Using Swarming to Build Complex Dashboards

Noelle Twomey
noelle.twomey75
@gmail.com

Paidi O'Raghallaigh
Cork University
Business School, UCC
Cork, Ireland
P.OReilly@ucc.ie

Tadhg Nagle
Cork University
Business School, UCC
Cork, Ireland
T.Nagle@ucc.ie

David Sammon
Cork University
Business School, UCC
Cork, Ireland
dsammon@ucc.ie

ABSTRACT

This paper reports on a project that took place in a large corporation to build a Customer Profile dashboard to provide a holistic view of its customers. Prior to the project, no such view existed and customer data was distributed across multiple sources and very few people had access to all required sources. In the absence of any co-located team with the required skillsets, the action researcher led a swarming approach to building the dashboard. She found no evidence in the literature of swarming being used for the creation of such digital artefacts. Based on her experience with this project, in this paper she offers insights as to how she undertook the project, the lessons learned, and the benefits (as well as difficulties) in undertaking this project. She found swarming to be a useful mechanism for resolving complex problems. It attacks the problems from diverse and expert perspectives offered by highly motivated team members. In this project, swarming produced a high quality digital solution that stakeholders felt was of superior quality to what otherwise would have resulted.

Author Keywords

Swarming; Collective Intelligence; Action Research; Design Research; Dashboards; Data Visualisations; Information Systems Development.

ACM Classification Keywords

H.1.1 **[Information Systems]:** Systems and Information Theory.

INTRODUCTION

This project looked to solve an internal issue for a company, ABC Corp, where no holistic / 360-degree view of its customers existed. ABC Corp is an American multinational corporation that sells data storage, as well as a range of other hardware and software solution. This was a problem for those in ABC who had reason to be in contact with customers - from executives to sales staff and

technical support engineers. There were many silo'ed views of the customer available but there was no single view that was comprehensive enough to build a holistic 'picture' in a short window of time. In order to build a holistic customer profile (CP) data from multiple sources would need to be stitched together. This would be a time consuming exercise as individual reports needed to be run and in addition very few people have access to all of the reports.

The project undertook Action Design Research in the areas of Dashboard Design and Data Visualisation. In addition, a collaborative swarming approach to the research was adopted. The project **focused on the Customer Profile needs of Executives in the XyZ Business Unit of ABC Corp.** XyZ is a scale out network-attached storage platform offered by ABC Corp for high-volume storage, backup and archiving of unstructured data. This paper describes in detail the journey of the lead author as an action researcher reviewing this problem, exploring the problem statement, and taking steps to resolve the problem. The paper describes in detail the journey of the researcher and her swarm team. The researcher used an agile framework to manage the entire project. This paper serves to introduce the reader to the intelligence swarming collaboration approach adopted during the project, while emphasising the benefits and some limitations that this approach had on the outcome.

SWARMING

Henry and Hiltbrand [1] describe swarming as "… *small groups of people who come together for short periods of time to execute a task, take advantage of an opportunity, or solve a problem. These teams are formed to leverage a disparate set of skills that are needed to address the task at hand".* By utilising the group's collective intelligence, the experience has been that projects deliver better solutions than any one individual could have done on their own. In his book 'The Wisdom of Crowds', James Surorwiecki [2] states "… *under the right circumstances, groups are remarkably intelligent, and are often smarter than the smartest people in them"* and they *"... do not need to be dominated by exceptionally intelligent people in order to be smart".*

The concept of swarming *"... enables these groups to form quickly, optimize the challenge, and then disband to form other swarms and address other organizational challenges"* [1]. Swarming has been seen to work even when the group is formed from individuals not co-located. Location is no

longer a barrier owing to advances in technologies, which enhance the swarming methodology. The Consortium for Service Innovation has described swarming as 'collaboration on steroids'.

METHODOLOGY

The term 'Action Research' (AR) was first used by Kurt Lewin in the early 1940's when he was researching alternative methods to traditional scientific research for resolving social problems [3]. It has its roots in studies of social and workplace issues. It was pioneered independently and concurrently throughout the 1940's in both the United States (for example by Lewin), and in Great Britain (for example by the Tavistock Institute). It could be argued that over the past 70 years the premise of AR has more or less remained unchanged. Many definitions of AR have been put forward over this period. For example, Lewin defines it as a research approach in which the researcher generates new social knowledge about a social system, while at the same time attempting to change the system [3]. Likewise Rapoport defines it as a research approach that aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science through joint collaboration within a mutually acceptable ethical framework [4]. In short, it is a research approach that combines theory and practice by way of intertwining research and practical activities in bringing about change. It is an iterative process with a strong feedback loop focused on learning by doing for change. The resulting outcomes benefits not only the organisation by resolving its issues, but it also aids academic research by generating relevant knowledge grounded in practice.

The researcher uses an agile framework in managing the AR project. In addition, she embraces the role of swarming in resolving a complex problem and also generating new knowledge. The concept of swarming is introduced as a mechanism for generating knowledge that goes beyond what the researcher herself or any one individual could ever contributed on their own. The approach to the project is based on Action Research where the individual and her team utilise an Agile Methodology together with Design Thinking tools – see Figure 1.
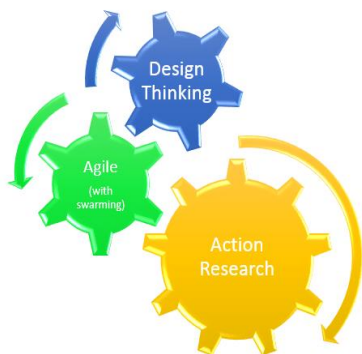

Figure 1 - Research Approach to Project

One of the most referenced AR frameworks is that of Susman and Evered [5]. A modified version of their framework (as Figure 2) is adopted by the researcher to guide her AR activities. This version emphasises the cyclic process of AR.

Figure 2 - Action Research Approach

The Figure below shows the timeline of the project with the key activities mapped to the various stages of the methodologies used to throughout the lifecycle.

Figure 3 – Project Timeline and Key Activities

THE PROBLEM

ABC Corp does not have a holistic 360-degree view of their customers. Instead there are many silo'ed views of the customers available from multiple data sources. So the crux of the problem is that while there are many views available there is no one single view that is comprehensive enough to provide a holistic view in a short timeframe. It would be an extremely complex task to merge data from many sources to build a complete Customer Profile (CP). This lack of a single Customer Profile was affecting ABC Corp's ability to either react to customer needs and issues or proactively address them. Furthermore it had a negative effect on customer relations as the customer was sometime made feel that ABC Corp did not know them. This problem was an everyday problem which could manifest itself in many ways, for example:

- Executives were going to client sites with insufficient information and were often blind-sided during customers' engagements.

- Executives and engineers were attempting to address customer issues while not fully understanding the customer profile.
- Engineers were often led into support situations like lambs to the slaughter without having a full understanding of a client issue.

When the action researcher was initially discussing this issue with the stakeholders in XyZ, she had first-hand experience of just how difficult, time consuming, and manual the process of creating a Customer Profile was. For example, a large customer (with in excess of a billion dollar turnover) was visiting ABC Corp's executive briefing centre to discuss a potential sale opportunity and also to voice some concerns about the level of customer support they were receiving. Fortunately ABC Corp had advance warning and time to prepare, but it still took four people (including the researcher) approximately three working days to build out a Customer Profile for this customer. The output was a fifty page slide deck that included a high level customer profile, sales history, services history, key performance indicator metrics, known issues at this customers various sites globally, and also analysis as to why the customer would potentially think they were not receiving the correct level of service from ABC Corp. So the problem here was not that XyZ needed more data but that it just did not have an easily consumable and readily accessible version of the data in one place. To add further to the severity of the predicament, the XyZ product install base was growing at an exponential rate.

For the XyZ the short term goal was simply to have a 360 degree view of its customers, a single version of the truth. The long term goal was to use this consolidated view to predict a customer's every move - whether it be in relation to buying new products and services or requesting support from the XyZ support organisation. This would help XyZ in moving away from a reactive support organisation to a proactive organisation.

THE INTERVENTION
This section explain how the researcher applied a swarming approach in generating knowledge required for creating a Customer Profile dashboard in an agile fashion. A dashboard is *"... a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance"* [6]. What the researcher found very interesting was that without exception all of the extant literature she reviewed was based on case studies, none of which were written from the perspective of someone designing and implementing a real-time dashboard or indeed from the perspective of an action researcher. Indeed a lot of the literature was written from the "what not to do" angle but there was little help in outlining 'what to do'. Here we outline the steps that the researcher undertook in swarming a way forward to

building the Customer Profile dashboard for XyZ executives.

Communicating the Problem
The researcher shared and verified her problem statement, via round table discussions and interviews, with her peers from other business units in ABC Corp's Global Customer Service Group. Her reasons for doing this were twofold

1. She wanted to get a thorough understanding of whether the problem was unique to XyZ or a wider problem within other units of ABC Corp.
2. She wanted to determine if a similar problem was being addressed successfully (or otherwise) elsewhere in ABC Corp and how this was being done.
3. She wanted to understand if any potential solutions she came up could scale to resolve similar problems elsewhere in ABC Corp.

She learned that this was also an unresolved problem elsewhere in ABC Corp. She also met with the Global Services Reporting and Business Intelligence team. After much discussion the team came to the realisation that while they could help her with the data, their existing business intelligence and reporting tools could not provide a 'single dashboard' for XyZ executives as they felt that performance would be comprised by the real-time number crunching that would have to occur in producing the Customer Profile.

Researching the Problem
Over the next number of weeks, the somewhat disheartened researcher continued researching what other organisations were doing and what tools they used to build dashboards. A chance conversation with a colleague revealed that a particular BI tool could possibly help her. The researcher attended a five day course, on using the BI tool to marry data from various sources to produce high quality data visualisations. The only negative realisation was that connecting to the various disparate data sources was not going to be an easy task.

She started to talk about her issue and ideas with just about anyone that would listen. For example, at ABC Corp's Big Data Conference in Boston, she met one of the guest presenters who had recently joined ABC Corp as a Consultant Technologist. He spoke about a new Data Lake that he was creating at ABC Corp and what a Data Lake could achieve for the organisation. The researcher went off on a search and found a blog entry by James Dixon CTO of Pentaho explainging: "*If you think of a datamart as a store of bottled water – cleansed and packaged and structured for easy consumption – the data lake is a large body of water in a more natural state. The contents of the data lake stream in from a source to fill the lake, and various users of the lake can come to examine, dive in, or take samples"* [7].

Marketing the Vision
The researcher met with her peers and the stakeholders in XyZ and they set out to create a cohesive vision for what the proposed project was hoping to achieve. She utilised

innovation games, such as the product box and billboard design games. One of the product boxes produced was for a fictional service referred to as Data Crunchies – see Figure 4. On seeing the outputs from the games, the Executive Sponsor was confident that the team grasped the problem and had a clear idea of what it would take to resolve it. The hope now was that the team could use these outputs to market their vision to the larger community and also to serve as a reminder of the bar they had to rise above in order to resolve the problem. However, she still awaited executive approval for the project.

Figure 4 - Data Crunchies Product Box

The team also worked together on developing an elevator pitch, which they felt needed to be concise, convincing, understandable, and most importantly serve as a catalyst for conversations. The final version of the elevator pitch was as follows:

"For XyZ Executives who need a holistic view of their customer base. Data Crunchies is a self-service dashboard that provides Executives with an all-encompassing view of their Customers from their install bases to CSAT trends to proactive service opportunities. Unlike today's fragmented view, "Data Crunchies" contains all the relevant data needed in one place which is easily accessible for the first time ever."

Selling a Product Prototype
The researcher collected the user stories, which gave a clearer picture of exactly what the user needed to do and which data they required. Using this information she produced an initial low fidelity of the dashboard on a whiteboard. She came to suspect that this would not be enough and that she would need to produce a functional prototype using the BI tool, her newly acquired BI skills, and a 'Data Pond' that she would create from snapshots of some of the data sets she could get access to. A sample of the result of this work can be in Figure 5.
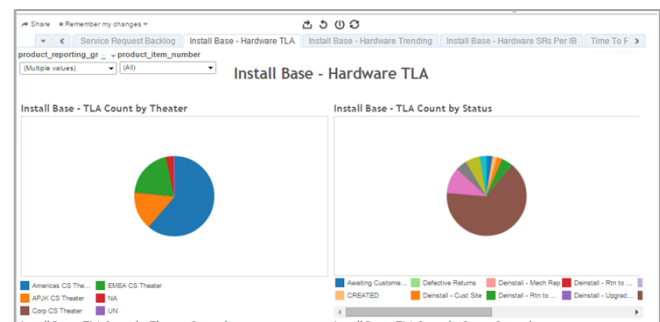

Figure 5 - Early Dashboard Prototype

She was aware this was still a very raw version of what the stakeholders wanted to see but at the same time they would be able to interact with it and get a feel for what a Customer Profile dashboard could look like. At the same time she would gather their feedback. She believed that if she could convince the executives that with their backing she would be able to source the correct skilled resources to build the solution. Shortly afterwards the executive sponsors informed her that the project proposal was approved in principle. The researcher immediately reconnected with the Data Lake Consultant and it was agreed that the project would be used as a proof of concept for the Data Lake initiative within ABC Corp's Customer Service Division.

Forming the Swarm Team
The fact that the researcher still did not have a team of skilled resources available was by now an increasing concern. The Data Lake Consultant offered to source a team of skilled resources to assist in producing a proof of concept. The only stipulation being that the proof of

concept would need to be delivered in a very short time frame – three weeks. It was also decided that a 'swarming' approach would be used to deliver the project. In the absence of designated resources, swarming would allow for people to opt into the team based on their skill set and their interest, and that location would not be a barrier. Within days the researcher was introduced to a BI Tool Consultant (from Los Angeles), a Data Scientist (from Boston), a Business Intelligence SME (from Bangalore) and a Data Lake Expert (from Seattle). With the fear of lack of resources now allayed, the attention of the researcher now turned to getting these people to gel into an effective swarm team and to work well together.

Norming the Swarm Team
The swarm team met so that the researcher could review the problem statement with them and bring them up to speed with what she had been doing over the previous months and the vision for the project. They now started to populate a project data sheet (PDS). Although the researcher had completed a project charter earlier in the process she felt that a PDS would help with the following:

1. Identifying the project community
2. Identify the key stakeholders
3. Defining the business objective
4. Recognising the performance attributes
5. Completing a Trade Off Matrix
6. Categorising possible risks to the project
7. Defining Key Milestones
8. Defining functions for various users

The swarm team revisited the user stories that the researcher had previously collected. They used these to create a product backlog so they could start to plan the release cycles. They carried out a 'T-Shirt Sizing Exercise' to help prioritize the stories in the backlog. With T-shirt Sizing, the team estimated whether they felt a story was extra-small, small, medium, large, extra-large, or double extra-large, relative to the overall body of work that would need to be executed. By focusing on relative sizings and eliminating numerical sizings, the team was free to deliberate in a more abstract way about the relative effort that would be required for each story. Next they prioritised the stories within the backlog.

The newly prioritised and estimated backlog helped the swarm team to convey expectations about what was likely to be developed, in what order, and in what timeframe. This was used to create the team's release or iteration plans. The researcher felt that a release plan was an important artefact for the product owner (which was herself) because it allowed her to communicate with the project stakeholders and to manage the broader expectations for the project. It also helped the swarm team to plan and visualise the release order appropriately. The release plan became a guide-post that channelled the drive of the swarm team on a definite course. They decided to keep their sprints or iterations to a maximum of one week cycles with the objective of producing at least four or five features in each cycle/iteration and being fully complete within three weeks.

Swarming the Iterations
Due to the fact that the swarm team members had all opted into this project, there was little storming typical at this stage of many team formations. Ready to start their work, the researcher and the swarm team did not know what to expect. They all dialled into an online video conference from their local desks. The BI tool consultant had the reigns and opened a blank BI workbook and they started from there. They had identified in their release planning that they were going to work with the data that had already been ingested into the Data Lake. At the same time, the other team members were locating the other data sets, ingesting them one after another into the Data Lake and parsing them for use. This was a continuous process. If any one of them had a down cycle they jumped in with the BI Tool Consultant and the Researcher who were busy visualising the data in the BI Tool. The researcher noted how: "*The experience was phenomenal, we were constantly bouncing ideas off each other but the real benefit of swarming soon became apparent. I obviously had ideas of how I would like to visualise the data and had done in [my earlier prototypes] but [the BI Tool Consultant] brought it to another level, he had 2 years' experience of creating visualisations for multiple companies, he had a great eye for what worked aesthetically and had in-depth knowledge of what graphs and colours people found easier to read. While I, from an operations perspective, knew what Metrics / Key Performance Indicators should be compared in the same graphs*". At the end of their first 8 hour session they had created a number of new BI worksheets - an example of which can be seen in Figure 6.
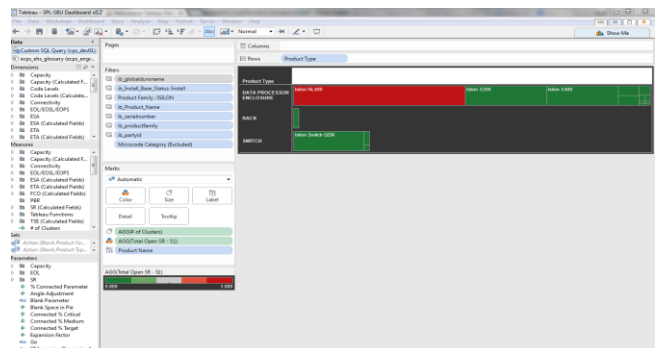

Figure 6 – Example of BI Worksheet

Although they had planned to use the stakeholder group to evaluate their outputs at the end of each iteration, the researcher found that the stakeholders were keen to see the work. So next morning she sat with some of the stakeholders and presented the outputs they had completed the day before. The researcher brought this feedback back to the swarm team. The team immediately recognised that this more frequent feedback would benefit the project as they would be getting near real time feedback and direction from their stakeholders. They decided to change their

approach immediately to incorporate these daily feedback cycles. Each swarming day would now start by reviewing the feedback and addressing the changes requested by the stakeholders.

The days quickly turned to weeks and they were churning out daily copies of the BI worksheets for review with the stakeholders. The team members were working odd hours in order to complete the backlogs on time. Each day all team members joined an online video conferencing session and remained totally connected for approximately eight hours each day / evening. They were all aware in real-time of what was happening, who was doing what, and how the project was developing. They talked and asked questions almost continually. This meant there were no delays waiting for each other's' responses.

At the start of the third week they had close to seventy BI worksheets. However, the researcher noted how: "*I had Stephen Few's Dashboard definition ringing in my ears that a dashboard is a visual display of the most important information needed to achieve one or more objectives arranged on a single screen so the information can be monitored at a glance. Having 70 worksheets was excessive by anyone's standards but at the same time it was almost all the data the stakeholders wanted to see*". The researcher knew they would need to consolidate the worksheets onto a smaller number of dashboards. She expressed her concerns to the team. They realised that they were bringing worksheets together to tell a story. They started to look at the user stories and used the features, epics and stories to guide the drill down functionality.
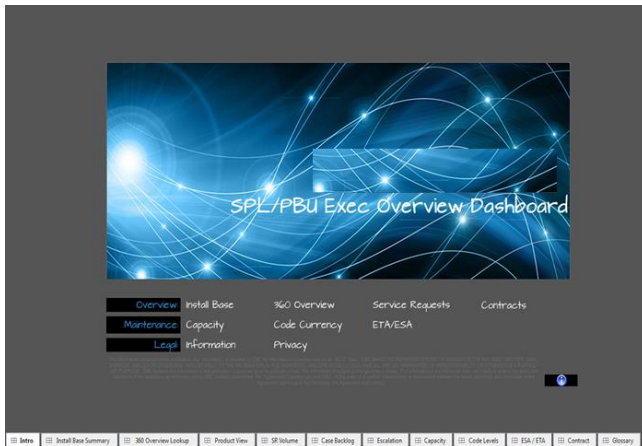

Figure 7 - Customer Profile Dashboard

On presenting the work to stakeholders, the researcher observed them interacting with the new dashboards. Their feedback was very positive, some of the thoughts were:"*Before I would have had to extract this data and slice and dice it myself", "Have you any idea how much time this saves me*", and *"This is awesome!"*. Obviously the swarm team was excited that the project was going well but they also knew that they would be disappointing the stakeholders shortly as some of the data that they requested

such as the CSAT and Escalation data was proving more difficult to get access to and would not be available before the team finished its work. The team continued its work until it was finally at a point where it could hand over the newly created Customer Profile dashboard to the stakeholders – see Figure 7.

Evaluating the Outcome

For the final evaluation the swarm team released the proof of concept dashboard not only to its own stakeholders but also provided working copies to the wider Customer Services operations in ABC Corp and their respective executive groups. There were a number of reasons for taking this direction:

1. To counteract the AR threat of producing an overly narrow solution and understanding.
2. To market the dashboard and gather interest from groups outside of the XyZ group.
3. To provide a wider and deeper evaluation of the dashboard to support a stronger business case.

They followed up with round table meetings and interviews. The response was exceptional and without exception each reviewer had nothing but positive feedback for the team. The team was inundated with invites to demo the dashboard to the wider middle management audience which it gladly accepted. One evaluator suggested how the dashboard *"... started the creative juices flowing of what else this type of Dashboard could be used for"*. It opened doors for the team to display its work and since then they have been approached to consult on creating a Customer Profile dashboards for other use cases within ABC Corp.

LESSONS LEARNED

The following is a summary of the learning outcomes from completing this Action Research project:

1. Swarming was a very exciting and energising approach to the project. The whole process was a learning experience. The swarm team were divided by geography but unified in their vision and commitment to the end solution. The researcher had not experienced a collaborative process like swarming before. She found that: "*No one was involved because they 'had' to be, everyone was involved because they 'wanted' to be. The skills and experience that people brought to this project without doubt facilitated in-depth discussions and because we were all involved in every element I believe I gained skills myself that I wouldn't have otherwise been exposed to from the collaboration as a result*".

2. Visual tools were invaluable throughout this project and in supporting the swarming activities.

- The tools helped to bring the problem to life and in gaining stakeholders' confidence.
- Techniques like the 'product box' assisted in getting the stakeholders end state vision across.

- The tools and techniques mapped effortlessly to agile and in turn to action research making implementation of this project more stimulating then projects the researcher had worked on previously.

3. The need for research to guide the swarming was crucial to its success. Had the researcher not been participating in an action research project she felt she "…*would be certain of the fact that I would have made many common mistakes when it came to building out the dashboard. Having researched the area of dashboards and data visualisation helped me in avoiding many of the common pitfalls as pointed out in the literature that I had reviewed prior to commencing the project as highlighted by the many authors*". However, she found that the academic and practitioner literature on swarming mainly referred to the use of swarming in problem solving situations. Many trade press and other articles spoke of swarming within the context of call centres or support centres. The only exception was the gaming world where swarming was becoming commonplace.

4. Swarming requires having the right skills on the swarm team. In 'World of Warcraft' players form temporary teams based on the unique skills required to overcome challenges. These teams are known as 'Pick up groups' (PuGs) in gaming. The selection of team members is based on identifying other players' skills and their statistics in a skills database or repository known as 'The Armory'. Henry and Hiltbrand [1] suggest that organisations should be investing in skills data bases similar to 'The Armory' to "…*gain a firm grasp of the competencies and skills associated with each of their employees*". The researcher concurs and recommends that skills databases should be developed companywide to encourage group participation and adoption of swarming practices. The introduction of such skills databases could further enhance the rate of adoption of swarming where the idea of PuGs could be explored to the ultimate benefit of the organisations.

5. The importance of getting the frequency of evaluations right when undertaking swarming should not be underestimated. Opinions differ, some might think daily reviews were excessive but the swarm team found that they were optimum for the proof of concept. It allowed the team to deliver exactly what the stakeholder was expecting in a shorter timeframe.

CONCLUSIONS

The researcher found no evidence in the literature of swarming being used for the creation of physical or digital artefacts. Based on her experience with this project, she feels swarming is an ideal method for a diverse group to not only problem-solve but also to ideate and create physical and digital artefacts even when group members are not co-located. With so many companies in existence today who have employees disbursed across many countries and continents, she predicts that swarming is likely to become mainstream over the next number of years. Swarming is an

ideal process for solving wicked problems: "*Because wicked problems are complex and diverse, it is necessary to attack them from multiple perspectives, and the diversity of these perspectives will typically require many different people with different backgrounds and competencies to come together*" [1]. In this project, swarming produced a high quality digital solution that stakeholders felt was of superior quality to what otherwise would have resulted. Swarming brought the following benefits:

- Swarming is more than a tool. It is a behaviour and possibly even a philosophy.
- Swarming provides access to highly skilled specialised resources that otherwise may be inaccessible.
- Swarming is a means for rapid knowledge sharing, skills growth, and accelerated learning.
- Swarming can capture and share knowledge / best practices through organisations.
- Swarming is based on an 'Opt In' model with the result that team members tend to be highly motivated.
- Swarming promotes collaboration rather than competition between team members.
- Swarming aligns people and projects based on the needs of the organisation and the desires of the people doing the work.

Swarming, therefore, seeks a Sweet Spot at the intersection of employee's skills and interests and the organisations goals and objectives – double win.

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