firm's ability to develop innovative solutions come from the collective knowledge – including customers (Prahalad and Ramaswamy 2000:81).

Firms engage in a dialogue with customers, allowing them to become co-creators of products and services (Prahalad and Ramaswamy 2000:83). SSD departments face problems caused by huge diversity of instruments and various methods and technologies for their effective reprocessing. Within so many variables, there is a need for extensive knowledge and experience as well as thorough understanding of process specificity. The former is provided by manufacturers and consultants while the latter by the end user. There is evidence that increasingly more consumers, driven by the need for solutions, want to engage and interact with firms and thereby co-create value (Prahalad and Ramaswamy 2004). In those instances end-users directly benefit from obtaining solutions tailored to their needs – often ahead of anyone else on the market.

So who is the lead user eventually?

Fundamental assumption is that end-user will benefit from engagement in development of a particular innovation. The need for a solution is the primary driver for one's pro-activeness but in many cases knowledge obtained through the exercise can radically transform the problem or perspective one has got against it. In such instance the outcome may not be what was initially expected. Like in the case of load dryness after a washer-disinfector cycle. Very often changes to the loading procedure rather than the equipment or process make the most significant improvement.

It is therefore the first characteristic of von Hippel's lead user model that becomes problematic when decontamination sciences are considered. Whether one faces needs that will become general in the entire sector is difficult to judge and due to large variety of problems sterile services face even more difficult to predict.

It is highly unlikely that everyone else will be able to benefit from a solution particular end-user develops but the question may be "at what percentage?" will make it significant. If many individual users or user firms want something different in a product type, it is said that heterogeneity of users' needs for that product type is high.

If users' needs are highly heterogeneous, only small number of users will tend to want exactly the same thing. In such case it is unlikely that mass-produced products will precisely suit the needs of many users (von Hippel 2005). That is the main reason for the need of small, highly specialised solution providers in the sector. One-specialised-size-fits-all approach is most certainly not going to work, however many specialised sizes will allow to choose the best possible fit.

This approach paired with globalisation of even small enterprises guarantees sufficient size opportunities for firms to engage with as there will be others struggling with the same problem that will welcome the solution instantly.

What is important in this discussion is the fact that lead user status is subjective when one applies the formula to a particular individual. This academic detachment from the research object – in this case the end-user – does not take into consideration individual's interpretation of the concept. Within so many emerging trends that will become common within sector's niches.

This, paired up with overall understanding of the benefits from obtaining a solution makes any pro-active individual a lead-user because in discussion between safe or unsafe instruments the purely commercial outlook becomes less important.

So, while from the theoretical point of view there are two outcomes – one does or does not fit the lead-user model, in practice, from users' perspective that is far less important – what matters is the result.

Interestingly, there is one more outcome. There is a third group that indirectly benefits from engagement of lead-users. Firstly, this group gets inspired by solutions others developed and adapt them to suit their own needs. Secondly, what is more of a cultural change, they discover that engagement in development may solve their problems as well – even when they are different. As a result they may decide to become the lead users. From my point of view engagement will always have a higher probability of success compared to waiting until particular solution is discovered.

Drivers of change

Pavitt (1984) found that users were the developers of majority of the most important scientific instrument innovations, and also the developers of most of the major innovations in semiconductor processing. It can be argued that users and providers of early electronic and semiconductor technologies had similar backgrounds what made the process far easier. In healthcare there is a major dichotomy between backgrounds of end-users and providers of medical technologies. On top of that there is a strong influence of regulations and safety requirements that double the difficulty.

Nevertheless, in 2003 Lüthje conducted a research among surgeons working in university clinics in Germany. At that time 22% of 261 interviewed were actively involved in development of innovative surgical technologies. As expected, percentage is significantly lower but the number is still significant. Remarkably however, when commercial value of the innovations which involved lead user surgeons developed is considered, 48% were or soon would be marketed by manufacturers of medical equipment (Lüthje 2003).

In the absence of similar data within SSD departments it would be beneficial to ask how many sterile services managers and technicians got involved in solving problems directly relating to their environment? From my experience and recent conversations with industry members the level of involvement seems to be low. And it is not necessarily about looking at cutting edge solutions but the little specific things that make their particular environment different – instruments, logistics, department layout, environmental control, etc. Von Hippel points out that minor innovations are cumulatively responsible for much or most technical progress – they become building blocks of bigger, more complex structures. There is evidence that about 80% of innovations can be tracked down to the cumulative result of minor technical changes (Hollander 1965). This shows the importance of cumulative effect of small innovations. When this phenomenon is analysed from the perspective of sterile services and the multitude of issues and challenges they face it becomes apparent that the major issue for firms who can address these problems is to obtain the relevant information. Most of it is held by staff – and not only managers but personnel at all levels.

Empowered lead users

This creates a curious situation where on one side there are sterile services, rich in knowledge and in the need for solutions and on the other solution providers in need for this tacit, local knowledge. Whenever in physics such a difference of potential occurs an opportunity is created for energy to flow. All it needs is a conductor. In case of decontamination sector there are social and business networks that are the perfect conductor for information to flow. Networks link the need for information with their source and solution providers with those in need.

Energy source disconnected from the consumer does not bring value as on its own it cannot transform it for the higher purpose. Similarly, the end-user disconnected from the network and firms and consultancies that can effectively turn the knowledge into solutions do not bring value.

Networks create ecosystems that bring together necessary ingredients needed for efficient decontamination processes. Michele DeMeo portrayed the relationship between sterile services and operating room staff as a peer to peer supporting relationship (DeMeo 2014).

There is a need to take this concept further and open towards all the stakeholders of the decontamination environment. It should not be viewed as a hierarchical system of dependencies but a wide and diverse ecosystem of mutually beneficial, complementing relationships that delivers the mission of patient care. Academic research, engineering solutions, day to day operations have got a common goal and support each other.

Networks enable individuals to share information, strengthen relationships and build on collective knowledge. It is the strength of ties (Granovetter 1973) that increases the intensity of information exchange as well as its quality that increases with the amount of trust within the network. Such conditions enable collaborative innovation.

Change Cultures

Apart from confidence in its own decontamination processes end-users benefit from solutions that make their specific workplace more efficient and more comfortable to work in. Internal changes also improve health and safety conditions within the working environment – directly by eliminating hazards and indirectly by making the instruments and equipment safer to handle.

These incentives however compete with the fear of raising concerns or admitting that despite equipment validation and audits there are issues. Some issues directly increase the health risks for patients and hospital staff while others manifest themselves as system inefficiencies that increase the financial burden on decontamination departments and take resources from other hospital departments.

Empowered users become drivers for change and need to feel comfortable within the role and have the support of the higher management.

Yet again it is much easier when one operates within a network that supports the cause as the trust mechanism will allows to share the risks (Gulati et al. 2000:204) and diminish opportunistic behaviours (Mitra 2012:72) which in this case would push responsibility for additional costs and consequences towards the person highlighting the problem. Strong internal networks based on trust enhance strong cultures that embrace change (Chatman and Cha 2003:23).

As Weick (1987:114) claims, employees default to the culturally embedded behaviours – I would like to strongly encourage sterile services staff to default to empowered lead users.

Summary

Networks bring opportunities to end-users to inspire and interact with the development processes of solutions addressing their specific problems. Firms can also use networks looking for that specific insight and field experience that make their solutions better suited to actual problems. Since the NHS advocates a change of culture and making innovation everybody's job (Nicholson 2012) it certainly makes sense to engage networks and de-risk these efforts. Networks reach out beyond decontamination and even healthcare setting inviting inspirations from other disciplines of science and engineering. Whether this interaction results in development of entirely new technologies or simple improvements it makes a positive change and that drives the entire sector forward.

Within von Hippel's (1986) lead-user concept consumers must experience emerging problems and directly benefit from found solutions. This characteristic does not take user preferences into account. Given the multitude of new trends in medicine as well as understanding of benefits from implementation of innovations users can choose become drivers for change. Moreover, successful innovations within the network can inspire other users to engage.

It is also important to include the role of organisational culture that can hinder or promote collective behaviours such as engagement of user with solution providers. Strong cultures embedded in trust rich networks will promote information exchange. That creates a strong foundation for collaborative innovation that I will explore in more detail in the last article of the series.

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Part 3 – Implementation

The whole series of articles were titled towards collaborative innovation – this was done in purpose as we, people involved in decontamination of medical devices are not there yet. This last article looks at conditions necessary for the implementation of innovations that stem from collaboration.

Implementation, in case of innovations, is what distinguishes between ideas and concepts, and realised solutions we can touch and experience.

Implementation is also the hardest part, the most demanding, it tests us as well as the theories we try to prove, or disprove.

Thirdly, implementation is what makes it all worth the effort and what makes us do it again.

This article explores collaborative innovation in the light of its fit into decontamination environment. Concepts of closed and open innovation are introduced together with end-user engagement in co-creation.

Second part of the article explores tools, system and networks that are required to implement collaborative innovation in practice.

Innovation – the concept

The rise of the machines of industrial revolution started the engineering and scientific arms race.

Human or animal labour were subsequently replaced by technology that was able to perform the same tasks faster and cheaper. Innovations in technology became the tools in delivering precious competitive advantage.

Radical innovations brought us modern transport and information technology as well as breakthroughs in medicine like imaging technologies, respirators and many more we consider today as essential medical equipment.

At the same time incremental innovations were continuously improving these products and processes.

This way medical imaging arrived to digital, three dimensional world virtual reality that allows us to visualise what happens inside of human body in real time. Similarly, surgical techniques evolved with advancements in science and technology to modern minimally invasive surgeries using 3D cameras, robots and semi-automated instruments.

As a result we have increased survival rates of serious surgeries and in case of less critical cases reduced the risk of complications as well as overall time of patients' recovery.

What is also important is the fact that side by side with innovations in products and processes came improvements to the way they are manufactured. Innovations on this side of the supply chain were equally important, as they stand behind wider accessibility of technologies due to lower costs of manufacturing and better quality of end products.

The closed innovation

Historically innovations were by large the fruit of firm's internal Research and Development (R&D) resources. Early industrial innovations aimed at improvements in productivity and overall efficiency of the production units (Chandler, 1990).

As markets became more and more competitive this form of innovation became the tool that produced advantage over other market players. By utilising internal R&D resources firms took advantage of benefits of both scope and scale (Chandler, 1990).

This concept was fitting well with vertical integration model where firms acquire elements of their production supply chain and exercise R&D within their own development, manufacturing and distribution. In case of large companies the price for the control over the R&D output and supply chain comes as several major problems.

Firstly, research very often produces spill-overs that despite being of value were not fitting with firms core activities – as a consequence most of these projects were simply shelved waiting for originators to leave and implement those innovations elsewhere (Smith and Alexander 1988).

Secondly, with the rapid advancements in technology and globalisation of supply such lack of flexibility leads to inefficiencies. In the worst case scenario acquired resources may become technologically redundant.

Thirdly, development, especially in case of very innovative technologies requires heavy investment and carries significant risks of failure.

Companies attempting to innovate internally have got to bear the risks and costs alone. Fourthly, firms implementing vertical integration became bound to the resources they acquire, rising the overall inertia of the system.

Should a need for change of technology occur due to a general market trend, change of regulations or competitor with disruptive technology companies are faced with a dilemma whether to abandon current technology, which is equivalent with making particular unit redundant, or continue with the old technology suffering on the market. In the decontamination sector there are additional problems that firms face.

Given the complexity of issues and the need for multidisciplinary R&D expertise it is very difficult for companies to secure all these resources internally. Furthermore, top level expertise comes at a price smaller companies may not be able to afford in the long run.

The low level of trust between companies in the sector (de Sternberg Stojalowski 2013) makes information exchange difficult. The global outlook of most companies in in the sector makes protection of intellectual property impractical because of the costs.

This creates further tendency to internalise R&D – develop internally and hold to information tightly.

Open innovation

In order to facilitate growth and progress in companies the way innovations are implemented had to change. Firms had to turn their interest to the outside world in order to secure necessary resources and information to fuel R&D and speed up implementation of innovations.

Chesbrough (2003) coined the term "open innovation" and described it as the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Companies are now seen as a collection of competencies rather than as portfolios of business units (Prahalad and Ramaswamy 2008).

Open innovation as a process takes advantage from combining internal and external information and capabilities and implements them into frameworks, systems and processes.

Open innovation gets embedded in business models that specify requirements for these frameworks, systems and processes and mechanism that extract value of those combined resources.

Open Innovation not only encourage access to external resources but also releases internal ideas through alternative routes to market (external channels), ones that are not currently used by the firm.

This way maximises value creation within an organisation (Chesbrough 2005).

This model proposes the opposite mechanism to vertical integration – internal resources are juxtaposed with ones sought externally.

Furthermore resources can be shared between organisations rather than acquired and controlled. This way resources are utilised when and where needed, eliminating consequence of owning redundant assets – making enterprises much more efficient.

In this model information can simultaneously draw from different sources – both internal and external to the organisation.

Von Hippel (1988) identified four sources of information that bring competitive advantage as: suppliers and customers; university, government and private laboratories; competitors; other nations.

Additionally, consulting with customers who are lead users can provide firms with ideas about discovering, developing, and refining innovations (von Hippel, 1988). Open innovation concept relies on the assumption that useful knowledge is broadly distributed. It further assumes that even the most capable R&D organizations must identify and include external knowledge sources as an essential element of innovation (Chesbrough 2003).

Open innovation model opens new possibilities, especially for smaller firms, in the form of information access through various forms of partnerships. The flexibility of the system allows them to engage in information exchange and technology sharing on the basis of long term alliances (Gerlach 1992) or project based mutual benefit agreements.

Smaller firms possess access to usually smaller pools of both knowledge and talent (Rogers 2004). Therefore smaller firms, especially those heavily engaging in research and development overcome this shortage engaging in cooperative R&D that include other firms as well as individuals, end-users and the world of academia (Mitra 2012:97). They exchange knowledge, technology and necessary resources to ensure competitiveness of their offering as well as improve their capability to innovate.

From the perspective of firms supplying information and technologies it is also a far better solution in comparison to having one single recipient or product or services.

These firms, like the one they support, may quicker respond to market changes and follow general trends without the lag caused by corporate politics of vertically integrated firms.

The shift of paradigms is required to change the way companies think about innovation. While in the closed innovation, the focus was on acquiring and exploiting resources and then capitalising on their use open innovation allows to globally share resources and value such collaborations create.

Open innovation requires a framework that brings demand and supply of information, knowledge and technology, finance and people together. Networks seem to be the perfect architectures that facilitate open innovation.

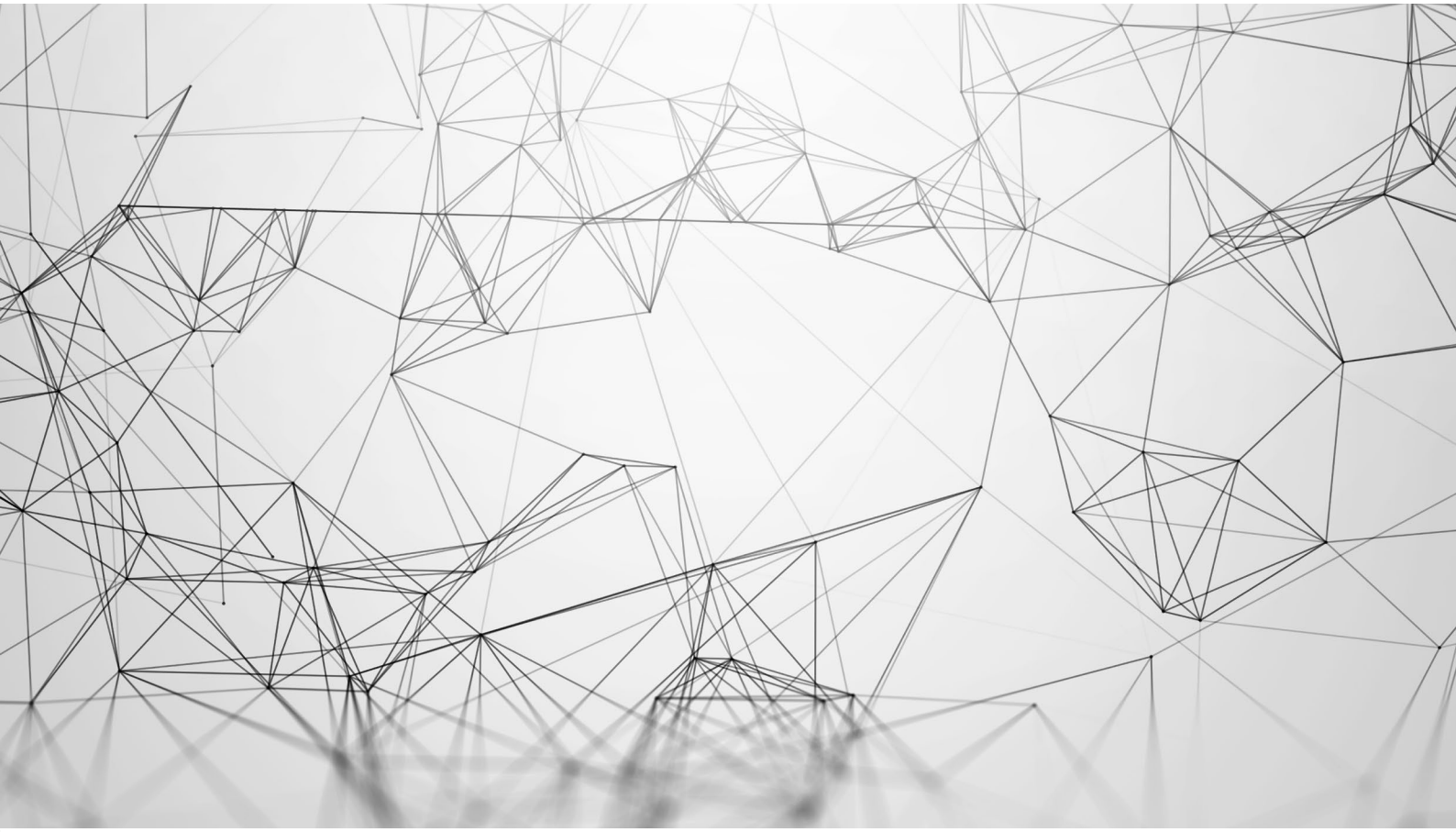
Collaboration and co-creation

R&D cooperatives are networks that bring together parties interested in capturing the value of the collective. Naturally these cooperatives bring together firms and deliver the effects of collaboration however the value is created of inputs of both firms, organisations, individuals that occupy different positions on the value chain of particular product or service.

Such collectives bring together suppliers of raw materials and components, logistics and distribution, manufacturers and service providers as well as finally customers and end-users. The latter group may not directly participate in sharing of revenues but in exchange for participation and knowledge receive products or services that better meet their requirements and needs. They contribute to better understanding of the use and exploitation of technologies and direct innovations to their own benefit – customers and end-users co-create value of the end product or service.

Competence became a function of the collective knowledge available to the whole system – including customers (Prahalad and Ramaswamy 2000:81). Prahalad and Ramaswamy (2000:81) also argue that in the current market place end-users and customers want to proactively engage with firms and thereby co-create value. It is no longer the case where market awaits products, but a demand pulls from the customers, usually specific to their circumstances. Prahalad and Krishnan (2008) propose a new formula R=G and N=1 that describes innovative product development through in collaboration with customers. N is the number of products suggesting that mass production of one size fits all solutions is no longer viable as customers want to customise their products. This goes in line with von Hippel's studies of lead users. R refers to resources and their global scope G. All this is pushing firms to innovate products to provide the personalised, individual solution and innovate on the product or service development side to use the resources in the most effective and efficient ways.

> "At the end it is all about networks"
>
> ~ Pawel de Sternberg Stojalowski



In medical and especially decontamination sector this approach has got a lot of merit as end-users deal with a variety of complex problems and every sterile supply department (SSD) operates in different conditions when instrument throughput, procedures and equipment are taken into account. In such conditions the N=1 adequately describes the challenge suppliers and manufacturers face when it comes to innovations in products and services. At the same time SSDs managers and staff possess a great wealth of knowledge and experience that should be utilised through collaborative development. Firms could also mobilise global resources to find the best way to supply the bespoke solutions that are needed. On the commercial side collaboration should not be limited to engagement with end-users but firms should look for ways to maximise value offered to end-users.

Implementation

At the end it is all about networks.

It was important to introduce networks in this series of articles in the beginning as they create the environment where information exchange takes place. Collaboration is defined as working with others to do a task and to achieve shared goals (Collins Online Dictionary 2014). Burt (1992) drew attention to networks as sources of information, highlighting such properties like access, timing and referrals. Networks do not hold information on their own – they are merely instruments that allow information to be transmitted between individuals. When individuals exchange information collaboration begins. Same rules apply when resources or risk is considered.

Trust plays a critical role in governing networks. Trust implies an inter-personal dynamic, a belief that the trusted person will look out for mutual best interests in a specific area (Gottesdiener 2007:6). In case of collaboration the specific area is the value created by the collective. Networks therefore facilitate collaboration.

End-User involvement

Open innovation creates a unique opportunity for end-users to actively engage in product and service development.

Lead-users can directly influence the end-product by providing user perspective so firms can better understand the practical aspects of application of their offering. Additionally firms learn about the environment within which products operate what can further improve their fit in the overall system.

End users can also highlight problems or particular difficulties their environments struggle with. These issues may become inspirations for firms as future R&D activities and become co-developed.

In decontamination setting it is also important for firms to gain access to various SSDs to learn the way they operate in different locations and conditions, how staff perceives and uses equipment and whether the equipment is used as intended. Such cooperation is of mutual benefit to all parties.

Developments arise from collaboration and collective knowledge as integral elements of the system rather than independent pieces of technology cut off from reality. End-users engagement in networks makes open innovation.

Open innovation hubs and online platforms

In principle open innovation requires networks facilitating information exchange and access to up-to-date information, broad knowledge, versatile range of technologies and talent. Online platforms and internet forums like LinkedIn (2014) and Meetup (2014) help bringing together people interested in particular subjects – be it decontamination, future manufacturing or any other subject.

They facilitate community driven knowledge exchange, making it easy and convenient. These online services bring additional important benefit, they eliminate the physical distance between interested parties, making discussions richer with international expertise and points of view and what is particularly useful in case of decontamination, allow to quickly compare solutions and their fit to international standards and regulations. Open innovation hubs focus on interpersonal information exchange. Whether people work together on projects or just socialise they build relations that in turn strengthen the ties in the network (Gulati 1998). Innovation hubs are often developed by universities to encourage commercial application of scientific research and spin-offs.

On that end sit organisations like Medtech Campus in Chelmsford (MedTech Campus 2014) or BioCity in Nottingham (Biocity Nottingham 2014). On the smaller end of the spectrum FabLabs and Impact Hubs (Impact Hub 2014) are found. They combine social and entertainment side of collaboration and this way appeal to more general public.

Innovation going public

On the extreme end of open innovation sits crowdsourcing and crowdfunding. These novel ways allow for innovations to originate from communities grouped around certain problems.

Members come with different motivations for participations but are united on the path to create value – through problem solving or product and service development. For the time being such groups are formed around more commercial initiatives like 3D printing, experimental electronics and robotics or arts and crafts.

Examples are FabLabs and Hack Spaces, where members collaborate, share resources and knowledge and learn from each other and what is most important make things and make things happen.

Crowd funding and crowdsourcing are slowly finding its way to niche markets like medicine through various Meetup (Meetup 2014) groups around medical technologies and platforms like Consano (Consano 2014) that helps funding medical research.

Crowd funding and crowd investment are two novel ways that bring the innovations to the market, allowing customers to decide upon feasibility of products or services when they are at very early stages of development.

Those ones that offer are able to present value to individuals get funded or invested in by them providing necessary capital for further development.

Crowd investing operates on the same principle, however is aimed at investment in return for idea originator's firm equity. In case of medical products, where development involves external audits, testing and validation of the process is much more complicated.

There is also the risk of "big companies" snatching early stage innovations and developing them internally. The latter risk refers even stronger to commercial crowdfunding campaigns as market entry barriers are lower and despite that many crowd funded campaigns gave birth to very innovative products like Micro, 3Doodler or Scanadu Scout (Wikipedia 2014), to name a few.

These products are aimed at general population and for medical products, especially those which are being purchased by national health services, it may not be applicable. On the other hand, with the support of global healthcare markets and strong collaborative communities it may become the way to innovate medical devices as well.

Conclusions

Open innovation requires access to broad range or resources including, information, knowledge and technology, just like solutions needed in medical device decontamination, which require multidisciplinary science and engineering.

All these resources however, without the collective will to collaborate will not make it possible to truly utilise the value that resides within the network.

Competence in collaborative model becomes a function of the collective knowledge available to the whole system (Prahalad and Ramaswamy 2000) and it is up to us whether we use it.

Any collective enterprise must benefit all parties involved. Collaborative innovation offers effective and focused R&D projects with guaranteed demand to firms willing to share resources. Yes, they share the profits with the rest of collaborators, but in exchange they receive expertise and resources they could not have accessed otherwise. Most importantly, they receive it upfront, reducing the risks and costs of necessary R&D activities.

At the same time, end-users collaborating on new products or services will get the chance to influence the development process to receive solutions that truly solve their problems.

It is worth mentioning that there are other parties who indirectly benefit from network driven innovations. Hospitals and clinics receive equipment or services that are more efficient and effective as internal problems are taken care of at the development stage thanks to end user involvement.

Additionally, in case of decontamination equipment and services the risk of infections being transmitted through surgical equipment is being reduced. Gladly, the ones that benefit at the end are patients.

Unfortunately decontamination sector networks are not governed by trust and therefore there is a risk of collaborative projects being jeopardised by opportunistic behaviours (Bradach and Eccles 1989:104). Because of that fear it may be also difficult, especially in the early stages, to organise and deliver collaborative projects.

Trust level grows together with the length and intensity of information exchange (Tsai and Ghoshal 1998:467)) and from social interactions (Granovetter 1985). It seems therefore that strong trust based networks bringing together solution providers, healthcare services and policy makers, as well as end users are the best place to start implementing collaborative open innovation.

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