LINKED DATA FLOWS IN MULTI-PLAYER GAMES FOR SERVITISATION

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1 ABSTRACT

The increased data complexity and task interdependency associated with servitization represent significant barriers to its adoption. The outline of a business game is presented which demonstrates the increasing complexity of the management problem when moving through Base, Intermediate and Advanced levels of servitization. Linked data is proposed as an agile set of technologies, based on well established standards, for data exchange both in the game and more generally in supply chains.

2 INTRODUCTION

Servitization was introduced by Vandermerwe and Rada (Vandermerwe & Rada, 1989) to describe how manufacturers extend their operations beyond making products to services associated with those products as a strategy to counter low cost competitors. Servitization is used as a means to move manufacturers up the value chain thus increasing their profitability. Implementing servitization is challenging however, and to date most best practise examples focus on larger companies (Baines, Lightfoot, Benedettini, & Kay, 2009). The desired improvement in profits may also not be easy to gain, with some authors reporting lower profit margins from servitized manufacturers, e.g., (Grönroos & Ojalsalo, 2004). Particularly for smaller companies, the challenges associated with the major strategic change of adopting servitization can act as a barrier.

Serious computer games have potential for accelerating adoption of servitization by manufacturing companies. Games can be used to can be used to entertain, educate and inform decision makers in companies. Helping them to devise good strategies, to apply servitization in their manufacturing businesses and to understand how business processes and information systems might have to change to ensure success. Studies related to servitization that use games are currently limited but promising, we are only aware of (Laine, Paranko, & Suomala, 2012). However the serious games have been used in the development of business practices (an essential step in servitization) (Liukkonen, 2009), and simulation has been used in the design of services (Oliva & Bean, 2008). Therefore we are confident that games which will allow manufacturing decision makers to learn about and experiment with servitization concepts can be built.

In this paper, we will examine one barrier to servitization, namely the requirement for increased complexity of communication and data exchange inside companies and between companies and their customers and suppliers in order to support the product service model. This is related to the notion of task interdependency identified by (Turunen & Neely, 2012) and may need to be tackled by changes to the organizational structure, such as enhancing vertical integration, to processes, such as ensuring the input of service staff into product design, and to information systems, such as improving their agility in the face of change. The games must be built as multiplayer games to simulate these communication and interdependency issues.

In this paper, we make the case for using web standards for data exchange, specifically the linked data approach (Bizer, Heath, & Berners-Lee, 2009), which provides a lightweight approach to data exchange and interoperability.

3 THE GAME: WIDGET PRODUCER

To illustrate the issue of increasing data complexity we present the outline of a business game for servitization. This follows the established pattern of computer games with ascending levels where the aim of the players is to ascend to higher levels in the game. The levels in this game are Base, Intermediate and Advanced, drawing on (Baines & Lightfoot, 2013). The game scenario concerns a manufacturer of machine tools, which manufactures a tool called the Widget Producer and at the start of the game operates in a traditional, product focused, way. The players begin at the Base Level.

3.1 Base Level: Sell the Widget Producer

- At the Base Level the players must make and sell Widget Producers. One aim of this level is to familiarize players with the scenario and game controls.
- Players at this level are:
  - Sales (who must negotiate sales at a profitable rate),
  - Factory (who controls manufacture of the Widget Producer) ,
  - and Buyers (simulated).
- Data needed:
  - production costs (economies of scale may be factored in),
  - number of units (Widget Producers) sold,
  - price for each unit (the Sales Manager can negotiate price),
  - production capacity of factory (set).
- Targets: players move to the Intermediate level when they have maintained 10% profitability for one round of the game at Base Level.

3.2 Intermediate Level: Sell and Service Widget Producer

- At the Intermediate level the company introduces a service contract. Buyers may opt for the service contract, which provides an overhaul of the machines, either once a year or after 100,000 widgets have been produced.
- Players at this level are:
  - Sales (who must negotiate sales at a profitable rate, and try to persuade buyers to opt for the service contract),
  - Factory (who controls manufacture of the Widget Producer, and of spare parts),
  - Service (who monitors the servicing needs of the buyers and deploys servicing staff with spare parts as required),
  - Designer (who monitors the servicing reports and improves the design of the Widget Producer and its spares to minimize servicing costs,
  - and Buyers (simulated).
- Data needed:
  - production costs
  - number of units sold,
  - price negotiated for each unit,
  - production capacity of factory (expenditure on design time can increase this),
  - number of units with servicing contracts and their value (the Sales Manager can negotiate price),
  - unit average quality (percent components needing replacement at service)

- cost of spare parts required and their value (expenditure on design time will reduce this cost),
- cost of warehousing for a stock of spares,
- cost of service personnel time (expenditure on design time will reduce this cost),
- Buyer satisfaction levels (simulated),
- cost of design time.

• Targets: players move to the Advanced Level when
- they have maintained 10% profitability for two consecutive rounds of the game at Intermediate level,
- with at least 50% of Buyers taking the service contract option,
- and 70% of Buyers with service contracts indicating that they are satisfied with the service at the end of each round.

3.3 Advanced level: Guarantee Widget Production Capability

• At the Advanced Level a premium service contract is introduced in which the manufacturer guarantees a maximum one day downtime for Widget Producer owners, i.e., if a unit cannot be fixed in a day, a replacement unit will be provided until the Buyer's unit is repaired.

• Players at this level are all of above, plus:
- Strategic Planner (this player may be a servitization expert or a simulation, they should monitor the data and suggest targets for the next round, their aim is to improve player performance).

• Data needed, as above plus:
- number of days for which a substitute machine must be supplied and cost thereof,
- number of substitute Widget Producer units held in stock, and cost thereof,
- number of units with premium servicing contracts and their value (the Sales Manager can negotiate price),
- number of substitute units held in stock, and cost thereof,
- number of substitute units requested,
- number of substitute units loaned on time (within 24 hours of service personnel call out).

• Targets: players are deemed to have won the game when:
- they have maintained 10% profitability at this level for two consecutive rounds,
- with at least 40% of Buyers taking the service contract option and 20% of Buyers taking the premium contract option,
- with 70% of all contract holders indicating they are satisfied with the service,
- with no premium service contract holders who have not been supplied a substitute machine on time when required.

3.4 Game Features

This game design has features which we believe simulate some of the barriers to servitization. At each level of the game more information needs to be exchanged between the players, and the number of players increases; between Base and Intermediate levels the number of players doubles. Furthermore the interdependency of tasks is increased. At the base level, the interdependency is governed only by production capacity and the need for Sales to negotiate a price that allows 10% profitability. At the intermediate level, poor quality (the manufacturing task) and poor design of units will affect profitability through the costs of spares, and will also impact on customer satisfaction. At the Advanced Level this effect is heightened: the more likely a machine will break the more replacement units need to be kept.

Servitization supply chains are classical demand lead, distribution channels, and as such are prone to phenomena such as the Bullwhip effect, in which oscillating customer demand magnifies up stream as suppliers build increasingly large inventory buffers to manage unpredictability. Our game should be able to simulate this effect in the Intermediate and Advanced levels because of the need to keep stocks of spare

parts and stand-by units. Better information exchange and a culture of openness are known to mitigate these effects in the real world. The multiplayer aspect of the game is therefore important: it must contain game play algorithms that control incentives to promote cooperation between players. These in turn help build communication flows and affect overall success. The objective being to help manufacturers understand how they need to improve communications between participants in their own business processes and supply chains in order to succeed with servitzation.

4 LINKED DATA

Standards such as EDI (Electronic Data Interchange) were designed for Business to Business activity, and underpin significant parts of modern commerce (e.g., the automotive industry) allowing the efficient and accurate exchange of data between organisations. However, EDI requires complex mapping rules to fit standard data to individual organisation's internal requirements. Standards for commerce, such as those provided by GS1[1] for unique identification numbers, allow for considerable detail with respect to the category and location of resources. Both approaches are currently unable to model and capture the range of data needed for effective use of servitization. One problem is the number of players who may be involved and the need for flexible adaptation of data to exchange with new, rather than long established, partners. Another problem is that the type of data needed for different servization scenarios can change substantially.

Linked data initiatives based on Web technologies (Bizer et al., 2009), by contrast, impose limited standardisation burdens combined with powerful flexibility. Linked data uses RDF, an XML based standard, to format data. XML has already proved itself to be a flexible format and is widely used to exchange data. What linked data adds is to give entities unique identifiers that are URLs: this allows web protocols, such as HTTP to be used to find information. An entity could be any thing in our game: a player, a particular Widget Producer, a type of spare part, a buyer company, a service visit etc. The fundamental feature of the Web, what makes it what it is, is the hyperlink; this allows people to browse the web, moving from one page to another related page gathering information. The same linking feature is essential in linked data also, with links being made between entities, providing mechanisms by which an interesting entity can provide the seed to find related data. In our game, the data might for example link a buyer company to the Widget Producers it owns, and those in turn to the service visits that have been made.

One further feature of linked data makes it appropriate: it does not assume that all data producers will agree standardised data representations (XML schemas defining the vocabulary used and how the data are structured) before hand. Instead mappings between schema are built using simple “SameAs” links between concepts that represent the same things. For example: the “Widget Producer” in our manufacturer’s schema may be described in the Buyer’s schema by the more general “Machine Tool” (perhaps Buyer runs a job shop and has a number of different tools allowing them to take on a range of manufacturing contracts). By placing a SameAs link between Widget Producer and Machine Tool the two sets of data about the unit can be combined. This feature makes possible the interoperability of data between different actors in the supply chain, and also makes it easy to integrate a new customer or supplier.

4.1 Linked Data in the Game

The use of a standard data format in the game design supports flexibility when planning game extensions or reuse. Imagine a case where we wish to design a game involving players who represent different organizations in a supply chain. For example, we chose to extend the Widget Producer game so that some of the Buyers are real players not simulations. These players also want to servitize their business, maybe moving from batch ordering of widgets to a model in which they have access to their customers’ production plans and contract to supply the right number of widgets at the right time as a service. A

[1] http://www.gs1uk.org/what-we-do/GS1-standards

standard data model facilitates this type of extension and supports reuse of any underlying game play algorithms.

The advantage of using Web standards is even more apparent when we consider the possibility of integrating publicly available Linked Data - so called Linked Open Data. Let us consider two possibilities: globalizing the Widget Producer game, and reusing it for a scenario in the Media Industry.

For the Global extension, say we wish the Advanced Level to take account of the fact that Widget Producers are sold worldwide. To honour the Capability Guarantee it becomes necessary that standby units are available in different regions. Firstly, players must decide the location of depots where stocks are to be held. Secondly, Sales must have data to determine whether the Guarantee can be offered to a given Buyer. Data to support the global extension to the game could be supplied from open linked data sets such as OpenStreetMap[2], with delivery times from depots to the Buyer location being calculated using GPS data.

In a Media Industry version of the game, the aim would be to support music producers in testing out different servitization models. Media is a sector which is, in effect going through enforced servitization, with consumers switching from the established product ownership model (based around CDs, DVDs etc.) to a service model based on downloads. For this game, the open data version of a resource such as MusikBrainz[3] could be used to simulate a Product Catalogue.

4.2 Linked Data in Supply Chains and Servitization

To compete in a globalized marketplace manufacturers need to be agile, taking on new customers, new products and materials. For information systems to support this agility they need to be based on standards that are equally flexible and can accommodate new data types rapidly and allow information exchange with new business partners without complex negotiation over proprietary data formats. Linked data offers this flexibility.

The linked data approach is well suited to the supply chain context in which different players need to model data to meet the internal needs of different styles of operation (raw materials, component production, assembly, fitting, repair and maintenance) and require access to information from other players in the chain. Furthermore, extensive work already exists to integrate into the linked data paradigm the use of networks of sensors (e.g. usage data for condition monitoring and servicing operations), and other heterogeneous sources of information (e.g. customer reports, structured and unstructured evaluations, or third party certifications). Open data can support access to valuable data in the public domain (e.g. continuous weather or road or air traffic reports). The absence of effective tools for rapid and easy data integration of customers and service providers remains a significant barrier to the uptake of servitization. Linked data may hold the key to providing an agile, information architecture to help overcome this barrier.

5 CONCLUSIONS AND FUTURE WORK

Our aim in this paper has been to contribute to the development of game technologies, design principles and protocols for servitization. In this paper, we have presented an outline of such a game, in order to open the debate on what games designed to accelerate adoption of servitization should look like. We applied three principles in our design: the game should address barriers to servitization, it should have game play aspects to challenge players and engage their interest, and it must have a learning objective. The barrier we chose to address concerned the increased task interdependency associated with servitization, and the consequent increased communication and data interchange needs. The game play aspects were provided by producing a three level game in which players must achieve pseudo-realistic business targets to move up the levels. The learning objective is for users to experience the increasing communication needs by having them play cooperatively in a multi-player gaming environment. From

[2] http://www.openstreetmap.org/
[3] http://musicbrainz.org/

this they should be able to take away an understanding of the kinds of changes to business practices and information systems they will need to make in their own businesses to succeed at servitization.

The second theme of our paper is to advocate the use of linked data and its associated technologies as a flexible approach to modeling data in the gaming environment. Potential advantages of this approach for the game are that extensions and new games become easier to design with a standard data model, and that open linked datasets, such as geographical data, can be used in the game design. There is also a case to be made for using linked data as an information exchange standard in supply chains. Testing linked data protocols in the safe context of the games provides an opportunity to test the robustness of this approach.

Next steps involve a detailed requirements elicitation process, involving manufacturers, servitization experts and games designers, in order to produce details specifications of games for servitization. These will then be implemented, tested and used to transform the adoption of servitization strategies by UK manufacturers.

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