Thesis Proposal:

How are learning objectives woven into the design of a serious game?
Instructional Design for Serious Games

Katrin Becker

Passive acceptance of the teacher's wisdom is easy to most boys and girls. It involves no effort of independent thought, and seems rational because the teacher knows more than his pupils; it is moreover the way to win the favor of the teacher unless he is a very exceptional man. Yet the habit of passive acceptance is a disastrous one in later life. It causes men to seek a leader, and to accept as a leader whoever is established in that position... It will be said that the joy of mental adventure must be rare, that there are few who can appreciate it, and that ordinary education can take no account of so aristocratic a good. I do not believe this. The joy of mental adventure is far commoner in the young than in grown men and women. Among children it is very common, and grows naturally out of the period of make-believe and fancy. It is rare in later life because everything is done to kill it during education... The wish to preserve the past rather than the hope of creating the future dominates the minds of those who control the teaching of the young. Education should not aim at passive awareness of dead facts, but at an activity directed towards the world that our efforts are to create.

- Bertrand Russell

Brief Summary

Topic - How are learning objectives woven into the design of a serious game?

The proposed work examines how to build and use games for learning.

Rationale

Such work requires a thorough understanding of both instructional design (ID) and games design (GD), and so is a natural match for someone with expertise in both areas.

Procedures

A. Outline different types of games; distinguish what kinds of things can be learned through each.
B. Look at – describe/define – G.D. Since the process must be built onto games design, an analysis of the games design process is first.
C. Analysis of ID theories and models with respect to suitability for use in instructional games design. Determine which ones are suitable for use in this context and which are not and why.
D. Observe the serious games design process – develop case studies of games designs.

Questions to examine:

1) What are similarities and differences between commercial games design and the design of custom learning games?
2) Where are the stress points in the design process, and what might some of the mitigating factors be?
3) What are the observed and perceived roles of the project participants?
4) How is the team organized and how are problems resolved?
5) What kinds of tools are used?
6) How do language issues affect the design process?
7) How are educational or instructional issues identified? Addressed?
8) What aspects of the game design were influenced/affected/altered by stated or emergent instructional (teach) and educational (learn) goals?
9) What kinds of assessment mechanisms are built into the game? How are they going to be used?
10) What kinds of external support materials are created to supplement the game itself?
11) To what extent are existing game models used in the design of this one?
12) How does this game ensure that the learners' experience gives them what is intended?

Outcomes

1. Parallels between G.D. & I.D. (intermediate outcome)
2. An Instructional Design Theory: A set of recommendations for the incorporation of instructional goals into the design of serious games.
3. An ID model (Serious ID, or Instructional Games Design) for the development of (some types of) instructional games.
4. A Theory of Learning through Serious Games (Serious Games Theory)

Some Key Resources

Game Design

The following are some of the key resources, both people and places that will figure heavily in my work. For more, please refer to my pathfinder.

People

James Paul Gee University of Wisconsin Madison; Educational Psychology (learning and literacy in video and computer games.) [http://www.soemadison.wisc.edu/edpsych/facstaff/gee.htm]

Simon Egenfeldt-Nielsen Psychologist, Is currently writing a PhD thesis on the educational potential of computer games taking commercial titles as the starting point. [http://www.itu.dk/people/sen/index.htm]

Chris Crawford One of the first people to speak and write about game design from an almost literary perspective, he has created his share of classic computer games. Chris is the founder of the Journal of Computer Game Design, the Computer Game Developers' Conference, and is the author of several books, including The Art of Computer Game Design. [http://www.dadgum.com/halcyon/BOOK/CRAWFORD.HTM] [http://www.erasmatazz.com/]

Ian Bogost Assistant Professor in the Information Design & Technology program at Georgia Institute of Technology, where he teaches and researches on videogames. http://www.watercoolergames.org/about.shtml

Clark Aldrich: Lead the international team that created SimuLearn's Virtual Leader; Aldrich speaks, writes, and does consulting work on e-learning issues. [http://ts.mivu.org/default.asp?show=bio&id=4702] [http://www.simulearn.net/SimuLearn/simulearn_home_page.htm]

Marc Prensky http://www.marcprensky.com/writing/

Places and Organizations

Games Developers Conference 2004: Serious Games Summit http://www.gdconf.com/conference/seriousgames.htm

Serious Games Project http://www.seriousgames.org/

MIT's Education Arcade Conference: Electronic Entertainment Expo'04 http://www.e3expo.com/conference_programs/mit/

DIGRA Digital Games Research Association http://www.digra.org/

Published Works

Alice Mitchell and Carol Saville-Smith, "The use of computer and video games for learning: A review of the literature" (Mitchell & Savill-Smith, 2004, p24 reference to 'architect' replaced by 'teacher') Key Resource: published 2004 – 84 pages – a comprehensive review of the issues, studies, and results up to 2004

Dempsey, J. V., Rasmussen, K., & Lucassen, B. (1996). *The Instructional Gaming Literature: Implications and 99 Sources*: College of Education, University of South Alabama.

Ben Sawyer's White Paper "Serious Games: Improving Public Policy Through Game-Based Learning and Simulation (Sawyer, 2002) – concerned with serious games in general rather – including policy and politics – but this is still a seminal paper in the area – this is, as far as I know, where the term was coined.

Instructional Design

People

(names are not annotated, as it is assumed all readers know who they are)

- Gail Kopp
- Merrill, Reigeluth, Jonassen, Gardner

Places and Organizations

- AECT http://www.aect.org/
- Instructional Technology Connections Website, created by Martin Ryder, University of Colorado at Denver School of Education *http://carbon.cudenver.edu/~mryder/itcon.html*
- EmTech Resources Site: http://www.emtech.net/index.shtml
- Explorations in Learning & Instruction: The Theory Into Practice Database *http://tip.psychology.org/* Greg Kearsley (gkearsley@sprynet.com) *http://home.sprynet.com/~gkearsley*

Published Works

Reigeluth, C. M. (1999). Instructional-design theories and models : vol. 2, a new paradigm of instructional theory. Mahwah, N.J.: Lawrence Erlbaum Associates.

Merrill, M. D. (2002). First Principles of Instruction. Educational technology research and development : ETR & D, 50 Part 3, 43-60.

Research Methodology

People

- Don Ratcliff: Notes for Five Part Seminar on Qualitative Research

http://www.vanguard.edu/faculty/dratcliff/qual/

Places and Organizations

- International Institute for Qualitative Methodology http://www.ualberta.ca/~iiqm/
- Design Based Research Collective http://www.designbasedresearch.org/

Published Works

- Yin, R. K. (2003). *Case study research : design and methods* (3rd ed.). Thousand Oaks, Calif.: Sage Publications.
- writing@csu: Writing Guide: Case Studies http://writing.colostate.edu/references/research/casestudy/index.cfm
- Introduction to Qualitative Research Methods - http://labweb.education.wisc.edu/cni916/index.htm
- Marshall, C., & Rossman, G. B. (1999). *Designing qualitative research* (3rd ed.). Thousand Oaks, Calif.: Sage Publications.
- Creswell, J. W. (2003). *Research design : qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, Calif.: Sage Publications.
- Merriam, S. B. (1998). *Qualitative research and case study applications in education* (2nd ed.). San Francisco: Jossey-Bass Publishers.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks: Sage Publications.

Proposal

You can discover more about a person in an hour of play than in a year of conversation.

Plato

Introduction

Any games designer can tell you that the first rule of digital games is: the game must be fun. If the game isn't fun, then nothing else matters. But is that all there is to games? It seems unlikely that mere 'fun' could support a 10 *billion* dollar a year industry [1], and that's in the U.S. alone. If "fun" is the sole reason for the popularity of games, how does one explain a first day sales record of $125 million for a single game (Halo 2[2]) (Yi, 2004). Can "fun" explain how one massively multiplayer online role-playing game (MMORPG) like Everquest [3] can acquire a ranking equivalent to Namibia when measured in terms of Gross Domestic Product? (Castronova et al., 2004). Clearly, there's more to games than "fun".

While "fun" can't possibly be the only requirement - not even in games designed purely for entertainment, it is certainly essential - meaning that if the game is not fun, then the rest: the quality of the graphics, storyline, etc. is irrelevant. Just the same, the potential embodied in "fun" should not be underestimated. Too often 'fun' is associated with ridicule and frivolity, and thereby denigrated. As a result, elevating the importance of "fun" in the context of an instructional intervention may be problematic. However, an examination of what actually constitutes "fun" in this context might yield a perspective, or alternate terminology, which might prove more useful. For example, "fun" is not really possible without "engagement", and engagement is a state we strive for in all our teaching. We can view fun as excitement and as a vehicle for engagement, which might help make it more palatable. Another possible perspective comes from the well-known games designer, Chris Crawford: "True fun is the emotional response to learning." [4]

Although they are becoming known as Serious Games, games designed for purposes other than pure entertainment, including games for learning, still retain "fun" as an essential

[1] According to a report released by The NPD Group on Jan 18 2005 about video game software and hardware sales in the US in 2004 http://www.npd.com/dynamic/releases/press_050119.html
[2] http://www.xbox.com/en-US/halo2/default.htm
[3] http://eqlive.station.sony.com/
[4] The original source for this quote has been forgotten. Chris says he's been using it a long time. Two recent references include: A feature on GameSpot in Aug-04 http://www.gamespot.com/pc/strategy/politicalmachine/news_6104371.html and a post on the seriousgames list by Chris on Dec 28/05 as part of a thread entitled "Is learning fun?"

ingredient. Fun is an essential element in digital games generally (Koster, 2004), and so must remain an essential element of Serious Games as well. Furthermore, fun must be acknowledged as highly subjective. The 'fun' in a game, even a serious game, must be carefully tailored to the intended audience if it is to be an asset rather than a liability. If past successes and failures in "edutainment" are any indication, then fun is an aspect often forgotten by many ISD people – and when it *is* included, its subjective nature seems generally to have been overlooked [5].

If we are to consider the use of games for learning, then we must also examine the instructional design process to see how the two, namely games design and instructional design, can be made to fit together. There are many accepted and well-tested process models for Instructional Design (Dick, Carey, & Carey, 2001; Hannafin & Peck, 1988; Reigeluth, 1999a, 1999b; Shambaugh & Magliaro, 1997; Wiggins & McTighe, 1998). In most of these models, the details of how the medium fits in to the delivery are left till near the end of the process. Unfortunately, none of the models are applicable in the case where the intervention we are designing is to be delivered as a digital game. I believe this is because when creating digital learning games, the design of the instruction and the design of the medium for delivery must be completely intertwined in order for it to be worthwhile.

Let me explain: the game must still be a game. A typical commercial game has a production cycle of 2-3 years, employs teams of 10 – 50 people, and costs $1 - $5 million to produce. Games contain[6]: input systems, networking systems, real-time systems, rendering engines, display systems, sound systems, artificial intelligence engines, asset managers, physics engines, and a front end (which is the only part the user gets to see). Game design is arguably as complex as instructional design – and when the two are combined, the complexities together become multiplicative rather than additive. It is naïve to assume that the instructional design can simply insert "game" in the right places in the existing literature and go from there.

The proposed work of this doctoral research will examine the development of a nontrivial (substantial) serious game in detail, which will in turn inform the development of an effective instructional design approach and model that can be used when creating digital game-based learning applications. In order to accomplish this, the major components of both processes (ID & GD) must be identified as far as is possible, including the cultural and semiotic perspectives of both professional groups.

[5] Definition: "lame" – fun that doesn't work
[6] I may have forgotten a few systems.

Background

"Our schools have been scientifically designed to prevent over-education from happening...The average American [should be] content with their humble role in life, because they're not tempted to think about any other role."

- William Harris, U.S. Commissioner of Education, 1889

The Current Generation is Different

Modern education continues to be condemned for not meeting the needs of our young people. Things keep getting worse, we say. At the same time, we complain about the shortcomings of the kids themselves. Kids today don't know how to pay attention (so we give them drugs like Ritalin). Kids have an apparent incessant need for "instant gratification". Kids don't know how to talk or write anymore.

How much of this is true remains to be determined, but apart from the age-old complaints[7] that the younger generation does not appreciate the ways of the older one, there do seem to be some measurable and significant differences in the way today's young people work and learn. Even though we have learned a great deal about how people learn and effective ways to teach them, we still seem to be loosing ground. There seems to be a mismatch between the educational system and the people it seeks to educate.

One possible explanation for this apparent disconnect between formal education and the target of our attention is that kids really ***are*** different from previous generations, although perhaps not quite in the ways we complain about (Beck & Wade, 2004; Prensky, 2001b, 2001c). A failure to acknowledge and understand these differences could result in a greater and greater divergence between how we teach and how the learners learn (Norman, 2001, 2002; Papert, 1998). Perhaps more than at any time since the development of the factory model for learning, a gulf is developing between the institutions of learning and the learners themselves. It's not surprising that more and more kids complain that school is a waste of time. For many of them, much of it actually ***is.*** The world that the kids have been born into and must eventually inherit is a very different one requiring very different skills for success than the world their parents were born into, or their grandparents before them. Some aspects remain relatively unchanged – it seems

[7] "The children now love luxury; they have bad manners, contempt for authority; they show disrespect for elders and love chatter in place of exercise. Children are now tyrants, not the servants of their households. They no longer rise when elders enter the room. They contradict their parents, chatter before company, gobble up dainties at the table, cross their legs, and tyrannize their teachers."
ATTRIBUTION: Attributed to SOCRATES by Plato, according to William L. Patty and Louise S. Johnson, Personality and Adjustment, p. 277 (1953).

kids have *always* complained that school was boring or irrelevant. In and of themselves, knowing how to cope with boredom and do things one doesn't like are useful things to know, and it doesn't look like the world is changing enough to eliminate the need for these skills. Other aspects have changed significantly, and the ramifications of these changes have by and large not been accounted for in formal education. Perhaps three of the most significant differences are:

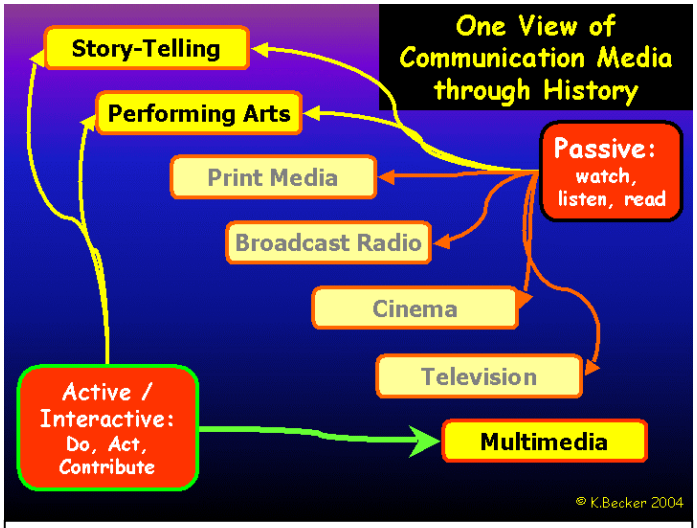


Table 1 – Multimedia *requires* interactivity (passivity is futile)

1) These kids have grown up with access to what seems like the entire world's knowledge through the internet[8];
2) They have the ability to communicate with anyone and everyone[9] with access to that internet regardless of age, station, or economic status;
3) The primary leisure time activity for young people in the developed world has become video game playing. In fact, the video game industry has now surpassed the movie industry, and some television executives are now admitting that video games are also affecting television viewership. (Pethokoukis, 2002; Reynolds, 2004; Yi, 2004) While parallels can and should be made between video games and other forms of media, including web-based applications, literature, film, and theatre, it must be recognized that *Video games are different*. Multimedia and games are interactive in a way not seen since before books became the dominant (learning and) communication medium (see Figure 1), and in a way that sets them apart from all other forms of media.

[8] No generation before has had to cope with such an abundance of information. While this will not play a major role in my proposed work, it does figure into the picture. The gamers, perhaps more than any generation that came before it, need to develop critical analysis skills in order to sift through the information available to them. The processes that have so far worked reasonably well for establishing credentials and building reputations are no longer adequate, and new approaches must be developed. Part of this process can be observed as it evolves on weblogs and wikis. There are unprecedented opportunities for people to comment on the writings of others – organizations like the New York Times provide forums where readers can discuss articles, while others, such as SlashDot, provide more direct means to add your own comments.

[9] Witness the evolution of Wikipedia: http://en.wikipedia.org/wiki/Wikimedia and such developments as weblogs (blogs): http://en.wikipedia.org/wiki/Blog, and now video blogs like Peter Jackson's: http://www.kongisking.net/kong2005/proddiary/

According to a recent study (Beck & Wade, 2004), these 'kids', who now comprise a cohort larger in number than the entire baby boomer population, are indeed different in some very promising ways. This new cohort, called 'Gamers' by Beck and Wade, include those born after 1969. One of the things they share is that all grew up with computer and video games as an integral part of their culture – even if they didn't play. The presence of these gamers is beginning to be felt in the corporate world, and although they also form a significant force in education, their influence has thus far been small there. It is not yet known why that is.

Play and Learning

You must train the children to their studies in a playful manner, and without any air of constraint, with the further object of discerning more readily the natural bent of their respective characters.

- Plato

As a society, we willingly acknowledge the value of games and play elsewhere among our social interactions: very young children play and it's often called learning. Sports of all kinds have long enjoyed a special status, so much so that top athletes are viewed as role models in many western societies. Young animals of almost every mammalian species [10] play as well. It is thought that this is one way that animals have of practicing and perfecting the behaviours they will need as adults. A measure of intelligence in animals is how long and how much they continue to play as they mature: more play = more intelligence. Throughout history, play has been an integral part of our entire culture (Huizinga, 1950).

So where does one draw the line? At some point it seems, we are expected to stop all this nonsense and get down to work. Caillois (1961) claims that a game one is made to play stops being a game, Huizinga suggests that play and seriousness are opposites, and yet the qualities described by gamers to be the most desirable are what Csikszentmihalyi (1991) calls "optimal experience", or flow. In most of western civilization, play is to be kept apart from work – somewhere between the elementary school and high school, learning and play become disconnected. Learning becomes serious work, and play comes to be seen as frivolous. Much of the current generation (those 'in charge' – the baby boomers) has espoused this philosophy. In fact we have segregated play and work so well that we now require expensive retreats & corporate gurus to teach adults how to play because we seem to have forgotten. When did we forget how to play? When did we relegate play to a place apart from 'real life'? It seems to me people once kept time for play as an integral part of day to day life – that's part of the reason for

[10] As well as some birds.

all the celebrations (Sutton-Smith, 1997). And yet, play seems to be an essential element in problem solving.

> ***Overall, play or paratelic thinking creates a means for adapting to one's environment by providing self-confidence, new ideas, and relief from stress, and by reinforcing social relationships.***
> - ***play provides both adults and children with experiences on which to build later learning;***
> - ***play promotes flexibility and possibly creativity in problem solving, which may or may not lead to more successful problem solving; and***
> - ***play can relieve factors that inhibit learning, such as stress. (Diamond)***

In the 1980's, with the rise of computer aided instruction, "edutainment" became fashionable, but it has never achieved the recognition or respect of other forms or uses of digital media (such as "e-learning"), with good reason. Very little that was produced evolved beyond a drill-and-practice approach, and most of it amounted to little more than *e-workbooks*. The situation eventually became extreme enough, that to this day, even hinting that a game might be educational causes game publishers to run the other way. One of the few games that has managed to survive in spite of being labeled as educational is coincidentally the best selling computer game franchise of all time, namely, Will Wright's The SIMs[11] (Wright, 2000).

In recent years, there has been a renewed interest in the use of computer games to teach, in part because the runaway popularity of the video game industry is causing people to want to understand what makes this medium so popular. As a result, researchers are beginning to recognize the substantial learning that *already happens* in computer games (Aldrich, 2004; Beck & Wade, 2004; Gee, 2003; Prensky, 2001a). Games *already teach*, but in order to realize the potential of games as a learning device, we need guidelines and more information about *how* games teach, *what* they teach, how people learn through games, and how to design games as learning tools. Up until now, professional educators, and especially academics from Education have played a very small role in this research. I don't think we, as educators and instructional designers should just let the application of this new medium to education evolve unattended. The creation of games for learning is gaining momentum, and it's going to happen with us or without us. Games developers, many military organizations[12], and the corporate sector are already

[11] http://thesims.ea.com/us/index.html
[12] Witness some of the games in production and already in use at the US Department of Defense: http://www.dodgamecommunity.com/modules.php?op=modload&name=News&file=index&catid=2&topic=&allstories=1

developing games for learning. We, as educators, could help it along. My goal is to find a way to bridge the two design approaches of games and instruction so we can do just that.

Origin of Topic

One learns more from a good scholar in a rage than from a score of lucid and laborious drudges.

- Rudyard Kipling

In early 2004, I had a conversation with a former student of mine (Eric) who just finished a paid project at the Banff New Media Institute. He'd been working on a game intended to support Physics 30. He complained to me about the lack of direction and expertise related to the design process. The 'tech team' knew how to make this game go, but the rest of the team did not know enough about games design to appreciate what was needed, *nor did the tech team know enough about instructional design to proceed without them*. As a result, the graphic designers, scriptwriters, and instructional design components became involved far too late to be of value. The tech team ended up spending their time alternately waiting for direction, and re-doing things they'd already done. The instructional designers simply had no idea of the implications of their decisions in terms of the effect on the development of the game. While I'm sure this is not true of all design teams working on educational games, it is true often enough – and I'm quite sure that there are even more who avoid the use of games altogether because the support in design is lacking.

While I am not a professional games designer, I have written a number of games, and I do know enough about the process to appreciate Eric's complaints. Some aspects of a game take far more development and testing than others. Some elements can be in development long before the final instructional design is complete (some aspects of character interaction, for example). Others need to be known and settled before the first line of code is written, for a change to one of these will have enormous repercussions.

While listening to Eric, it occurred to me that I.D. for games intended to teach and train (Serious Games) must follow quite a different process from other forms of I.D., and that games for learning must be designed using somewhat different approaches than most of those being used for games design commercially now. One requirement is to develop an effective I.D. model and process in the games design environment, and this will require someone with a thorough understanding of BOTH fields. I am that someone.

How ID for Games is Distinct from ID for other Digital Media

Games are distinct from all other digital media. They share qualities with many other forms, but also have other qualities that set them apart (Egenfeldt-Nielsen 2004). While most, if not all of the qualities that make a computer game "good" (i.e. popular, engaging, entertaining, etc.) can also be found elsewhere, there have been few, *if any*, other entities that have captured the attention, time, and money of an entire generation the way games have. Given their popularity, it would seem reasonable to conclude that there is some *thing* or combination of things that make this medium distinct. In his seminal work on "intrinsic motivation", Thomas Malone names four essential characteristics of good games: control, challenge, fantasy, and curiosity. (Malone, 1980a, 1980b, 1981)

If games are distinct from other forms of media, then ID for games is also distinct from ID for other media. The central thesis of my work is that ID for games must come ***out of*** games design, rather than being imposed on top of it. And the synthesis of such an approach must come from someone who has experience with building games as well as playing them. This was not the case with "edutainment", and I think this is part of the reason why, in the words of the kids who have it inflicted upon them, most edutainment "blows". People designing the games often just don't get that the learning must be integral to the game itself, not an add-on or plug-in. That means that the instructional objectives must be woven into the game *design*, not just the game application. Without a thorough understanding of programming and software design, it is not possible to see the possibilities and limitations of gaming, and without an understanding of learning theories, their application, and instructional design theories, it is not possible to design a game that will deliver on its instructional objectives while retaining that which makes it a good game. There need to be people on an instructional games development team that know both, and if these are different people, they must be able to communicate effectively with one another.

The challenge of integrating learning objectives with the delivery medium is far from new. In some instances, this is easier than others. For example, when designing worksheets for drill and practice, it is common to create a pleasing background connected with the current theme. In the work I do with the "Ducks in the Classroom[13]" project, vocabulary and word games are created on a pleasing background – possibly a nest, words enclosed in images of eggs, duck footprints, etc. This idea of 'decorating' a worksheet works well for a great many themes, and can

[13] http://pages.cpsc.ucalgary.ca/~becker/HatchingProgram/index.html

be applied quite effectively and generically. Need a worksheet related to Louis XIV? Add some pictures, maybe a few quotes, and if skillfully done, we have added value, fun, even connections for the learners to capitalize upon. The same principle often works reasonably well for instruction delivered via a website – so long as the website is primarily organized as 'print transferred online'. Taking online delivery a step further, the principle *still* largely holds, even when there are various interactive elements on the website or CD. The Hatching Project Candling Tutorial[14] is a case in point. It includes many images, video, and self-tests, and it has received many positive reviews from all over the world, but aside from the non-linear interconnections, it is still many orders of magnitude less complex than a computer game.

Unfortunately, when applied to fully interactive media (specifically games), what I call the 'decorative media principle' does not translate well. The result is often a game that is little more than a wrapper for the instructional materials. Rather than incur the wrath of well-meaning, but misguided edutainment developers by giving specific examples, a purely hypothetical description will be offered here[15]. The game starts off as many typical commercial games do, with cool images and some sort of backstory - you are the world's last hope, and must use your superhuman powers to save mankind, and some sort of quest or challenge that must be overcome - defeat the enemy, or recover the lost treasure. But then, when the gameplay reaches a crucial moment, a new screen pops up showing what any child over 6 can identify as an "exercise", and the world-saving task to be accomplished turns out to be solving a quadratic equation. The answer to this equation, for some thinly justified reason, is the key. Even though the resultant number has no connection to the rest of the story, it is some kind of magic number that defeats the enemy. Even worse, this 'embedded worksheet' looks nothing like the rest of the game – in fact, it looks very much like the paper worksheet that was used in the same class the year before. This is what has become synonymous with 'edutainment'.

To be fair, there are some wonderful examples of fun games that employ this principle effectively – to remain with the hatching theme, examine the kewlbox.com game called "Fowl Words[16]". This game is little more than an interactive worksheet, but the artwork, sounds, and design make it a great deal of fun. Part of what makes this particular game work is

Figure 2 Fowl Words Game

[14] http://pages.cpsc.ucalgary.ca/~becker/HatchingProgram/Candl
[15] Any relationship to people, *living or dead*, or to software, *ditto*
[16] http://www.miniclip.com/fowlwords.htm

that it does not pretend to be more than the simple puzzle it is.

There are other multimedia applications that are also highly complex, such as the software support for Computer Supported Cooperative Learning, and the design of such systems are also challenging. The design of one such installation is described by Carl Bereiter (2002). The methodological approach of design-based research used in this specific project will be discussed further in the section on methodology; but it is relevant here as an example of a highly complex set of interactive tools, that are, nevertheless still tools. The role of the technology in this case is to *support* learning activities, whereas the role of the technology in the case of games is to *be* the learning activity. If games for learning are to be taken seriously, they must be design to work *both* as games *and* as learning 'objects'. The synthesis must be complete.

ID in the Context of Serious Games

Although interest in Serious Games is growing rapidly (See pathfinder), I have still seen very little that deals specifically with ID in this context. And, although it is necessary to "get" games to design good ones, it is unreasonable to expect all members of a design team to be gamers. This may change as time progresses, and more and more of the population has at least some experience with games. In the mean time, a crucible, where games designers and instructional designers can meet and collaborate must be created.

Why Me?

I am always doing what I cannot do yet, in order to learn how to do it.

- Vincent Van Gogh

I have 25 years' experience in programming and systems analysis and design to bring to this problem. Instructional Games Design requires someone who understands both the language of games design and development, and the language of instructional design. Since I am convinced that the ID aspect must be built on top of and into the game design rather than the other way around (Buckingham, 2004; Fabricatore, 2000), the odds favour someone with her roots in Computer Science (CS) over someone with roots in Education. In addition, I have 20 years' experience working with and teaching gamers. University computer science students have always been among the greatest consumers of computer and video games – a significant proportion of freshman entering a computer science program are experienced with the medium of the video game, and this was already true in 1983 when I first started teaching them about programming. Straw poles taken in first year computer science classes indicate that at least half of all freshman computer scientists became interested as a result of playing games.

Purpose of the Work

We, as we read, must become Greeks, Romans, Turks, priest and king, martyr and executioner, that is, must fasten these images to some reality in our secret experience, or we shall see nothing, learn nothing, keep nothing.

- Ralph Waldo Emerson

Games for purposes other than pure entertainment are rapidly gaining in popularity and there is a concern in the serious games community that ID is an element that is not receiving adequate disciplined, organized attention. Both the corporate sector and the Military (in many countries now) are actively pursuing (and funding) the development of simulations and games to teach, and not just for skills training, but also in the areas of decision-making, problem solving, team building, and others. We seem to be at a crossroads. We can let the games designers along with their military and corporate sponsors control the process alone, or we can develop ways for the **ID & GD folks to forge new teams together.**

Although games development is still largely seen as a black art, it is still possible to extract various general principles, such as those suggested by Walpole[17] (2004), Crawford (2003b), Prensky (2001a), and Aldrich (2004), among others, and this will be a necessary early step. Serious Games ID must incorporate these principles, as well as the features and limitations of the game that will be the medium of delivery, right from the start.

Rationale

We have to continually be jumping off cliffs and developing our wings on the way down.

- Kurt Vonnegut

Most of my recent research as well as the bulk of my most innovative instructional interventions have involved the use of computer games in one form or another (Becker, 2001; Parker & Becker, 2003). ID for Serious Games ("Serious ID"?) will require a close coupling between both design processes, for neither can be completed in the absence of the other. In more traditional ID approaches, while the choice of delivery method or tool may be made early on, how these are to be used is often not decided until towards the end of the process. Even when the delivery medium is developed alongside or as part of the intervention, it is assumed to be quite malleable, and that portions of the technology can be tested and adjusted as necessary. This will not work here – in that respect, a good game has more in common with a good novel, play, or movie: one cannot develop a portion of a movie and then see how it works before completing the

[17] http://www.gamedev.net/reference/design/features/wageslave/

rest. In a learning game, about the only part that can be completed before the games development team becomes an integral part of the process is the initial needs analysis.

Those elements that make a game compelling *must* be preserved if games are to retain the respect of those who will use them. One of those things is that the game must still be fun. If it's not fun there is no point of going to the trouble and expense of making it a game. To that end, another aspect of this work will be to face down the problem of "fun" as ridicule; fun as frivolous.

Is this Work Necessary?

In the schoolhouse, we have the heart of the whole society.

- Henry Golden

"This interest in games is encouraging, but most educational games to date have been produced in the absence of any coherent theory of learning or underlying body of research. We need to ask and answer important questions about this relatively new medium. We need to understand how the conventions of good commercial games create compelling virtual worlds." (Shaffer, Squire, Halverson, & Gee, 2004)

The following list is repeated from one sent to the "seriousgames[18]" mailing list by Lisa Galarneau.[19] Her list is repeated here with her permission. She managed to sum it up pretty well, and the consensus on the seriousgames list was in agreement. Much of this list is also described in (Galarneau, 2004).

Why Games in the Classroom Haven't Caught On (So Far):

1. It was tried with great expense and only marginal success during the 'edutainment' era. Many people feel burned by a lot of hype that wasn't perceived to have delivered.
2. Many 'educational' games are what Brenda Laurel calls 'chocolate-covered broccoli' (Laurel & Crisp, 2001) - they may motivate for a while, but don't offer anything novel or more effective pedagogically.
3. Many teachers aren't comfortable with technology.
4. Many educators and parents believe that kids can't learn if they're having fun.

[18] http://www.seriousgames.org/maillist.html
[19] Lisa Galarneau (Work: http://www.synapsys.co.nz Play: http://socialstudygames.com)

5. Many games/sims take much more than 20 minutes to get involved in and get something out of. Most classes don't have that kind of time. Instead teachers are having to spend too much time 'teaching to the test' to have the luxury of using games.
6. Fun, open-ended games/sims often aren't 'accurate' enough to satisfy educators and scholars. If they are, they end up being boring.
7. What games/sims are really best at are not directly transferable skills, but something much more subtle: increased skill, capability or shifts in perspective that may only be apparent over time. (Kurt[20] can tell you lots about this!)
8. Unlike business, learning is not seen as mission-critical to education. (Being able to regurgitate certain bits of information is). Business, the military, etc. have to use games and simulations because we are coming to understand that they effect real change and learning. And those types of organizations cannot survive if their people don't evolve and learn. I know this is a controversial statement, but it's the way I see it. (Not sure how government fits into this theory, though! ;-)
9. Believing in games requires faith, vision and a willingness to take risks. How many organizations have leadership that support this kind of approach?
10. There are games being used very successfully, they're just under the mainstream radar.

[20] That would be Kurt Squire, http://website.education.wisc.edu/kdsquire/

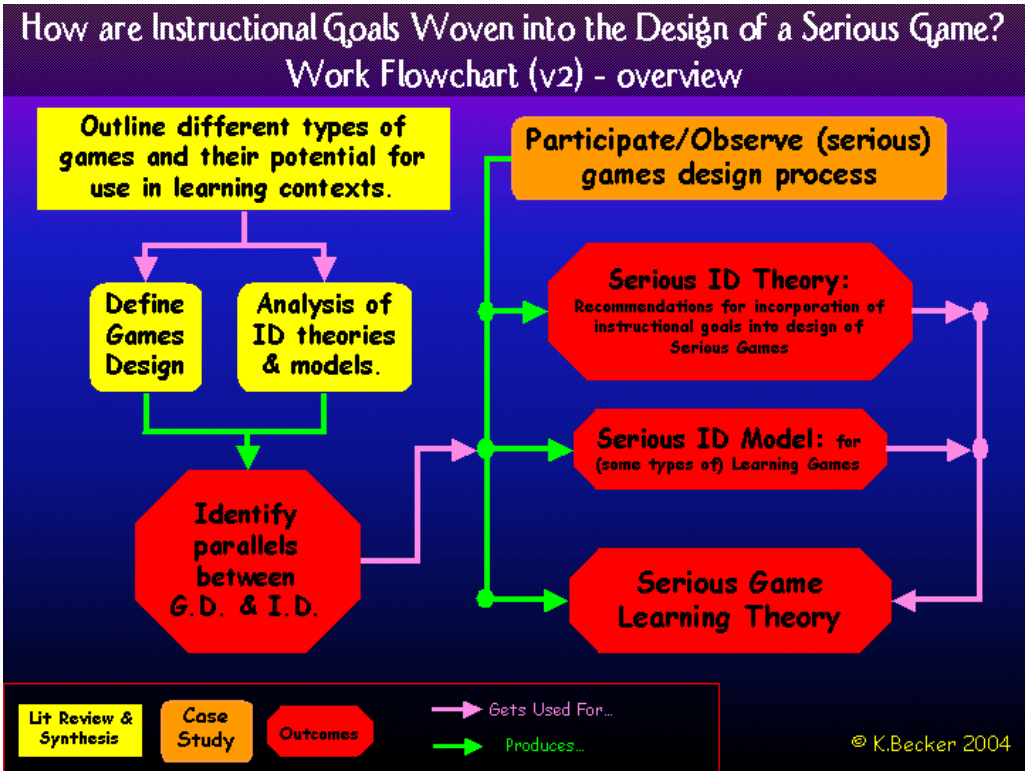
Procedures

One does not discover new lands without consenting to lose sight of the shore for a very long time.

Andre Gide (1869-1951) French Novelist

This work will ultimately result in the development of a theory of learning through games that will in turn inform a theory of instructional games design. A prototype ID model can be produced, and can eventually be tried in one or more real applications.

Steps towards this final goal will include:



A. Outline Different Types of Games.

Distinguish what kinds of things can be learned through each. A starting point for this work has already been completed by Marc Prensky (2001d). Note that ID using existing games is different from ID for custom games. For COTS (Commercial, Off-The Shelf) and other pre-existing games, since the design of the game itself is not alterable, only how it will be used, it must be known what the games are useful for before a reasoned choice of such a game in a learning context can be made. As such, only custom games will be considered in this work.

Outcomes

- List of Game genres:
  - ***a)*** Defined
  - ***b)*** Key features
  - ***c)*** Potential learning situations
  - ***d)*** Potential content and activities

Methodology, and Resources: Game Genres

Scope/Magnitude/Time

The classification of games genres is moderately well known (Wolf, 2001), and although there will continue to be developments (and arguments), a useable list of game genres can be created and defined in the space of a few days. The list of genres will be relatively complete, but the list of potential applications can not be. The purpose of this exercise is to produce a working guide, rather than the definitive answer. This information can later be used as a basis for further study, such as trying to discover why some games (or genres) are more successful as learning objects than others.

Methodology

Sources of evidence will include:
Documentation: books, web articles
Archival Records: listings on Moby Games

- Review Sources – compile list w/ definitions.
- For each genre: identify key features of representative games, potential situations, content, and learning activities.

Resources

- (Björk & Holopainen, 2003; Prensky, 2001d; Wolf, 2001; Wolf & Perron, 2003)
- Moby Games (A game documentation and review project) http://www.mobygames.com/

B. Examine – Describe/Define – G.D. (Games Design)

Since the process must be built onto games design, an analysis of the games design process must be started first (before looking at ID). While games design is still largely a black art, there will still be some basic principles and processes that can be described. There are differences between games design processes in large and small organizations. For example, smaller companies tend to concentrate on one game at a time. They have a very small overhead. Larger companies can afford to be more speculative; they can also devote resources to more than one game at a time. These differences will necessarily result in differences in approach and the team

dynamics. If one is developing a serious game, these dynamics must be understood so we can work effectively within the existing framework.

Outcomes

- List of basic principles of game design.
- Glossary of terms.

Methodology and Resources: Games Design

Scope/Magnitude/Time

The scope of the problem itself is large and not the primary focus of this work. Consequently, the scope of this task will be limited to remain within a moderate time frame (approx. 3 mo.), and no definitive answer is expected. The main purpose of this work is to create a basis for comparison against which to compare the design being studied as it unfolds.

Methodology

Sources of evidence will include:

Documentation – books as referenced
Archival records – post mortem articles on Gamasutra; published interviews

- Recent literature on games design will be examined in order to extract some basic principles.
- It is not expected that any straight-forward design model (such as, for example a waterfall model) will be found.
- Verification of the validity of the basic principles proposed will be triangulated against written accounts (post-mortems) provided in the sources identified.

Resources

- Gamasutra – The Art and Science of Making Games (online games developer's magazine: http://www.gamasutra.com/) – contains many post-mortems written by members of games development teams
- Chris Crawford (Crawford, 2003a, 2003b)
- Eric Zimmerman[21] (Salen & Zimmerman, 2004)
- Clark Aldrich (Aldrich, 2004)
- Will Wright (creator of the SIMs), Warren Specter (designer of DeusEx), Sir Peter Molyneux (Designer of Black & White, and Fable)

[21] http://www.ericzimmerman.com/

C. Analysis of ID Theories and Models in the context of the design of learning games.

The primary goal here is to determine which theories and models are suitable for use in this context and which are not and why. This will also include an examination of some failed examples of learning games (i.e. games that were designed as 'edutainment', that did not deliver on their promises). A result of this part of the work will be a synthesis of core requirements for ID relevant to games.

One of the questions I want to address when I look at these is, What is the value added when viewed through games? Can learning through games make use of this theory in novel ways? I don't simply want to make theory 'soup' by chopping up bits of others and reassembling them, and then trying to pass this thing off as a new theory. In each case I want to see how this applies specifically to games, and what, if anything is unique to games.

Outcomes

- List of Theories and Models relevant to games, justified.
- Initial propositions about why edutainment failed.
- Glossary of terms.

Methodology & Resources: Analysis of ID Theories & Models

Scope/Magnitude/Time

This work has already begun, it is expected to take another month or two to complete. Documentation is available upon request.

Methodology

Sources of evidence will include:

Documentation: books and web articles

- Create list of ID theories / Models that will be considered.
- Match each theory against game design principles to see how well they fit. Any with a good enough fit will be retained for consideration later on during the work.

Resources

- Theory into Practice Website, "The Theories" (http://tip.psychology.org/theories.html)
- Merrill (Merrill, 2002)
- Jonassen (Jonassen, 2000; Jonassen & Association for Educational Communications and Technology., 2004; Jonassen & Land, 2000)
- Reigeluth (Reigeluth, 1999a, 1999b; Reigeluth & Squire, 1998)

Intermediate Outcome: Combination of 'B' & 'C': Parallels between G.D. & I.D.

This must be connected back to games design. A key tenet of this work is that the learning objectives must be embodied in the game itself, and the activities intended to promote the desired outcomes must be embedded within the game. The parallels between G.D. and I.D. is primarily new work, there are very few sources. Garris, Ahlers, and Driskell (2002) have offered an input-process-output model of instructional games and learning, but it does not address the perspective of the games design itself. A part of this outcome will include a characterization of design that is general enough to be applied to both design activities.

D. Case Study: Observe the serious games design process

Develop case studies of games designs to explore what actually happens.

It would be instructive to watch the design and development process for a 'regular' game as well as for a serious game for comparison. Unfortunately, this will not be possible within the scope of this thesis. The outcomes of such research can, and will be approximated through step 'B' (Define/Describe Games Design).

Rationale for Approach

"For many years, a proposal writer had to discuss the characteristics of qualitative research and convince faculty and audiences as to their legitimacy. Now, there seems to be some consensus as to what constitutes qualitative inquiry and such a discussion is not needed." (Creswell, 2003, p179-180) Given that, the rationale that follows will only seek to explain why the methods chosen are appropriate for *this* study.

One step in the process of discovering how games *should* be designed is to document how games *are* designed. For this work, the *case* must be an event: the design of a learning game. After-the-fact reports, while useful, routinely omit elements whose relevance has expired from the perspective of the design team, and so really the only way of gathering comprehensive data on the design process is to actually follow a design as it unfolds. There really is no other way to do this than through field study, and since such an effort can only do justice to one design process at a time, an in-depth case study would appear to be the most logical approach. "As a form of research, case study is defined by interest in individual cases, not by the methods used." (Stake, 2000, p. 435). Although there are have been a few noteworthy publications on the topic of designing learning games (Fabricatore, 2000; Garris et al., 2002; Kafai, 1995, 2001; Malone, 1980b; Papert, 1998; Pivec, Dziabenko, & Schinnerl, 2003), and several literature reviews

(Dempsey, Rasmussen, & Lucassen, 1996; Mitchell & Savill-Smith, 2004) as a field of study, the design of learning games is in its infancy. The available body of prior research is small (Shaffer et al., 2004) – therefore an exploratory study is appropriate.

Exploratory studies can help to identify or uncover important categories of meaning, and generate hypotheses for further research (Marshall & Rossman, 1999, p.33), and these are both important goals of the proposed research. Also, given the immature nature of this field, Peshkin's claim (2000) that case study design is not an event, but a process that occurs throughout the case study is particularly relevant. Since there are no currently known studies[22] of the design of an instructional computer game, this one will be centered on the questions of interest, which are outlined in the next section. These questions, together with the main question: How are instructional goals woven into the design of a serious game? and the central tenet that the instructional design of a game must be embedded within the games design will provide the focal points around which the data collected can be interpreted.

The proposed design of the case study is that of an embedded single-case as described by Yin (2003). The main unit of analysis is the design of the game, while secondary units of analysis will be the experiences of the groups and individuals involved in the design. This case promises to be revelatory, as it is the first of its kind.

Some Questions of Interest (not necessarily in order, and not comprehensive)

1. **What are similarities and differences between commercial games design and the design of custom learning games?**

   Many current researchers involved in the use of games for learning have chosen to locate the scope of their research as being connected with either commercial off the shelf games (COTS), or custom designed games[23]. This would imply there is a distinction between the two. I suspect there is. With some background (available from CPSC 585, as well as through Gamasutra) on the pressures faced by commercial games designers, it might be interesting to compare that against pressures that emerge from a study of the design of a custom game. Further, the motivations of commercial games designers are, well, commercial – in other words, there is a requirement that the product make money. This is not the case with learning games – at least, it should not be the primary goal. Addressing this question can be accomplished partly through a review of available literature (such as game post mortems),

[22] There may be some in progress, and I will try and find out who is doing what.
[23] I don't have specific references at the moment, but can find some: Kurt Squire divides his time between the study of COTS in classrooms, and in the development of custom games. Jim Gee's perspective comes from COTS, etc.

and partly through interviews with participants in the case that have experience in commercial games – they can be asked what differences they see. With a functional description of the games design process, it will also be possible to compare the case against that.

2. Where are the stress points in the design process, and what might some of the mitigating factors be?

Stress points will be identified as those places where disagreements occur. The number of people involved and the amount of time (both in terms of elapsed real time and 'meeting' time) expended to resolve the issue will contribute to a measure of 'severity'. It is postulated that these stress points will highlight areas where the expectations of one group such as the games designers, do not mesh with the expectations of another, such as the instructional designers. Since the overriding goal is to discover how instructional goals get incorporated into the design of a game, these stress points may uncover places where the design processes clash.

3. What are the observed and perceived roles of the project participants?

A necessary task in the study will be to examine the division of labour and responsibilities during the design process. This includes both roles and tasks as observed, as well as interviews with individual project participants. This will involve tracking logs of who does what, as well as interviewing individuals about their role in the project. Discrepancies between stated (imposed by project), perceived (identified by individual involved), and observed roles will be noted. Overlapping roles, duplications, and gaps may be uncovered through this process.

4. How is the team organized and how are problems resolved?

While some of this relates back to questions 2 and 3, looking at the overall organization, and comparing that against the individual roles can provide some insights to a model of an ideal, or at least requisite organizational structure.

5. What kinds of tools are used?

In particular what kinds of record-keeping, documentation, and development tools are used. Are they custom or off-the-shelf? How are these tools used? It may be possible to determine a set of common tools that facilitate communication among the various affinity groups. If different groups have radically different requirements in terms of tools, this may warn of communication hurdles that will need to be overcome.

6. How do language issues affect the design process?

I have noticed some striking differences in the terminology used by these two groups of experts. In some cases they use the same words but mean different things. This is a source of

difficulty, which must be addressed. (Shaw & Gaines, 1989) A translation between ID & GD is necessary if we are to design educational games that still feel like games. There is a certain amount of overlap in the terminology used, and in at least some cases there are subtle but important differences in the meanings of the words used. (eg. The way rapid prototyping is used is one example; the distinctions between iteration and recursion are different in education from those understood by programmers.)

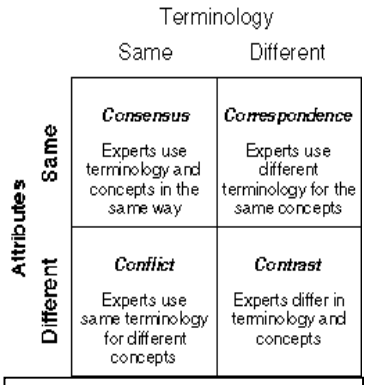


Figure 3 Conceptual Structures (Shaw & Gaines, 1989)

7. **How are educational or instructional issues identified? Addressed?**

Are participants aware of the educational goals of the project? How do they indicate their awareness? It is suspected that successful commercial games incorporate what amounts to instructional goals already, but this is not a deliberate act on the part of most designers. An understanding of how the different groups view the goals of the game and how they are expressed within the game may lead to ways to address difficulties in translating learning goals into game elements.

8. **What aspects of the game design were influenced/affected/altered by stated or emergent instructional (teach) and educational (learn) goals?**

Learning goals are likely to be framed as either "educational" or "instructional", and each is expected to present itself differently, and to result in different choices in terms of implementation. An "instructional" perspective implies we want to teach the players 'X'. This equates roughly with the first three levels of Bloom's Taxonomy (knowledge, comprehension, application) (1964) and the implementation will involve telling, showing, and demonstrating, while a "learning" or educational perspective is more concerned with orchestrating the situation or environment to facilitate the discovery or construction of a particular idea, concept, relationship, causality, etc. This perspective corresponds to the final three levels of Bloom's Taxonomy (analysis, synthesis, evaluation) (ibid.)

9. **What kinds of assessment mechanisms are built into the game? How are they going to be used?**

Various metrics are routinely built into games – to gather use stats, provide player feedback, as well as to feed back into the control system to trigger various game actions (help; suggestions; level-up, etc.). Can a learning game make use of the same mechanisms employed by commercial games, or will additional or alternate approaches be required?

10. **What kinds of external support materials are created to supplement the game itself?**

It is assumed that there will be minimally, a "Teacher's Guide". This development will be followed as a distinct, but related process – successive drafts will be compared to see how content changes and how that connects back to the evolution of the game.

11. **To what extent are existing game models used in the design of this one?**

In other words, how many existing games (and which ones) were examined? Which ones were chosen as suitable for providing models and exemplars, and why?

12. **How does this game ensure that the learners' experience gives them what is intended?**

Games are not linear. Content in games is presented within the framework of a set of rules or logical relations. As a result, unexpected scenarios are common in games (for a fairly extreme illustration, see: Something Awful: A Week in the Life of The SIMs[24]). There are many choices for how to cope with these emergent behaviours. How does the design team envision addressing these issues? How are they in fact addressed, if at all?

Methodology

Sources of Evidence

Documentation: any official documentation produced during the design of the game, including, but not limited to: memoranda, meeting notes, email communication

Archival records: funding applications; research and background documents used in the development of the game design

Interviews: open-ended, focused, and structured. Each member of the design and production team will be interviewed (focused approach) at least once during the cycle to gather information about their own perceived roles, goals, frustrations, and achievements. While it will likely not be possible to interview all contributors (such as all native elders and other tribal council members, etc.), attempts will be made to contact one or more members of each group that provides input or consultation on the project.

Direct observation: I will not be a full participant in all aspects of the design, and in some situations I will act as observer (either formal or casual, depending on the situation) during meetings. Provisions for multiple observers may not be possible, so other members of the meetings will be used to verify notes whenever possible.

Participant observation: I have an active role as part of the design team so the opportunity for data gathering through participant observation exists, and I will take full advantage of it.

[24] http://www.somethingawful.com/articles.php?a=2392

Physical artifacts. All physical and electronic artifacts produced for the game in the course of the study will be catalogued and described. Where possible, copies will be archived. These will include, but are not limited to: program documentation, functional specifications, requirements specifications, application tools, game engines (AI, graphics, networking), screenshots, demos, videos, etc.

Validity and Reliability

- Time span for data collection will be as protracted as possible to allow for careful, unrushed data collection.
- As many participants as possible will be included in the study – ideally, everyone who contributes to the project will be included in at least one structured interview to determine their role.
- Participants will all be given an opportunity to review notes and summaries based on their comments and contributions.
- The researcher will maintain a separate log and diary to record reflections, comments, concerns, and uncertainties as well as the other notes. These 'private' notes will not be publicized. This will allow the researcher freedom to comment while still allowing participant notes to be reviewed by the participants themselves.
- Data collected will be corroborated with and triangulated with other participants so that when the analysis is being done, it will be possible to identify outliers and discrepancies.

Analytic Strategy

- Keep as much of the data collected in electronic, text form as possible. This will permit extensive data mining, comprehensive indexing, and the greatest flexibility in analysis. Statistical textual analyses can be performed on words and phrases, which can suggest categories and common themes, as well as topics or concepts that might otherwise be missed. Note that such textual analysis may also highlight the researcher's bias, both linguistically (word choice) as well as perceptually. Perceptual biases are often difficult to detect by the researchers themselves, but it is clear that interpretation of observations are inevitable, even when all reasonable measures are taken to avoid bias. Biases in interpretation will tend to show themselves in the choices of descriptions, and these can be revealed through statistical textual analysis. Once set up, such analyses can be performed at regular intervals and interpretive biases can be highlighted early, allowing for ongoing validity assessment and adjustments, if necessary.
- Conduct constant comparison (compares new evident to prior evidence to identify similarities and differences between observations)

- Use pattern finding and categorization; negative case and discrepant data approaches (the search for contradictory, variant, or disconfirming data within the body of data collected that provides an alternative perspective on an emerging category or pattern)
- Use analytic induction to generate explanations, theories and to test generalizability.

Notes & Resources: Studying the Design Process

- NSF Mixed Method Evaluations: Overview of the Design Process for Mixed Method Evaluations, NSF Division of Research, Evaluation and Communication (REC) http://www.ehr.nsf.gov/EHR/REC/pubs/NSF97-153/CHAP_5.HTM
- Research design: qualitative, quantitative, and mixed methods approaches (2nd ed.) (Creswell, 2003)
- Designing qualitative research (3rd ed.) (Marshall & Rossman, 1999)
- Yin, R. K. (2003). *Case study research : design and methods* (3rd ed.). Thousand Oaks, Calif.: Sage Publications.
- Merriam, S. B. (1998). *Qualitative research and case study applications in education* (2nd ed.). San Francisco: Jossey-Bass Publishers.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks: Sage Publications.
- Creating and Using a Performance Measure for the Engineering Design Process (Kline et al., 2003)

Design Research

As an avenue of inquiry, researching the design process is practiced in many disciplines, including, but not limited to: computer science, architecture, graphic design, engineering (to an extent), as well as education. Each has its own perspective, uses the available terminology in subtly different ways, and focuses on the different aspects of the larger design process according to its own culture.

By and large, and perhaps not surprisingly, engineering and CS both tend towards an engineering approach to design. CS looks at how best to design programs[25], while engineering largely looks at how best to design structures. The field of software engineering in particular concerns itself with the application of engineering design principles to the production of software. However, there remains a fundamental difference that distinguishes the two practices, and it remains at the heart of why software engineering has thus far failed to devise an effective design methodology, or to eliminate the human element from programming (Weinberg, 1998). Engineering is primarily concerned with the production of physical artifacts, but software has to do with the representation and manipulation of information. This is a key consideration in the proposed work, as a game is ultimately a piece of software.

[25] Another area of CS that concerns itself with design, namely Human Computer Interfaces (HCI) will be discussed in the next section.

Architecture and graphic design are concerned not only with artifacts, but also with aesthetics. Although graphic design may be *presented* using multimedia, its primary effect is visual and it communicates primarily in an artistic sense. By contrast, architecture has some things in common with engineering, but the esthetic aspects set it apart. If architecture were simply about building the *right or best* structure, then research efforts could focus on uncovering what "right" is. A scientific approach would suffice; it could concentrate on evaluating designs based on some measure of goodness, and once the "best" house had been devised, everyone could live in one. There is obviously more to architecture than this, and the study of design in architecture must clearly involve more than understanding how to design the best structure. I will come back to this in the next section, as the study of design in architecture is fruitful ground for approaches to the study of the design of instructional games. Among other things, games also carry an aesthetic requirement that cannot be disregarded in a design.

Design in education falls under the purview of Educational Technology, and, specifically, Instructional Design. One approach to studying design in education, that of design-based research is currently enjoying favourable attention. The broad goal of design-based research is to engage in theoretical research in realistic learning settings. The primary arena for this form of research is in the classroom (Brown, 1992). Philip Bell (2004) describes the goal of design-based research as being to "better understand how to orchestrate innovative learning experiences among children in their everyday educational settings, as well as to simultaneously develop theoretical insights about the nature of learning". He also refers to this as design experimentation, which is "theoretically-framed empirical research associated with the enactment of complex interventions in everyday settings".(Bell, 2004). This research often involves a tight relationship between researchers and teachers or implementers. "Design-based research is, at its heart, an attempt to combine the empirical exploration of our understanding of those environments and how they interact with individuals." (Hoadley, 2004, p205)

According to the forgoing definitions, the work proposed by this author does not qualify as design-based research. It is nonetheless *research on design*. The design being researched here is that of the artifact itself *before* it becomes part of any intervention. The proposed work is not empirical as no experiments will be conducted. The study of the design process proposed here differs from the study of the intervention. The intent here is not the improvement of the intervention itself, but rather a better understanding and improvement of the artifacts used as part of an intervention.

Approaches to Studying Design

There are many ways to approach the study of design, and Ame Elliott describes a classification she uses in her Ph.D. dissertation on the use of images in the early phases of

Approaches to Studying Design in Architecture (Elliott, 2002, p 22)

	Approach to Studying Design			
	Art	**Science**	**Conversation**	**Profession**
Purpose of architecture	Express personality of architect	Solve problems	Make world more equitable	Satisfy clients while making money
Nature of the early phase of design	Inspiration and burning need to create generate ideas	Problem description begins design	Dissatisfaction with the world starts dialogue	Client need begins design
Methods of inquiry	Proximity to greatness, learning by doing, constructing virtual worlds	Protocol analysis, codify design knowledge, develop computational tools	Protocol analysis, encouraging dissent through role playing and games	Ethnography, surveys
Role of sketching	Develop personal style	Refine ideas and produce plans	Encourage exploration and conversation with self	Follow training to generate alternatives for client evaluation
Role of precedents	Imitate the masters	Efficiently reuse ideas	Understand prior design rationale, make successive projects better	Communicate with clients

Table 2-1: Comparison of Approaches to Studying Design

architectural design. Ms. Elliott proposes four basic viewpoints for making sense of design. Although described as part of her work in connection with architectural design, the approach can be generalized, and applied to both games and instructional design. Ms. Elliott describes how design can be studied as Art (personal expression, arbitrary), as Science (systematic, structured, procedural), as Conversation (defining the problem *is* the problem, design problems are wicked[26] (Rittel & Webber, 1973)), and as Profession (work practice study, culture of workgroup, user-centered). A more detailed examination of instructional design in particular from the four perspectives will be presented during the course of the work, but for now a brief explanation follows.

In instructional design, design-as-art is expressed as design-as-craft. It is associated with creativity, personal talent, and expertise. This view predates the recognition of instructional design as a discipline. The age-old practice of apprenticeship embodies this view. Great

[26] I find it fascinating and gratifying, that further searches into design research leads me back to "Wicked Problems". It seems each time I try to "stray" in finding other approaches to this problem I am led back to this one.

'teachers' are recognized "because of their unique ability to channel an absolute truth, and the physical expression of this truth is mediated by the [teacher's] personality." (Elliott, 2002, p24, ref. to 'architect' replaced by 'teacher').

Design as science developed in architecture as a contradiction to the view of design as art. A similar parallel exists with instructional design, dating back to the turn of the last century, and John Dewey's call to link science to educational practice and learning theory (Dewey, 1900). What this approach still shares with the view of design-as-art is a belief in an absolute truth. A "right" way exists and can be found. It also shares with design-as-art, a need for a 'master-class', in this case a form of scientist (educationist?). A main purpose of instruction in this view is to solve problems (gaps). The connection between instructional design and artificial intelligence became cemented in the 70's, both tending to share the view that problems can be solved through the application of scientific principles, and that even ill-structured problems can be transformed into well-structured ones through a classic divide-and-conquer strategy. This approach also demands that the design problem be completely described before the design is started.

A third view is that of design as conversation. This perspective offers an alternative to the difficulties inherent in the coupling of complete problem definition and an absolute truth in design. This view holds that the purpose of design is to define the problem. This is where Rittel and Webber's seminal work on wicked problems connects with design (Rittel & Webber, 1984). Wicked problems cannot be judged right or wrong, so the role of absolute truth in this view becomes irrelevant. Further, Jean-Pierre Protzen has proposed three principles in decision-making: chance, absolute truth, and idoneity (Protzen, 1981). With absolute truth taken care of, the prospect of decision-making by chance implies an arbitrariness that lacks any basis for judgment. The third possibility: idoneity is consistent with the view of design-as-conversation, as it implies decision that are "proper and appropriate to the intentions" although they cannot be known in advance. Idoneity is achieved through conversation. This is the approach that is believed to hold the most promise for new understandings in the current proposal of studying the design of instructional games. This approach also connects back to design-based research in instructional design. According to Elliott, "The methods for exploring design as conversation are similar to those in design as science. In particular both approaches have protocol analysis in common. However, in design as conversation, the intent of protocol analysis is the opposite of design as a science. In design as science, the purpose of protocol analysis is to reduce the complexity of the design problems by dividing them into smaller and smaller chunks that are so simple even a computer could understand them. In contrast, the use of protocol analysis in design

as conversation is to increase the complexity in an attempt to include as many voices as possible in an attempt to define the problem." (Elliott, 2002, p.63). This provides a strong argument for the use of case study as a methodology.

The final view is that of design as profession, and it also shares many properties with instructional design. The key approach here is work practice study: "the existence of a culture of work, that is a set of social norms that regulate the behavior of anyone working at a particular type of practice" (Elliott, 2002, p.72). The user-centered design approach falls in this category. The goal is the development of technology. This fits nicely with many approaches to instructional design, but games cannot be included, due to their inherent complexity. The concept of education as a business also fits into this view of design. Design-as-profession focuses on the workplace in architecture; if applied to instructional design, the focus is the school or classroom. This also ties into Donald Schön's ideas about reflective practitioners, which favours an understanding of professional knowledge rather than its economic realities (Schön, 1987).

These are the four lenses through which the design in the case study will be viewed and discussed.

Field Work

"The only possible interpretation of any research whatever in the 'social sciences' is: some do, some don't. "

Ernest (1st Baron) Rutherford (1871-1937)

Some Key Considerations

- The act of design is the main focus of the study.
- An instructional game is, first and foremost, a game.
- The case being studied is the design of software, and software has to do with the representation and manipulation of information.

Scenario 1: Follow the Development of a Game For Learning

My role: - full participant – observer

Time Limit and Project Scope: As this project is dependent on securing adequate funding, I will set a time limit on how long to wait – if there is still insufficient funding for this project by June 30 2005, then this case study will be abandoned, and the second scenario will be used. The proposed project is very large and will span several years. As a result, the case study will follow and chronicle the initial design stages, which are likely to include the first year of development.

Project Outline

<The project itself is still in the development stages and so I am not at liberty to provide details here>

This work will involve keeping notes of meetings, collecting related documents, interviews with developers and backers, etc. This work will necessarily be of an evolutionary nature, as the best approach for gathering information will change over time, and unforeseen opportunities are likely to present themselves.

Scenario 2: Case Studies of 3-5 Completed Projects

If the funding for the proposed project does not come in time to permit me to study the development as part of my doctoral work, I will instead proceed with several case studies of existing educational games. This primary criterion is that these games must have been designed and created specifically as tools for learning.

The details for this scenario will not be worked out until necessary, but will include a combination of

- Examining existing documents associated with the game, including design documents where possible
- Interviews with key designers involved in this game
- Possible interviews with or examination of data collected on users of these games (users and their supervisors (which could be teachers, managers, etc.)

Games might include:

- OceanQuest (UofC - JRParker) http://pages.cpsc.ucalgary.ca/~parker/OceanQuest/OceanQuest.html
- VirtualLeader (Clark Aldrich) Simulearn http://www.simulearn.net/leadershiptraining.html
- Tibet (UofC - JRParker);
- RealLives (Educational Simulations) http://www.educationalsimulations.com/

My role: - the design will be studied after the game is completed – I will not be a participant.

Methodology – Several Games

----------***More to come as necessary***----------

Essentially, the approach for this scenario will be similar to the primary one, except that participant observation will not be possible, and interviews will necessarily be conducted after the fact. For a game like “VirtualLeader”, it may be possible to visit Clark Aldrich and interview him in person.

Outcomes

1) Parallels between G.D. & I.D. (intermediate outcome)
2) An Instructional Design Theory: A set of recommendations for the incorporation of instructional goals into the design of serious games.
3) An ID model (Serious ID, or Instructional Games Design) for the development of (some types of) instructional games.

4) A Theory of Learning through Serious Games (Serious Games Theory)

Timeline

For more details see: http://pages.cpsc.ucalgary.ca/~becker/Main/PhD/Devel/TimeLine.html#now
2004: write proposal
2005:
- Mid-March – candidacy
  - Ethics

'Background work' – A-C can be done simultaneously
2005: data gathering (case studies) on-going
2006: finish data gathering; analysis & writing
2007: finish / defense

Appendix: Interview Questions for Structured Interview 1

To be used for all participants:

1. Do you have an official title on this project?
    a. If not, what would you say your position is?
2. Are you being paid to work on this project?
3. Why do you think you were brought on board to work on this project?
4. What do you see as your role in this project?
5. What is your contribution to the design of this game?
6. What do you hope to get out of your experience on this project?
7. Have you worked on games before?
    a. In what capacity?
8. How does this project differ from others you've worked on?
    a. How is it similar?
9. What would you say is the purpose of this project?
10. How would you describe the "Big Picture" view of this game?
11. Do you see this game as an educational game?
    a. Why?
12. What do you think players *can* learn from this game?
13. How do you think players will learn these things?
14. What do you think players *will* learn from this game?
15. Were you aware of any educational objectives in the design of this game?
    a. What were they?
16. How do you think they have been embodied in the game, if at all?
17. How do you feel about the use of computer games to teach?

Appendix: Catalogue Information for Artifacts and Notes

This forms the basis for the database of items that will be collected. As patterns of items begin to emerge, further classification categories will be developed. This form can easily be created in an electronic database like Access for ease of sorting and searching as well as some kinds of reports.

Date:_____ Time:_____

Type: (circle)		
Documentation	Observation Notes	Electronic Artifact
Archive	Participation Notes	Other:_____
Interview Notes	Physical Artifact	_____

Topic: _____
Main sorting category – may also include one or two secondary categories (others go under keywordsy

Site / Location:_____
Where data is being collected; and/or where artifact/file is being stored (since this catalogue index will be separate from the data)

Participants: _____

Keywords: _____

_____

Significance (why this is of interest):_____

_____

Notes & Comments:

Appendix: Essential Game Elements

These things are necessary if we are to understand how to use them to teach to a specific goal. They are the tools or elements we have at our disposal as instructional designers. The target audience influences ***everything*** about the game.

According to Ernest Adams, Game design is neither Science nor Art. A science requires formal methods. Games design has none. A science also posits hypotheses and seeks truth. Games design does not. It is also not an art since it is not primarily a means of aesthetic expression. They are a collaborative art form more closely related to movies and television than fine art. Games design is a craft. It has both aesthetic and functional elements, and craftsmanship of high quality achieves elegance.

All games have balance. They must be:
- Fair: all players must have an equal chance of winning *at the start*
- Challenging but not too much so: the game must be neither too hard nor too easy
- Winnable – the game must end sometime
-

All games must contain positive feedback:
- An achievement that makes subsequent achievements easier (eg. Taking a piece in checkers; being 'kinged' is better still)
- Positive feedback prevents stalemate
- Must be controlled to avoid giving the lead player too much advantage
- ***KB:*** must be player-age-related
-

Games must contain negative feedback as well:
- Achievements have a cost as well as a benefit (loser goes first next time)
- Element of chance: ensures setbacks.
- Victory is defined in non-numeric terms – giving something up may have strategic merit
- Difficulty level increases as players progress

Appendix: Types of Learning and Possible Game Styles

By Marc Prensky (2001a)

From *Digital Game-Based Learning* by Marc Prensky (McGraw-Hill, 2001)

"Content"	Examples	Learning activities	Possible Game Styles
Facts	Laws, policies, product specifications	questions memorization association drill	game show competitions flashcard type games mnemonics action, sports games
Skills	Interviewing, teaching, selling, running a machine, project management	Imitation Feedback coaching continuous practice increasing challenge	Persistent state games Role-play games Adventure games Detective games
Judgment	Management decisions, timing, ethics, hiring	Reviewing cases asking questions making choices (practice) feedback coaching	Role play games Detective games Multiplayer interaction Adventure games Strategy games
Behaviors	Supervision, self-control, setting examples	Imitation Feedback coaching practice	Role playing games
Theories	Marketing rationales, how people learn	Logic Experimentation questioning	Open ended simulation games Building games Constructing games Reality testing games
Reasoning	Strategic and tactical thinking, quality analysis	problems examples	Puzzles
Process	Auditing, strategy creation	System analysis and deconstruction Practice	Strategy games Adventure games
Procedures	Assembly, bank teller, legal	imitation practice	Timed games Reflex games
Creativity	Invention, Product design	play	Puzzles Invention games
Language	Acronyms, foreign languages, business or professional jargon	Imitation Continuous practice immersion	Role playing games Reflex games Flashcard games
Systems	Health care, markets, refineries	Understanding principles Graduated tasks Playing in microworlds	Simulation games
Observation	Moods, morale, inefficiencies, problems	Observing Feedback	Concentration games Adventure games
Communication	Appropriate language, timing, involvement	Imitation Practice	Role playing games Reflex games

Note: This is intended to be suggestive, not exhaustive. Comments welcome at marc@games2train.com.

References, Resources

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