Service design based on smart urban lighting

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Published in:
Open Innovation 2.0 Yearbook 2014

Published: 01/01/2014

Citation for published version (APA):
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Abstract
The lighting industry is in transition from a hardware only industry to a full solution and services industry. With the growing availability of all kinds of data on the one hand, and flexible lighting systems (with sensors and controls) on the other there are many opportunities for new business with services in lighting. It also creates opportunities for new professions, such as in the design of lighting services and in the development of software applications for smart solutions: professions that are new and require different skills than the traditional ones in the hardware related industry.

Introduction
Last year, in the Open Innovation Yearbook 2013, we presented the case of participative innovation in smart urban lighting, with a vision on the future of urban lighting and its transition towards a focus to improve quality of life in cities. In the past months various projects have been initiated to make this vision a reality. All of these projects build on the enabling technologies that led-lighting and ICT solutions provide and seek for meaningful services. In these projects various public and private organisations collaborate to explore new venues. A reflection on these projects shows that new skills are required compared to the traditional professions in the public lighting domain. We will first explain the context of smart urban lighting, and then we will show practical examples of two cases, before reflecting on the consequences for jobs in this field.

Innovative Lighting Solutions
Public Lighting and Public Lighting Infrastructure can play a significant role in achieving ambitions of cities in making the city an attractive place to live. Technological developments include an upgrade of the public lighting infrastructure and system by connecting to ICT solutions. This enables cities to offer a wide range of intelligent and integrated services benefitting society and individual citizens and bringing cities closer to the ambition of becoming smart cities. This integrated lighting- and ICT solution can best be explained by describing 4 levels of the system (see also Figure 1):

- **Devices**
  The number of devices is growing rapidly. Traditionally, devices in public lighting contain public lighting luminaires and traffic lights. This is gradually expanding with other types of sensors and actuators, either with low bandwidth, such as timers, light intensity sensors, microphones, movement sensors, fine-dust sensors or high bandwidth for example camera’s, interactive displays, touch screens, and smart phones. Many devices collect or use data and are therefore connected (the Internet of things).

- **ICT**
  On the ICT level the connection is made with data and software applications. The data that is collected through different devices contains e.g. time, people counting or proximity measurements, weather information, movements, energy consumption, camera data, etc. Mash-ups and data analytics will lead to insight in emerging patterns or correlations that can be used for various software applications.

- **Services**
  At this level meaningful services are developed that provide value for the relevant stakeholders. In urban lighting there are often different stakeholders that use the area, with different needs and wishes. The ultimate goal of urban lighting solutions is to create value for societal stakeholders by creating a healthy and liveable city. Smart lighting can offer valuable services for different stakeholders using the ICT based lighting platform.

In this four level model, technology is considered an enabler. Technological developments create new opportunities for applications. These applications become meaningful when they address relevant societal needs.

In the coming years innovation will take place at all four levels. Businesses will drive technology developments, securing intellectual property and providing hardware to the market. This hardware will become mainstream, easier to produce in low-cost countries and will create little jobs in Western Europe. However, in the field of meaningful applications designed to address societal needs there are more opportunities for new jobs, especially in the domain of developing new services with lighting. The type of jobs is shifting from hardware related jobs towards the design of lighting services as well is to the development of software applications for smart lighting solutions: jobs that are new and require different skills than the traditional jobs in the hardware related industry.

- **Infrastructure**
  The level of the infrastructure can be seen as the ‘road’ that enables all ‘traffic’. Traditionally for public lighting this meant the underground wiring for power. Nowadays it also includes Internet connectivity as well as wireless solutions. In the coming years, the infrastructure will become a dense network to enable the connection of all kinds of devices and communicate all kinds of data.
The development of meaningful applications requires a changing attitude interconnecting the different levels:

1. Open platforms, open data and open knowledge make new connections possible. By linking data and integrating various perspectives new solutions for societal needs emerge. Data analytics becomes an important element to identify emerging patterns and spot new opportunities. It also enables to determine the impact of solutions. The technical challenge lies in the selection of the required devices to efficiently and effectively collect data and integrate all data into a total system.

2. Innovation driven by societal needs requires the active involvement of all stakeholders to find solutions that cater for their different needs. Stakeholders turn from objects to active participants, being involved in all stages, including very early ideation and prototyping. The active involvement of stakeholders is also needed to develop new revenue models that enable the continuous innovation and further development of the services. Municipalities may be able to provide basic infrastructures in public lighting, but due to budget restrictions it is not realistic to expect that all investments will be done from the public domain. By understanding the potential value of innovations for the different stakeholders, also opportunities for co-investment arise.

A Changing Business Environment
Meaningful applications in public lighting are based on societal needs and use the enabling technology in lighting and ICT to provide solutions that address the needs of the stakeholders. Different areas in cities have different stakeholders with different needs. The solutions will need tailoring to the specific situation. For example, an entertainment district in a city has different stakeholders with different needs than a residential area or an area around a school. For each project it is therefore important to start with an inventory of the specific stakeholders of the area and their needs. Based on these needs a creative process starts to define a proposition for an urban lighting solution. With intelligent lighting solutions it is often possible to address different needs with one technical platform as long as the platform is able to offer this flexibility. To illustrate this process we give the example of two projects that are currently in development.

Increasing the Hospitality in a Public Square
One of the projects the TU/e Intelligent Lighting Institute is involved in is the Amsterdam Smart Lighting project. In this project a smart lighting solution is being developed for Hoekenrodeplein, a square in Amsterdam. This project is a collaboration between the city of Amsterdam, Philips Lighting, Cisco Systems, Alliander and the Intelligent Lighting Institute. All partners invest in this pilot with the ambition to create a showcase for smart lighting solutions. Hoekenrodeplein is situated in the surrounding areas of the Amsterdam ArenA where frequent soccer matches and various events take place; the Heineken Music Hall and Ziggo Dome, both hosting large scale music events; the Arena Boulevard, with various shops; the Bijlmer ArenA train station; and Reigersbos, a residential area. So although it is very close to lively areas, the square itself is mainly used by commuters just passing it on the way to their destinations. In the redevelopment of the area an investigation was made of the main stakeholders in the area and their needs. These needs were defined as:

- **Sustainability**
  The city of Amsterdam has the ambition to reduce energy consumption and lower the carbon footprint and therefore would like to use led-based solutions. Furthermore the idea is
to only provide light when needed, and dim the lighting when possible. This is also preferred to reduce the level of light pollution.

- **Safety**
  The reputation of the area is not as good as the city would like. Improvement of the safety is needed for crime prevention and will improve the image of the area. Lighting is seen as a good way to support this need. Furthermore, a specific element in this area is the need for crowd management solutions when events are taking place and large numbers of people visit the area. Smart lighting solutions might also help to manage these crowds.

- **Hospitality**
  Various stakeholders wish to improve the hospitality of the area to attract people and to make them stay in the square for leisure activities. This will also increase the social safety and social cohesion in the area. Smart lighting solutions would potentially have an impact on the hospitality.

Because of these needs, propositions were developed for a smart lighting solution with the ambition to cater for as many needs as possible. The proposed solution is an adaptive lighting solution that creates an attractive atmosphere in any circumstance. It adapts to the use of the square: commuting or leisure. The solution exists of a set of dimmable led lights that reduce energy consumption. The system uses people counting sensors to be able to dim the lights when there is nobody around, but that also gear up when light is needed. Because the square is quite large it also makes use of the fact that the same light level might not be needed everywhere at the same time: by lighting up areas of the square where people are present, a pleasant atmosphere can be provided when it is not so busy, thus create an inviting atmosphere that attracts more people to stay and stay longer. When it becomes busier more lights are turned on, creating a larger area that is attractive to spend time. Furthermore, to increase safety when it is very busy, the system can be geared up to calamity lighting, enabling surveillance and emergency officials to keep an eye on the crowd or provide help when needed. A side effect might be that when these high light levels are applied, some people will find the place less attractive and will leave. Once the amount of people is down to a certain level, the lighting will change again to create a cosier atmosphere.

Technically, the system needed to create these light-on-demand settings involves just lights, people count sensors and an application to design and trigger lighting scenarios. When looking further in the needs identified by the stakeholders, an opportunity was found in using the same technical system to increase a ‘virtual stage’. Dedicated spot lights can create a stage for (music) performers and local talents. People can book airtime on the stage through an app. or portal. The performance can be recorded or streamed to the web by the video camera that is normally used for people. This virtual stage can be promoted in connection to events in the area and might make the square more attractive to visit and create a prolonged stay of people before or after events in e.g. the ArenA, Heineken Music Hall or Ziggo Dome. It is even possible to charge a fee for the booking of the virtual stage, thereby creating a revenue model to earn back the investments for the development of the app. and for new investments in the smart lighting system and related apps in the area.

This case shows that the technical system enables the creation of various services for different stakeholder needs. The challenge lies not so much in the technology (although a good system integration of various existing building blocks can still be a challenge in itself), but more in the development of meaningful services that make sense in this specific area. The type of people needed to perform such projects is not the traditional lighting designers that are used to make a lighting plan based on uniform distribution of a sufficient lighting level. In this case the challenge is to creatively design services using the available technology and integrate the different needs into one solution. Furthermore, more dynamic lighting scenarios need to be designed, that address issues as atmosphere creation and changing the behaviour of people (in this case to invite them to stay in the square they otherwise only pass by). This will not be just a one-time design, but regular new lighting scenarios are needed to keep the square attractive over longer time for returning visitors. The hardware infrastructure allows for such flexibility.

**Increasing Safety in an Entertainment District**

The city of Eindhoven is currently implementing its vision and roadmap for urban lighting. This involves the set-up of various living labs in the city to explore the opportunities of innovative lighting solutions to increase the quality of life in the city. One of the living labs is related to the project Stratumseind 2.0. Stratumseind is the entertainment area in Eindhoven, a street of approximately 400 metres long with around 50 pubs, attracting over 20 000 young people every weekend. As in many entertainment districts, incidents happen. Moreover, the businesses in the area are suffering from reduced turnover. This was the reason to start collaboration between the entrepreneurs, breweries, property owners, police and city council and set up the living lab to explore...
the possibilities to structurally improve and increase the economic and social activities on Stratumseind. The main needs identified in this case are:

- **Safety**
  The ambition is to reduce the amount of incidents. Stratumseind is also a very well-known area for specific events such as the celebration of national holidays and victories of the Eindhoven soccer team PSV. At times it can be really busy, and crowd management becomes an issue.

- **Liveability**
  Improving the liveability for the neighbouring residents. Some residents are living directly above the pubs and others live in adjacent streets and experience the area as being very noisy at times.

- **Attractiveness**
  The area is well visited in the weekends, but mostly late at night. There is a need to extend the liveliness for a longer time by attracting more people during daytime and early evening.

One of the propositions being explored at Stratumseind is the ability to influence mood and stress levels of the visitors of the street. For this purpose a research project ‘De-Escalate’ was defined that got awarded with a national subsidy in the Netherlands. Partners from various organisations also invest in the project, including the municipality of Eindhoven, Polyground, the Dutch Institute for Technology Security and Safety, the association Criminnee, Philips Lighting, ViNotion and the TU/e Intelligent Lighting Institute.

The idea is to install a lighting system that enables different atmospheres through dynamic lighting scenes. The existing public lighting will be replaced by led, where not only warm white and cool white light, but also red, blue and green leds are integrated in a fixture. The led’s can be controlled individually, allowing the creation of a very wide range of colours and intensity levels, as well as dynamic patterns. In this way different scenarios can be created that respond to triggers in the street and aim to diffuse escalating behaviour. For this system to work it is important to establish whether there is a risk for escalating behaviour.

In the living lab a ‘base camp’ has been opened recently where data from various sources is collected and combined to determine the real time level of the risk of escalation. OpenRemote provides an open platform that integrates different devices and provides a user interface for the control of the lights. The data that is collected contains a number of real time measurements such as: 3D sound measurements to identify noise levels and the direction of the noise, social media watching to identify how Stratumseind is being mentioned, and counting people entering and leaving the area to establish the bustle. Other data is collected with a delay, such as: police reports on incidents, determination of origin and counting of mobile devices to establish where groups of people come from, litres of beverages consumed by collecting data from the breweries or amount of waste thrown in the street measured by the cleaning service. Correlating the data on the incidents to specific parameters is done to predict when there is a higher risk for escalation. Historical data from past incidents is now used to find such correlations. Based on the determined risk level, lighting scenarios are activated. For this purpose different lighting scenarios will be designed that aim to diffuse the escalation and in the living lab their effectiveness will be researched.

Also in this case the technological infrastructure provides opportunities to address also other needs. An example here is that when the 3D sound sensors were installed, it suddenly appeared that during the weekend there was no block of 3 hours that the residents in the area could sleep well. After the closing of the pubs, late in the night, it was quiet for a while, but very early in the morning the cleaning cars caused high noise levels again, followed by the ringing of the bells of the nearby church. By changing the time of the cleaning to coincide with the church bells, the liveability of the area was significantly improved. Another example is the use of the lighting system not just to diffuse escalation, but also to create a more attractive atmosphere in the early evening to invite people to come earlier or attract other people at different times of the evening.

The challenge in this case lies much more in the integration of all the information collected by the sensors and other systems. The analysis of data of different nature and combining patterns to create new insights is a key element in this case. This requires new skills for data scientists. With these insights lighting scenarios can be designed and tested on their impact on the mood and behaviour of people.

**New Professions**
Looking at the two cases presented above we can see a shift in the type of skills required from the more hardware related to new ones that focus more on the ICT and services part. We would especially want to highlight two professions that are new in the domain of urban lighting: the data scientist and the dynamic lighting service designer.

**Data Scientists**
Data scientists know how to gather data with the Internet of Things. They know what combination of
sensors and data gathering is required to obtain relevant data and how to register the data. They also know to apply the various models, theories and tools to add and extract value from sets of the gathered heterogeneous data. They turn data into information. What is also relevant in the context of smart urban lighting is to use this information to understand and influence human behaviour. The data scientists bridge the technical competences and the social sciences.

Dynamic lighting service designers
These designers need to be able to empathise with the different stakeholders. In comparison with traditional designers, who focus mainly on users, they need to extend their scope and research the needs of a wider range of stakeholders. This will provide them with insights as input for various use scenarios. With the help of these scenarios they can search for creative ways to apply new technologies to alleviate the needs and provide new services for the different stakeholders. Next to these skills, they also need to understand the impact of lighting on people’s mood and behaviour to be able to create desired atmospheres and experiences. In comparison to traditional lighting design, this also requires the application of dynamic and interactive lighting scenarios. Moreover, these designers need to be very aware of the ethical impact of their designs. This is particularly important for public spaces.

Both professions are needed on recurring basis; therefore more work is being created than one might think at first sight. The renewal rate of the infrastructure is relatively low: once broadband and sustainable energy provision is secured there is no need to change the infrastructure on short term again. The renewal rate for devices is slightly higher, because of the limited technical lifetime (such as electronics), and with new and better technology being introduced they may have an even shorter economical lifetime. The renewal rate for the software and applications is even shorter. The data scientist might find new emerging patterns that spark the development of new applications. New applications are launched daily in the smart phone business. Similar renewal rates may apply for software applications build on open platforms in the field of smart urban lighting. Also the renewal rate of services will be relatively high. New applications will give rise to the need for new lighting scenarios. Moreover, even when there are no innovations on the other levels in the system, regular new lighting scenarios will be needed to keep an area interesting and inspiring. On top of that changes in weather, seasons, type of festivities etc. might call for adapted lighting scenarios. So both professions are not just needed in the design and implementation phase of projects, but will be needed over the lifetime of the system to adapt the system to keep the city an attractive place to live.

Contact
The projects mentioned are done in collaboration with various partners. If you are interested, please contact us through: www.iii-lighthouse.nl or www.tue.nl/ili.

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Introduction

The crowd-based asset is the new source of innovation and economic growth. Organisations that embrace this new industrial paradigm will prosper. Yet, despite our awareness of the core assertion of open innovation thinking — that ‘the assets necessary for creating innovation will not necessarily be collocated with those for commercialising them’ — our openness to harness the power of the crowd has not embedded itself as widely and as fundamentally as it could or should. Perhaps we need to re-imagine some of our trusted frameworks to make them more suited to, and of greater value in, a crowd-empowered world.

In a super social world of ubiquitous, always on, low friction communication, the boundaries between the worlds we all inhabit individually and collectively are progressively blurred and indistinct. Crowds flow across one another and intermingle, transforming into a fog of tribes, trust and relationships. This new world is defined by the insight, asserted by Chesbrough, that the assets we require to innovate are increasingly dispersed, and, as such, this fluid and interlinked economy presents a vast pool of enormously valuable resource. If we can form the necessary connections in our cloud of crowds, the opportunities to innovate are boundless.

Crowd assets are the new source of innovation and economic growth. As the digital world witnesses both declining transaction costs and the emergence of the so called ‘grown up digital’ demographic as active agents in a commercial setting new models of business, collaboration and value creation are emerging. Whilst this generation may be harkening to re-engage with more traditional notions of ideas of collaboration, sharing and trust the channel in which that engagement is happening is anything but traditional. Online connectivity has ushered in a massively extended ability for people to connect and create new opportunities without boundaries in a way previously unthinkable. Organisations that embrace this new industrial paradigm will prosper.

Aspects of the power of crowd-assets are already visible to us. In 2013, the world witnessed the continued rise of highly-efficient, disruptive shared economy models whereby crowdsourced innovation, drawing on mobile and remote expertise, financed $5 billion of democratised crowdfunding. While the breadth of investment is certainly impressive, the real power of crowdfunding comes from harnessing the wisdom of the crowd and creating a community of individuals emotionally and intrinsically motivated to spark real change. When compared to traditional commercial thinking and financing mechanisms, crowdfunding underscores a paradigm shift towards progressive funding that will transform global funding models.

While crowdfunding is a powerful mechanism for entrepreneurs to raise capital to finance their idea or project, crowdfunding espouses many non-monetary benefits. When entrepreneurs tap into larger social networks to pitch an idea, they begin to create mindshare and market share within a virtual community. The virtual community then becomes a critical resource for the entrepreneurs, not only for the funds provided to the project or business, but also for the ideas they share. For entrepreneurs, being in direct contact with potential customers is of tremendous value, as it allows market value, size assessment and direct product feedback. However yet to create real value from all this, the entrepreneurs must be comfortable and familiar with the notion that ‘customers’ can inhabit many roles as co-creators, advocate, innovators and investors.

In parallel with the emerging class of entrepreneur and small business, incumbent organisations which were neither founded nor shaped in this connected world still have opportunity to create value in this new economy if they can innovate through embracing crowd based models.

The innovation imperative is undeniable. Research from Bain and Company (1) indicates that companies in the top 25% of their innovation survey grow significantly faster than others, achieving up to 84% growth over a five-year period compared to 28% for lower performers. Moreover, a recent Accenture survey (2) of senior executives in the US and Europe indicated that 93% of executives surveyed regard their company’s long-term success to be dependent on its ability to innovate. Only 18%, however, believe that their own innovation strategy is delivering a competitive advantage.

Open-innovation thinking and extensive academic research consistently uphold the need for new innovation models that can potentially take us beyond the boundaries of the notion of what constitutes the organisation and there are sound examples of good practice with some notable successes. Still, even with the connectivity and collaboration developments inconceivable when Chesborough’s first statement of Outside In models was made, such practices have yet to embed themselves as a natural and default mode in most organisations.
Why is there such a Knowing-Doing gap?
Is it possible that this new economic model causes us to reject our analytical decision support frameworks because they appear to be inherently redundant and of little value in the crowd empowered economy? The seminal ideas of Abernathy (*) were rooted in the boundaries of the organisation as they might have been regarded in 1967. By the same token, Williams and evangelism. (**) thinking on reducing transaction costs might be challenged significantly by the notion that external and crowd based solutions more efficient.

Can we rely on models and thinking rooted in such a pre crowd empowered paradigm?

Do we lack the frameworks to assist us in uncovering crowd based opportunity within our firm?

Are we therefore left rudderless, without the necessary compass to navigate the opportunity presented in the new crowd empowered economy?

If this is indeed the case, help is at hand. In this paper, we assert that, with some minor adjustment, many of our more trusted models can assist us in making sense of the opportunities available by providing us with a new crowd aware set of lenses to analyse and decide. Furthermore, we will propose a new and simple framework to help identify crowd based asset classes that will provide a pathway to identify application at a business unit and organisational level — and by so doing allowing an organisation to thrive in a disruptive and crowd based world. We refer to this as the crowd asset model.

The Web 2.0 economy has fundamentally transformed the way people interact and communicate. Geographical boundaries are no longer real constraints for organisations. Technological and societal changes mean that the floodgates are open for easy access to minds across the globe. With these technological advances and new levels of access to people, firms are presented with a plethora of opportunities for collaboration, co-creation, and a sharing economy. Different players in the value chain come together to create, improve, and deliver new product and service offerings.

For businesses, the crowd has become the source of efficient solutions, shared assets, deep insight, co-creation and the mobilised groundswell of activism and evangelism.

The validity of the notion of value and insight being present in a crowd has long been established. In 1714, the British Government was desperate to solve ‘The Longitude Problem’. Thousands of seamen were lost at sea each year due to imprecise longitude measurement. To solve the problem, the British Government offered £20 000 as a prize to the person who could solve the ‘Longitude Problem’. Considered impossible by many experts, John Harrison, the son of a carpenter, invented the first ‘marine chronometer’, which provided a precise location of a ship’s East-West position. The resolution of the ‘Longitude Problem’ is a testament to the power of crowd wisdom: an organisation or institution with a problem broadcasts it to a large group of disparate problem solvers. Those problem solvers are not blinded by the internal politics of the organisation, instead, they have the freedom to focus solely on the problem at hand. Moreover, while many individuals are indeed motivated by financial rewards, research shows that individuals are also swayed by intrinsic motivators: the respect and recognition from others. This is an incredibly powerful resource for firms.

In a more contemporary context, a powerful example of harnessing the crowd through open innovation is derived from InnoCentive, an organisation which serves as a platform for R & D development challenges that plague leading Fortune 500 companies. Organisations like Eli Lilly and Proctor & Gamble (as well as non-profit and government agencies like NASA, the Air Force Lab, and Rockefeller Foundation) post a challenge to InnoCentive’s solver community of 270 000 members from 170 different countries. Through additional partnerships with The Economist, Nature Publishing Group and Popular Science, the network of experts with access to the challenge spans 12 million people. The prize for solving a posted challenge ranges from $10 000 – $100 000, but solvers are simultaneously incentivised by the acclaim for success.

Similarly, we could point to another example of crowd based wisdom applied in a slightly different way to create value: Wikipedia. With 23 million articles in 285 languages and over 100 000 authors, Wikipedia is a testament to the collective power of individual minds and to the innovative spirit of crowd wisdom: had we been tasked with predicting the success of Wikipedia over Microsoft Encarta, the latter probably would have been considered the likelier of the two candidates to succeed, as Microsoft is a well-funded company with extensive resources and an established infrastructure. Yet reality shows the opposite: with 365 million readers, Wikipedia is now the world’s go-to source for knowledge, and that knowledge comes from authors all over the world, working for free for a cause they believe in. Wikipedia is the tipping point for the power of the modern crowd.

While the key illustrations here support the notion of looking outward for innovation and value, it also
is important to recognise that each has distinctive transactional relationships and the value is created in different contexts. As we will come to demon-
strate, it is important to understand these dynamics in order to effectively bridge the knowing-doing gap.

If we accept that it is indeed more reasonable and beneficial to embrace the open business models and harness crowd-assets, why aren’t there more organisations doing so?

The crowd asset economy challenges traditional business concepts and theory. In the world of the collaborative and shared economy, with its free-
mium revenue models where social applications with no revenue can go from launch to being valued in billions of dollars at the time of IPO, the bound-
daries of the organisation seem relentlessly tran-
sient and value creation models out of step with what was done before.

To traditional business thinking, the idea that Patagonia, the outdoor clothing firm, should set up an online platform to permit its customers to sell their used Patagonia products to those who might want them, but at no cost and with no revenue model for the company itself — they simply facilit-
tate the sale — might seem at best counter intu-
itive and at worst foolish. Yet Patagonia recognises that this builds brand loyalty, introduces new con-
sumers to the brand and, helpfully, provides further insight to the customers’ perception and assess-
ment of their product throughout its lifecycle. What is most important about it is that they have recog-
ised that this transaction will take place anyway, but they have taken the choice to be involved in it and hence somehow direct it and benefit from it.

In addition, leveraging external R & D in the innov-
ation process helps organisations to save both time and money. Development costs of innovation are reduced by greater use of external technology in the firm’s own R & D process.

Where then do incumbent organisations turn to tools and frameworks to help make sense of the challenges? In a world where innovation becomes ever more common for agile emergent organis-
ations innovating at market entry point, it may seem that the familiar analysis and decision support models are of less use and we are left struggling to identify the opportunity. Does this perhaps leave us without analytical models and method to act upon?

If this is the case, in order for your organisation to embrace the opportunity of the crowd empowered business, we must transform the current frame-
works to reflect the current landscape.

One of the main challenges businesses are facing in the sharing economy is their strongly defined traditional and inflexible definition of business model and organisational boundaries. In this model, boundaries are either implied or explicitly expressed largely by the extent to which management control can be made to reach, and by a constrained view of where value can be created. This has the effect of closing the mind to engagement and collabor-
ation models that have higher reciprocity, may link through several degrees of separation, and are inherently trust based.

It also prevents the adoption of innovation within the traditional notion of the value chain to find value creation opportunities which are novel or where traditionally we would have thought that only cost or threats might be found.

We contend that in a crowd empowered, open and collaborative economy, we cannot take such a rigid and firm view. Instead, we propose a move from this somewhat 2D monochrome world of the industrial economy to a multi coloured 3D perspective in the crowd asset economy.

While the crowd based view may appear challenging, it is possible to adapt some more familiar models to showcase the scope of the changes in order to analyse how we can introduce parts of them into our organisations, and for those common tools to act as guides into an otherwise obscure environment.

As an example, let us consider the McKinsey 7S framework. Developed by Waterman and Peters, this valuable and well understood framework has guided strategic development and thinking for thirty years by reminding us of the interrelated nature of seven key elements in an organisation and the need to balance, align and accommodate adjustments across these seven areas through periods of change. One of its great strength is that it does not seek to present an optimum arrange-
ment, it simply reminds us that all the elements are linked and that a change in one will have impli-
cations for the others. This flexibility means it can be used as an analysis framework and a planning or decision support tool. A major development and an acknowledgment of an understating of the complex nature of organisations it has served us well.

However, presented in its two dimensional for it implies a defined boundary to the organisation as we might traditionally understand it. It subcon-
sciously guides our thinking to imagine that our management approach begins and ends with that which we can directly influence, within our tradi-
tional notion of the management purview.
In a highly networked, crowd empowered world, the notion of a clearly delineated and vertically integrated organisation is a vision of stagnation and rigidity, and is therefore unable to embrace the opportunities that might exist to innovate within the business model and across products and services. We need to move the model into a 3 dimensional plane to unlock its renewed value. By allowing the individual extension of the 7 facets through an internally facing and externally facing plane, there exists an opportunity to innovate amending and/or enhancing through the crowd. This will allow businesses to look beyond traditional business models and constrictions and instead utilise and leverage crowd wisdom both internally and externally.

This simple adjustment can free our thinking to explore novel configurations of these elements into a more fluid idea of the organisation. In so doing it does not diminish the flexibility of the tool as it can still operate as analysis framework and a planning and decision support.

In this new form we can readily imagine accommodating the notion of cloud based systems, externally based skill sets, embracing multiple and perhaps transitory shared values, as part of the seven elements in our organisation.

It is possible to adapt other established models to similar effect and so reinvigorate them for the crowd based economy.
Porter’s Value Chain is a value analysis tool that helps us to identify the value adding process, describes the ‘business we are in’ and, since its popularisation in the book Competitive Advantage, has been a standard tool for consultants and practitioners alike. However, its linear and process oriented model, separating primary and secondary activities, is generally illustrated and visualised with its arrow shaped 2D schematic that describes functions that we might typically associate with business units and, subliminally if not explicitly, binds our thinking into the traditional notion of the organisational boundaries.

The model has been adapted elsewhere to expand our understanding of how we can adopt more open crowd based models into an existing business model.

Yet we would like to take that a step further to reinforce and expand the point, by employing the device we used to adapt the 7S model. The use, scope and transformational power of the insight become more compelling and our notion of the boundaries of our organisation dissolve more readily into one where the idea of crowd driven innovation is visible. It illustrates comprehensively that value generation can be an open and collaborative process and that we can and should look to efficient crowd assets to innovate and grow.

This modest adjustment demonstrates that these models have continued application and value, and that whilst a crowd empowered environment requires us to open our thinking, we have no need to entirely abandon many of the good management practices we are familiar with, we simply need to adapt them to open our horizon of analysis.

The additional virtue of this modest adjustment to the Value Chain is that it is particularly helpful in demonstrating that innovation has a scope of application from the businesses unit level, to the firm and then beyond. This is useful for whilst change can be made at a business unit level and is not dependant on wholesale change, we contend that the true winners in a crowd empowered economy will be the ones who adopt a more wholesale and transformational model of their firm and not those who take a piecemeal approach tinkering a little here and there, flirting timidly with the crowd.

One useful visualisation tool to illustrate this is one developed by IBM’s Institute for Business
Value Analysis. This figure is typically employed to demonstrate the opportunity created by the introduction of new and disruptive technology and it shows, in a simple and understandable fashion, the breadth of response available to organisations in their readiness to embrace the opportunity. Some are more iterative and cautious, and seek to utilise the opportunity to enhance what they already do. The more ambitious ones employ the opportunity in a more transformational manner and see it as a chance to reinvent, transform and create entirely new opportunity. This same reference can describe the opportunity presented by crowd assets.

This illustration has a tremendous familiarity and simple, but practical, application to us, as we can all plot the location of our own organisations on it. In reality most will have two plots the ‘as is’ and the ‘aspirational’.

The impact of the crowd economy is, however, so profound, driven as it is by economic, societal and technological factors, that, in order to prosper, a firm should move to the disruptive end of the graph, and do so before it becomes a question of survival.

So in our ambition to move from knowing to doing we have established a better grasp of the dimensions of distributed assets through the restructuring of established frameworks. This allows us to look outwards as well as inwards, now we need to

Figure 5: 3d Porter

Figure 6: IBM graphic

Source: IBM Institute for Business Value analysis, 2012
identify the practical application of the distinctive crowd asset classes that may have value for us. Let us consider some of the generic opportunities that present themselves.

As demonstrated in our examples, one obvious opportunity is crowdsourcing. If Henry Chesbrough coined the term 'open innovation,' Jeff Howe coined crowdsourcing and there is a strong philosophical connection between the two concepts. According to Jeff Howe, 'crowdsourcing represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively), but is also often undertaken by sole individuals. The crucial prerequisite is the use of the open call format and the large network of potential labourers' (1).

This sits comfortably with Chesbrough's idea that 'firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology' (2).

While large cap organisations like Proctor & Gamble or GE utilise open innovation and crowdsourcing to breakthrough new products, small businesses and entrepreneurs can look to these activities as means of incrementally improving their products and services with other companies as partners or through crowd feedback. By opening up the research and development process to the crowd, small businesses can capitalise on the abundant knowledge base of the crowd.

A subset of crowdsourcing contains the concept of crowdfunding, a practice we have already referred to as a manifestation of the disruptive possibilities of the crowd asset economy. It is one of the most promising resources for restoring capital to businesses, defined as the collective effort of individuals who network and pool their resources, usually via the Internet, to support efforts initiated by other people or organisations. In its various forms, crowdfunding allows entrepreneurs and SME's to solicit capital from investors, using social networks and crowdfunding platforms to finance their businesses and projects. By doing so, individual entrepreneurs and early growth companies can solicit donations from individual stakeholders (including friends, family, colleagues, other business owners, etc.) by appealing to their intrinsic, emotional, and social motivations. Not only does crowdfunding solve the challenges of early-stage financing for the business owner or entrepreneur, it also establishes a strong communication link between the funders and the company, whereby the funders can offer feedback and suggestions for the product.

Crowdfunding enables enterprises to validate products by gathering a critical mass of funding (and customers) before the venture even goes to market (and in some cases, before the product even goes into production!), ultimately mitigating the risk associated with a new product because the mass of customers already exist. This new mix of the collective creative with productive capacity and execution enables enterprises to identify, collaborate, and produce in an entirely unprecedented manner.

Establishing a strong communication link between the business owner and the crowd paves the way for open business models. According to Henry Chesbrough, 'Open business models enable an organisation to be more effective in creating as well as capturing value. They help to create value by leveraging many more ideas because of their inclusion of a variety of external concepts. They also allow greater value capture by utilising a firm's key asset, resource or position not only in that organisation's own operations but also in other businesses.

Open business models can help businesses from a revenue perspective by licensing its own technologies to other companies and by using outside resources for internal innovation, research and development initiatives. This saves the small business both time and money, in addition to incrementally innovating existing products and services.

Continual product innovation is essential for businesses to remain competitive and profitable. Crowd-empowered mechanisms like co-creation and open innovation are central to this process. Co-creation is defined as form of marketing strategy or business strategy which emphasises the generation and ongoing realisation of mutual firm-customer value. It views markets as forums for firms and active customers to share, combine and renew each other's resources and capabilities to create value through new forms of interaction, service and learning mechanisms (1).

Let's look at a way in which co-creation was utilised by a large corporate organisation. In 2005 the CEO of Intuit recognised the impact of co-creation with customers when Intuit customer service teams began experimenting with online support forums moderated by enthusiast employees. He asked the question 'how might we leverage user contribution at Intuit, both to enhance existing businesses and create new ones?' Two executives came up with the idea for enhancing the company's tax preparation software for tax
professionals. The company built a new community around in-depth advice for obscure tax issues, causing tax preparers to interact with each other. The site attracted 400,000 unique visitors (equal to the number of tax preparers in the United States), and contains more than 170,000 pages.

For Intuit, the company learned about the kinds of tax preparation questions that professional customers have, and many people went on to purchase the software as well. The organisation is rolling this insight out into new products (P).

The concept of collaboration is exemplified in the ideas of the shared or collaborative economy. Often seen as being a P2P phenomenon, it has valuable application in the B2B and B2C world to.

The crowd offers small businesses and entrepreneurs tremendous resources in execution through collaborative production of products, collaborative logistic solutions and efficient exploitation of assets. Car sharing, hackerspaces and shared workspaces speak to the willingness of consumers to connect with strangers to achieve some sort of shared goal. Technological innovations like 3D printing underscore the growth of collaborative production and distributed infrastructures. For small businesses, this means reducing costs by opening up production to the crowd and engaging the crowd for open and distributed innovation.

What more can be done to unlock this crowd asset economy to all? Porter’s model demonstrates how the existing Value Chain might be extended to take recognised functions and offer a crowd based twist. Yet this poses limitations by binding us into a recognised and established framework. Our aim is to free the thinking further still to allow for a range of innovation from the iterative optimiser to the disruptive strategic challenger and to be able to apply this analysis from the business unit level to a fully crowd empowered enterprise. As alluded to earlier, the characteristics and approaches to unlock these opportunities vary by the nature of the location of the value, the style of the collaboration in terms of its power relationship, and where we might place ourselves in the resulting value chain. To help make sense of this diverse spectrum of opportunity we are presenting an analysis tool that sets out the key crowd asset classes and how they can be identified and used.

We have classified crowd assets as falling within four main classes which are, as with all good frameworks, plotted into a quadrant defined by two axes. One axis expresses the spectrum of focus of value within a crowd. That is to say, is it vested in an individual who lies unidentified in the crowd and must be sought out? Or is it perhaps a group of agents in the cloud that create value through a series of coordinated but discrete activities? Or is it the entirely of the crowd acting in concert that creates the value?

The second axis is an expression of the power or control relationship between the organisation and the agents. This can range from a formal managed and controlled transaction with a clearly defined and direct management relationship to a situation where there is no power to directly influence or control the agents one can only nurture and encourage the crowd to mobilise the crowd.

Let us consider more closely what each quadrant represents and what typical type of activity we might find in each (Figure 7).

A. In this sector we consider assets that are found in the application of a crowd of individually skilled interventions that are collaboratively
harnessed to create value. This might include wiki creation and open source code writing, where the skills are vested individually but create value collectively and are bound collaboratively to a common end. An organisation might provide a platform or context for this type of activity to take place and some attractors to encourage it but the relationship is a less managed one, and takes the shape of a coaching role.

B. In this sector we consider specific skills that might be vested in a single individual or small group but these individuals exist, unbeknown to us, in a crowd. Here the skills are usually highly individualistic or deep and the value is created by attracting or locating these resources for a specific activity. This might include crowdsourcing highly specific innovation and R & D, design skills, or crowd sourced recruitment and is very much the heartland of open innovation. Typically this is a more highly managed relationship.

C. In this sector we can envisage the value from a mobilised group to take action. Here the crowd is the vehicle that fuels the activity, relying on the extended trust tags that ripple out hand to hand. This is the ‘strength of weak ties’ as observed by Granovetter (1). This ‘ground-swell’ relies on the aggregation of many small acts. The value is found in the swell, volume and pressure of activity and is reliant on influence and affinity. It is, however, a very difficult situation to manage or control in the traditional sense and so nurture, nudge and influence are the main methods employed here. This might include crowdfunding, campaigning, brand value development and viral marketing, or micro commerce transactions.

D. In section D we find the crowd connected infrastructure, where a series of discrete activities vested in individuals can create value when brought together as an operational services or collaboration. So each act has limited value in itself but when coordinated they provide a valuable function. Here we might find innovative service delivery like P2P delivery mechanism, open source production, and collaborative consumption models that require a group of participants to deliver.

The crowd asset model maps the breadth, spread and specific dynamics of the way in which crowds deliver value. It can be used to identify where there is value within the organisation that can be unlocked by utilising and integrating crowd based activity to a business model.

Hence if we rely on the deep and specific skills of individuals to create value, the sort of activity found in area B might unlock new value for us.

This is a tremendously diverse and flexible landscape and includes opportunities to reduce transactional costs by harnessing external resources to transact process, deliver deep insight otherwise not available, and unlock dormant assets that would require costly or unavailable internal resource by perhaps sharing a patent library with a crowd asset for example.

At the same time we can identify opportunity to re-focus or adjust our position in the value chain by applying specific competencies or facilities within a crowd enabled environment.

It is important to recognise that the model does not provide an optimum solution or configuration and that it is merely an analysis and decision support tool.

By using our reconfigured familiar frameworks we can free our point of reference to consider what we might once have described as the organisation to embrace a much wider set of participants to be included within that on either a temporary or permanent basis. The crowd asset model allows us to consider the value creation opportunities available by letting us locate value creation opportunity by crowd based and open models.

**Let’s Consider this via a couple of Practical Examples.**

GE and Quirky have applied multiple crowd-based mechanisms to invent new products for the global market. Like most companies of its size, GE has the money and the manpower to create and bring new products and services to market on its own. Yet recently, in an effort to expand its product portfolio and bring in external ideas, the organisation announced a partnership with a small company called Quirky. Quirky makes invention more accessible by bringing products to market through an online collaborative portal. Users (mainly inventors) submit ideas through the crowd sourced panel and the organisation selects which ideas it wants to bring to market. Once an idea is selected, the production team within the company works with the Quirky Global Community, covering all parts of the innovation ecosystem, beginning with ideation and ending with sales. Through distribution agreements with companies like Home Depot, Target, and Best Buy, Quirky is able to bring their users and inventors platforms to market.

Together, the GE and Quirky team created a platform on which the users can access GE’s patents. In
exchange for providing access to its patents, GE will receive a portion of the revenue from the product once it hits the market. If the invention makes it to market, the inventor is paid back 12.6% of whatever revenue the invention makes. GE, on the other hand, is actively adding new items to their portfolio of products by engaging with inventors and problem solvers from the outside. The basis of the Quirky/GE partnership is the development of connected home devices. For example, one of the main products expected to hit retail shelves for the holiday season is the Egg Minder, a mobile-connected smart egg tray that keeps track of not only how many eggs you have in your refrigerator, but also tracks how fresh the eggs are. If the egg tray suspects an egg is going bad, an LED light shines over the egg. Once the Egg Minder senses the tray is low on the numbers of eggs, it sends a push notification back to the owners’ telephone, letting them know it’s time to purchase more eggs. According to Quirky, while there was one main inventor of the Egg Minder, 2,383 influencers helped bring the product to market.

By using crowd-empowered mechanisms like co-creation, open innovation, and crowdsourcing simultaneously, organisations can create value chains that let more people into the process of innovation and value creation, while still controlling the process. Traditional methods of innovation are often concentrated in a company’s internal R&D or innovation lab. For GE, crowdsourcing highly-specific innovation, R&D, and design through Quirky’s community of engineers and members is not only efficient, it cuts innovation costs by creating an expansive value chain whilst retaining control over the process (see Section B in the Crowd Asset Model).

Following the announcement of their patent-sharing agreement in April 2013, GE announced in November that they will be investing $30 million dollars in the partnership with Quirky and the two companies will work together on 30 products over the next five years. According to Beth Comstock, GE’s Chief Marketing Officer, ‘There are a host of consumer applications that we haven’t had the ability to focus on. That just isn’t our core business’ (19). While consumer applications may not be GE’s core business, the Quirky team understands the brand value GE brings to the table. Through this collaboration, customers are able to purchase innovative products from a household brand — and with that brand trust comes the confidence in its functionality. See section C in the Crowd Based asset model below.

Another example is that of Local Motors. John B. Rogers was serving in the United States Marine Corps when he came up with the idea of Local Motors. Like his predecessors at Tesla, Rogers wanted to bring environmentally conscious cars to market. By focusing on efficient design and manufacturing, Rogers wanted his buyers to be co-creators participating in the process, a type of business model that would prevent unbought cars from rusting over in dealership parking lots.

Rogers channelled his vision into what is now known as Local Motors, the world’s first open source car company. The company brings together a global community of designers, engineers, fabricators and car enthusiasts to build new automobiles through distributed manufacturing channels. Local Motors also has partnerships in place with large enterprises including Siemens, Shell, and BMW. As part of their partnership with Siemens, Local Motors uses their computer-aided design (CAD) software and recommends the software to its global community of 30,000 designers.

Local Motors also works with large enterprises through hosted challenges, whereby the enterprise may outsource a design task to the Local Motors community of designers in exchange for cash prizes. For example, in 2012, the BMW Group challenged the community to define the future ‘premium vehicle’ in exchange for a cash prize. The parameters required the designers to address issues such as interior design, connectivity, and functionality.

In November 2013, Local Motors and the United States Army Rapid Engineering Force (REF) announced a partnership in which the organisations would jointly develop an online platform, aptly called the Army CoCreate, to enable the design and development of safer and better performing gear for warfighters. The Army CoCreate platform will bring together civilians, soldiers, scientists and inventors to develop these solutions and quickly get them out to soldiers on active duty. ‘Soldiers are living and breathing the fight, day-in and day-out, so they have the best ideas for new capabilities to solve their most urgent challenges,’ said Sergeant First Class Adam Asclipiadis. ‘We need to connect those ideas to the people who can make innovations a reality’ (13).

The initiative is divided into four phases. The first phase is centred on ideation, where Army CoCreate users brainstorm and submit ideas about the main challenges. Members of the Army CoCreate community vote on the ideas, determining which concepts will be selected as the main project. The second phase is about suggesting solutions to the challenges. Designers, inventors and enthusiasts can submit their sketches, designs and ideas for solving the challenge at hand. The third phase is about project selection; in conjunction with the
Army CoCreate Community members, the REF will select projects to develop. In the final stage, the Army will prototype the products using 3D printing and other technologies within the REF expeditionary laboratory. This is an excellent example of the manner in which organisations can use distributed infrastructures for production, crowdsourcing highly-specific R & D challenges, and connected infrastructure and operational services. By partnering with the RAF and engaging the Local Motors community of users, the two organisations will be able to ideate, create new products, and produce them more efficiently and with greater speed than if either organisation was operating independently. See sections B and D within the Crowd Asset matrix.

The crowd asset economy is the natural extension of the open innovation principles and we are still at the early stages of this new and exciting period.

We need to consider how we should develop and accelerate the adoption of the openness that will drive our new economy. These models and frameworks go some way to help in that process but the scope for experimentation and exploration within this is enormous. We believe that the spirit of openness and crowd empowerment should also lead this process and would like to open up the sharing of experience, evidence and practise to you the crowd. By engaging in an open exchange and collaboration in developing open source thinking on this subject we will embed and expand it more quickly.

For example, to operate within each or any of the four sectors of the crowd asset model requires different and sometimes new approaches and methodologies to those which we might be used to. If we were to consider the ability to understand and employ this new crowd based perspective as a competence or strength could we possibly map the characteristics that would evidence that an organisation possessed the skill? Might these include, for example, an organisation that rejects notions of highly defined, inflexible and segmented classifications of those with whom it has relationships? So the organisation that can understand and manage a circumstances where a customer can also be a collaborator, co-worker and innovator, simultaneously might have a significant strength and competitive advantage in a crowd empowered environment? If we can clarify these skills can we then develop them and, in so doing, move amongst the dimensions of a SWOT matrix to both develop strengths, reduce weakness and, by extension, embrace the opportunities offered?

To this end we plan to create a community of crowd asset exponents who can progressively develop the crowd asset model. This will be done through the sharing of insight and application via a cloud based community which ‘does’ the business of harnessing the opportunity opened up by the crowd. We can then develop novel applications of the framework to unlock greater value, chart and map key competencies and techniques, and create a catalogue of real world examples of the spread and application of the crowd in a business, civil and social contexts.

We began this article with a statement that the crowd asset is the new source of value and innovation, founded on the notion that the assets for innovation and value may well be located within the crowd. We also suggested that this approach was far from normal business practice and whilst we may increasingly recognise intuitively that there are possibilities here we are not moving from knowing to doing in anything like the numbers we could and should. Furthermore, we suggested that it may be that we need help to recalibrate our thinking to more effectively adopt the crowd empowered approach and that, by adapting some of our more familiar and well used frameworks, we might broaden our perspectives.

Through the introduction of the crowd asset model we can more fully appreciate the possibilities of the crowd empowered approach and how it is the natural extension of the open innovation model. We are now more readily able to move from the knowing to the doing stage. Yet at the same time we have acknowledged that this approach is still in its infancy and that the evidence and practicalities of this are somewhat thin on the ground. We ask you then to join this movement, this groundswell, and together as a crowd we will provide the engine, insight and inspiration for the next phases of economic and entrepreneurial dynamism that we all so desire.
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