"THIS BEER IS OFF!" - BUILDING A DIALOGUE GAME FOR SERVITIZATION

Victoria Uren & Panagiotis Petridis

ABSTRACT

Purpose: Development and evaluation of a prototype dialogue game for servitization is reported.
Design/methodology/approach: This paper reports the design of the iServe game, from user centered design, through implementation using the Unity games engine to evaluation, a process which took 270 researcher hours.
Findings: No relationship was found between either age or gaming experience and usability. Participants who identified themselves as non-experts in servitization recognized the potential of the game to teach servitization concepts to other novice learners.
Originality/value: The potential of business games for education and executive development has been recognized but factors, including high development cost, inhibit their uptake. Games engines offer a potential solution.

KEYWORDS: Serious games, game design, evaluation

1. INTRODUCTION

Business Games have existed since the 1960s with Top Management Decision Simulator being considered the earliest well known example (Meier et al., 1969). Business games have gained a foothold as a tool for education and executive development, where their ability to engage and inform, as well as entertain, can contribute significantly to learning. Typical examples of these include, in the manufacturing sector, Siemens *Plantville* (Brownhill, 2012), which gives players the opportunity and challenge of running a virtual factory, and games for teaching the concepts of Lean Manufacturing (Vaz de Carvalho et al., 2014). We are particularly interested in determining and advancing the role of serious games in advancing the adoption of product service systems. A few management games exist which address some issues relevant to servitization, for example, the *Mortgage Service Game* (Anderson & Morrice, 2000), concerns services supply chains, and the EDIPS board game is designed to teach design of Product Service Systems (Nemoto et al., 2014). However, relatively few serious games exist in the domain of servitization.

One factor which inhibits the uptake of games based on computer simulation is the high development costs associated with game development. This factor is being addressed using new development tools and game engines, which significantly reduce the cost of game development. In this paper we report the development process used to produce a servitization game prototype using one such game engine, Unity (http://unity3d.com/, accessed on 3 March 2015) in section 2, in Section 3 we characterise the prototype using a management game taxonomy (Greco et al., 2013) to assess the sophistication of the resulting prototype, and report usability evaluation in Section 4. Section 5 summarises the findings and outlines future work.

2. DEVELOPMENT PROCESS

The prototype game was developed using a user centered design process (Greenbaum & Kyng, 1992). In user centered design the needs of users are considered from the outset and at every stage of the software development lifecycle, the aim being to produce a highly usable product which fits to the users' needs. Typically a cyclic design process is employed with prototypes being tested at the conclusion of each design cycle. For the prototype described in this paper the servitization experts in the team put themselves in the role of users, who were conceived as manufacturing managers: a group well known to several of the researchers. Feedback gathered during the evaluation reported here will be taken as user input for the second design cycle. The development process took an

estimated 270 researcher hours, the breakdown of which is given in Table 1, and activities conducted at each stage are reported below.

Stage	Person hours(h)
Game Mechanics	44
Scenario Development	44
Dialogue Scripting	132
Implementation	50

Table 1: Resources used for prototype development

1. *Game Mechanics* - The first step was to select appropriate game mechanics for use in the game. A workshop with ten participants, lead by the games researchers, introduced the servitization experts to the available palette of game elements, approaches to play and the crucial concept of learning points. The learning points are the objectives which a serious game is designed to teach. It was concluded that a dialogue game, using scoring to reward dialogue choices associated with the learning points was a suitable game design for the prototype which could be supported using the Unity games engine, an approach which should reduce the development time and cost required.
2. *Scenario Development* - Immediately following the game mechanics workshop a brainstorming session was held which identified several possible scenarios and associated learning points. For this exercise the team broke into three sub teams, each containing at least one game designer and at least one servitization expert. The sub teams presented their ideas to the whole group and the best scenario was chosen. This scenario begins in a bar where the beer is bad, and is inspired in part by the Beer Game (Sterman, 1989), a well known management game for teaching the bullwhip effect in supply chains. The goal of players would be to solve the problem of bad beer. The learning points would concern the Basic, Intermediate and Advanced Services model (Baines & Lightfoot, 2013) of servitization, which is used in the knowledge transfer workshops run by the Aston Centre for Servitization Research and Practice. This model has proven effective in communicating the nature of servitization to managers of manufacturing SMEs.
3. *Dialogue scripting* - An intensive two day workshop was held with eight of the participants from the earlier workshop, which went deep into on the selected beer scenario, to develop non-player characters with whom players could interact to identify solutions to the problem of bad beer and scripting detailed dialogues. Techniques used in the workshop included role playing and story boarding, with the different dialogue options being collected on script cards, and by recording the researcher's role-playing the dialogue. To reinforce the learning point, the highest scores were associated with dialogue options relating to Advanced Services, moderate scores were associated with dialogue choices relating to Intermediate Services, and low scores were associated with dialogue choices relating to Base Services. The design process involved role playing dialogues between the player (cast as a beer inspector) and various characters who would be encountered.
4. *Implementation* - Once the scenario writing and dialogue scripting were complete, three scenes and accompanying dialogues with a small cast of non-player characters were implemented in Unity (see Figure 1). Unity is a game authoring environment which supports the creation of interactive video games (Watkins, 2011). Unity is one of a generation of game authoring tools, which make the production of new games faster and easier. Using the story boards developed at the workshop, one game designer implemented the game, with input from one native English speaker to script the final dialogues in colloquial style.
5. *Evaluation* – the final stage of the user centered design cycle is evaluation and testing. This is reported in detail in section 4.

Figure 1: Interaction with the hotel owner at the point where the user must make the first service design decision, left showing the virtual bar, right showing dialogue implemented in Unity

3. CATEGORISATION

iServe was categorised using the taxonomy proposed by Greco et al. (2013), in order to situate it in the landscape of business games and assess its sophistication. Greco's taxonomy identifies and classifies the relevant elements of business games which incorporate aspects of serious games, management games and simulations. It has five major categories:

1. *Environment of Application* – iServe is a Stand Alone Simulation, played as a single player game, with an Arbitrary time representation, Finite teleology (it has a clearly defined end), and Self controlled Learning (it does not require teaching support).
2. *Design Elements of the User Interface* – iServe presents a Simulation in One Run, with only one round being played, decisions are strictly Sequential and Qualitative, Haste is absent (players can complete the game at their own pace), the simulation is Transparent Box (players immediately see the effect of each decision on the score, and its Appearance is 2D graphics. The user interface is Software Based, and Savability of the game state is None. The virtual environment, supported by Unity, makes iServe unusual for a business game – it has a Vagrant Perspective and Relative Positioning (players can move around relative to the environment and non-player characters).
3. *Target Groups, Goal, Objectives and Feedback* – iServe is an Open target game, although manufacturing managers are a target the game could equally be used with business students. The goal of the game is primarily Teaching (as opposed to skills evaluation), with an element of Research. The Didactic skills in the game are Conceptual skills, rather than soft skills, such as communication, or Hard Skills concerning detailed technical operations. The Challenge of the game is Identical for all players. The Final score display provides limited Individual Debriefing and Immediate Feedback, which is Incomplete.
4. *User Relation / Community* – Because iServe is a single player game, Interactions Among Players are Absent, Player Composition is Single Player and Player Relation is Individual etc. However, we would argue that, because of the role of non-player characters in the game, it is a Role-Playing game: players need to put themselves in the place of the beer inspector to succeed at the game.
5. *Model Characteristics* – The development of the underlying simulation for iServe is (currently) limited to scripted dialogue between the player and non-player characters. It has a Realistic Domain, is Deterministic (players are rewarded for making good decisions without any element of chance), it concerns a Special Area of Interest (Servitization) rather than a whole domain, is Without Influence of External Data, and Configurability is Absent. Finally, Fidelity is low. In Greco's taxonomy Fidelity is calculated by weighting six key elements from the taxonomy, which for the prototype were scored as follows:

    - Behaviour – Deterministic (weight 1)
    - Interaction – Absent – players interact only with non-player characters (weight 1)
    - Player composition – single player (weight 1)

- Challenge – Identical – the player can only make predefined choices (weight 1)
- Didactic Goals – Conceptual Skills (weight 1)
- Appearance – 2D (weight 4)

This gives the prototype a total weighting of 9 (minimum 6 - maximum 36), which places the prototype in the low fidelity category.

This categorisation indicates that, while the iServe game required relatively little time to get a prototype up and running, the current version is not particularly complex. To use the terminology proposed by Kriz and Hense (2006), the game suffers from "under-challenge". More work would be required, particularly on the underlying simulation model, to produce a business game which is adequately challenging for the target audience of manufacturing managers.

4. EVALUATION

The target audience of the game is managers in the manufacturing sector. Despite evidence to the contrary (ISFE, 2010), the perception persists that gaming is confined to younger age groups. Managers in manufacturing are typically older. Therefore, they might be argued to be an audience who would have relatively little gaming experience and who would be hard to reach via games. The usability of the iServe prototype game was therefore evaluated with respect to age and gaming experience. A further factor of interest was whether the level of knowledge about the servitization topic would impact learning outcomes.

A game test was carried out at the Spring Servitization Conference 2014 (SSC2014) (http://www.aston.ac.uk/aston-business-school/research/events/ssc2015/, accessed 3 March 2015). Participants were drawn from all attendees, who included both industry and academic attendees with a wide range of expertize in servitization, from professors of Product Service Systems and industry experts to MBA students and conference organizers. The cohort was dominated by participants who gave high ratings to their servitization expertise (34 score 3 or above, 11 score below 3), and most had relatively little game playing expertise (32 score below 3, 13 score 3 or 4, none score 5) (Figure 2).

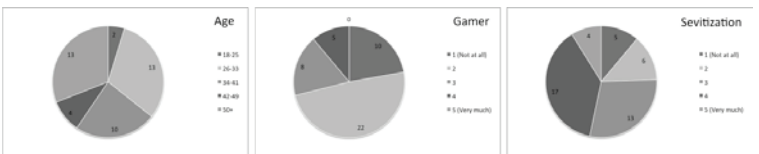

Figure 2: Participants' ages, gaming experience and servitization expertise.

Many of the participants were not regular gamers (32 of 45 players (71%) responded 1 or 2 to the question *"to what extent do you normally play computer games"* on a scale of 1 (Not at all) to 5 (Very much). This was an appropriate sample, since the target audience is manufacturing managers. If we assume the stereotypical manufacturing manager is an older male, then ISFE reports that 40% of 45-54 year olds and only 28% of 55-64 year olds will be gamers (ISFE, 2010).

Each participant was introduced to the game using a participant information sheet, and a researcher explained controls if the user requested it. The participant played the game to the end, when they received structured feedback on their performance. Game usability was measured by a self-report questionnaire with seven parts based on the past experience, overall user reactions, easy of use, playability, learning curve, comments and finally suggestions for alternative scenarios. The survey

combines 20 Likert scale questions (e.g. *"To what extent are you expert in servitization?"*) and 3 open ended questions (e.g. *"What do you think the game was trying to teach?"*).

4.1 Results

Table 2 presents the mean responses of the whole cohort to the key usability questions. Overall reactions were mid range with the exceptions of difficult-easy and rigid-flexible, implying the users found the game fairly easy but somewhat rigid. The latter is probably to be expected given the limited dialogue developed for the prototype. The mean responses for learning to play the game were above mid range, which is encouraging, given the limited numbers of gamers in the group.

Question	mean(s)
Overall reactions	
terrible-wonderful	5.2(1.8)
frustrating-satisfying	5.2(2.0)
dull-stimulating	5.4(2.1)
difficult-easy	6.2(1.8)
rigid-flexible	4.6(2.0)
Learning to play the game	
learning to operate the interface	5.8(2.4)
time to learn to use the interface	6.4(2.3)

Table 2: Mean responses over all participants

The High-D parallel coordinates tool (www.high-d.com/, accessed on 3 March 2015) was used for initial visual exploration of the data in this study. Visual analytics is used to explore data and rapidly identify trends and patterns (or their absence). Parallel coordinates (Inselberg, 2009) are a visualization approach in which multiple variables are represented by vertical axes with a polycurve (or polyline) representing the variable of interest (the axis for which is drawn on the far left). The power of the method comes from the analyst's ability to rapidly and intuitively compare large numbers of variables. Figures 3 & 4 present parallel coordinates visualizations comparing results for usability related questions. Unpaired t-test were conducted to support the visual analytics results.

4.1.1 Participant Age and Usability

Because manufacturing managers are typically older, the target age groups for the game were 42-49 and 50+. Preconceptions about video game users might suggest that older participants would have a more negative reaction to the game than younger ones. To explore this possibility, parallel coordinate analysis (Figure 3) for was conducted to explore possible relationships between the age of participants and their reactions to the game. The left hand axis shows Age Group. The remaining axes are from left to right: *terrible-wonderful, frustrating-satisfying, dull-stimulating* and *rigid-flexible* (all Likert scale (bad) 1-9 (good)). Each participant's responses are represented as a polycurve. The left hand plot shows, as polycurves coloured darker blue, the responses of participants from the target age group, 42-49 and 50+, with other age groups greyed out. The right hand plot highlights in brighter blue the age groups of more 'typical' gamers aged 18-25 and 26-33. Analysis of Figure 3 shows no indication that older participants had more negative reactions than younger ones.

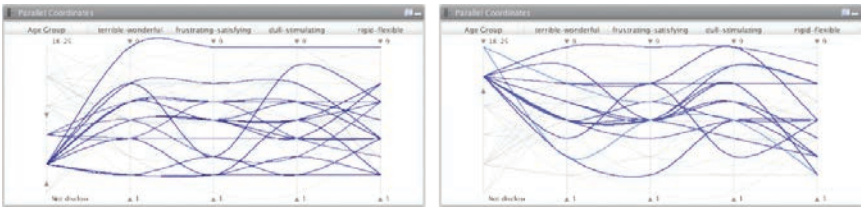

Figure 3: Left, responses of participants aged 42-50+. Right, responses of participants aged 18-33.

Following the visual exploration of the data, unpaired t tests were conducted to test the null hypothesis that there was no difference in the mean scores of younger (18-33) and older participants (34-50+) for the questions on overall user reactions, easy of use, playability and learning curve. No significant (5%) difference was found between the two groups on any of the questions.

The mean level of gaming experience declared by participants aged 18-33 was 2.4, based on answers to the question *"to what extent do you normally play computer games"* ((Not at All) 1 to 5 (Very much)). Participants aged 34-50+ declared average mean gaming experience of 2.0. An unpaired t-test was conducted to test the null hypothesis that there was no difference in the levels of gaming experience for the two groups and no significant difference was found at the 5% level. This is inline with evidence that gamers are not only found among the young (ISFE, 2010).

4.1.2 Gaming Experience and Usability

Figure 4 is a parallel coordinates plot of key usability responses visualized with respect to Gaming experience on the left hand axis. The remaining axes from left to right represent the *"Learning to operate the interface"* ((difficult) 1-9 (easy), *"Time to learn the Interface"* ((too long) 1-9 (very short)) and the overall reaction ((difficult) 1-9 (easy)). Each participant's responses are again represented as a polycurve. The polycurves are coloured with the most experienced gamers in the darkest blue. Note left and right hand plots show the same parallel coordinates plot but in the left hand plot the subset of participants (polycurves) who found the game easy to play (>5) is greyed out and in the right hand plot the subset who found the game hard to play (<5) is greyed out.

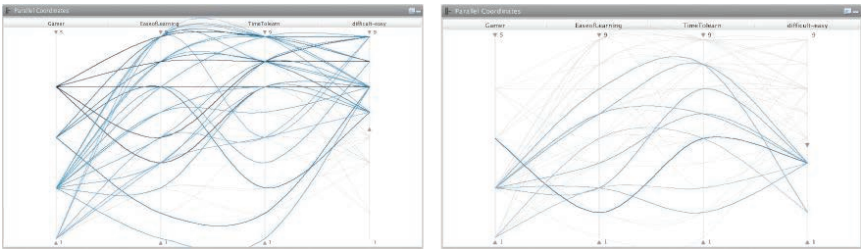

Figure 4: Left, responses of participants who reported finding the game easy to play. Right,

responses of participants who found the game hard to play.

The visual analysis indicates that that the response to the game is not related to gaming experience for this group. Some players who rated their gaming experience as 2 or 1 found it easy. However, others, who found the game easy, rated the system below 4.5 for Ease of Learning and 4 rated it below 4.5 for Time to learn. Players who found the game difficult typically had little gaming experience, but not all rated the game as hard to learn.

Unpaired t-tests were conducted with the null hypothesis that there was no difference in the mean scores of experienced gamers (score 3-5) and inexperienced gamers (score 1-2) for the questions on overall user reactions, easy of use, playability and learning curve. No significant (5%) difference was found between the experienced and inexperienced gamers on any of the questions.

4.1.3 Servitization Expertise and Learning Outcomes

Finally, we assessed whether servitization expertise would impact on the learning outcomes for the game. The game test was conducted at SSC2014, and therefore a large portion of the cohort were servitization experts. Table 3 reports the mean values for responses to the two learning related questions. Participants who responded 1 or 2 to the question *"to what extent are you expert in servitization (1 (not at all) 5 (very much))"*, denoted as novices, gave higher scores to the learning outcomes than did participants who responded 3-5, denoted as experts. Both groups also gave higher responses to the question *"do you think a novice would learn about servitization from the game?"* than to *"did you learn about servitization from the game?"*.

Question	mean(s)	
	Experts (score 3-5)	**Novices (score 1-2)**
Did you learn about servitization from the game?	2.3(1.1)	2.8(1.1)
If you have some expertise in servitization, do you think a novice would learn about servitization from the game?	2.6(1.1)	3.4(0.9)

Table 3: Mean responses for learning outcomes

Unpaired t tests were conducted with the null hypothesis that there was no significant difference between the scores for the novices and experts. While there was no significant difference at the 5% level between the groups for the question, *"did you learn about servitization"*, there was for the second, *"do you think a novice would learn about servitization"* (P 0.049). This indicates that the novice players were more positive about the game than experts.

5. CONCLUSIONS

In their discussion of theory oriented evaluation of business games, Kriz and Hense (2006) draw a distinction between 'design in the small' and 'design in the large'. Design in the small concerns the evaluation of how well an individual game models reality or delivers appropriate learning outcomes. In this respect the iServe prototype shows promise for educating novices in servitization concepts, with more positive responses on learning outcomes given by the less expert participants. Design in the large, on the other hand, concerns the use of games to *'change existing dysfunctional situations'*. The low uptake of servitization in some sectors arguably presents such a dysfunctional situation. For serious games to make an impact in this area they need to be able to address the target audience of manufacturing managers, who are typically older, and may lack gaming experience. The evaluation results presented here suggest that virtual world environments of the sort provided by the Unity gaming engine may be acceptable to both older participants and those with little gaming experience. This is counter to preconceptions that games are only suitable for younger learners and opens the approach to the target audience of manufacturing managers.

Our prototyping experiment with Unity has demonstrated that playable business game prototypes can be developed in viable time frames using game engine technology. However, user responses were typically mid-range and categorization using Greco et al.'s taxonomy (2013), indicated the resulting game was not particularly sophisticated when characterized in terms of typical features of business simulation games. More work is needed to make a really useful and interesting game; the user centered design approach taken to develop the prototype naturally lends itself to cyclical

improvement and the evaluation results reported here will be used to develop further versions of the game.

REFERENCES

Anderson, E. G., & Morrice, D. J. (2000). A Simulation Game for Service-Oriented Supply Chain Management: Does Information Sharing Help Managers with Service Capacity Decisions? *The Journal of Production and OperationsManagement*, *9*(1), 40–55.

Baines, T., & Lightfoot, H. (2013). *Made to serve: how manufacturers can compete through servitization and product service systems (forthcoming)*. Wiley Press.

Brownhill, I. (2012). Does gaming have a role to play in employee engagement. *Strategic HR Review*, *7*(7), 12.1.

Greco, M., Baldissin, N., & Nonino, F. (2013). An exploratory taxonomy of business games. *Simulation and Gaming*, *44*(5), 645–682.

Greenbaum, J., & Kyng, M. (1992). *Design at work: cooperative design of computer systems*. Hillside, NJ, USA: Erlbaum.

Inselberg, A. (2009). *Parallel Coordinates: Visual Multidimensional Geometry and Its Applications*. Springer-Verlag New York, Inc.

ISFE. (2010). *Video Gamers in Europe, in ISFE Consumer Survey*.

Kriz, W. C., & Hense, J. U. (2006). Theory-oriented evaluation for the design of and research in gaming and simulation. *Simulation Gaming*, *37*(2), 268–283.

Meier, R. C., Newell, W. T., & Pazer, H. L. (1969). *Simulation in Business and Economics*. Englewood Cliffs, NJ: Prentice Hall.

Nemoto, Y., Uei, K., Fujiwara, T., Mizoguchi, S., & Shimomura, Y. (2014). Strategic Thinking in EDIPS: Edutainment for Designing Integrated Product - Service System. *Procedia CIRP*, *16*, 92–97.

Sterman, J. D. (1989). Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment. *Management Science*, *35*(3), 321–339.

Vaz de Carvalho, C., Lopes, M. P., & Ramos, A. G. (2014). Lean Games Approaches – Simulation Games and Digital Serious Games. *International Journal of Advanced Corporate Learning*, *7*(1), 11–16.

Watkins, A. (2011). *Creating games with Unity and Maya*. Burlington, MA, USA: Elseveir.

ACKNOWLEDGMENTS

This work was supported by EPSRC Grants Ref EP/K014064/1, EP/K014072/1, EP/K014080/1 'Transforming the adoption of Product-Service Systems through innovations in applied gaming technology'; a joint project with Aston Business School, and the Advanced Manufacturing Research Centre, University of Sheffield The authors would also like to thank the attendees at SSC 2014 who participated in the evaluation.