NVIDIA, MATROX, PAPER? - UNDERGRADUATE GAME DESIGN TOOLS IN THE HUMANITIES AND SOCIAL SCIENCES

Dr Mike Cosgrave
History Dept, University College, Cork
Cork, Ireland
m.cosgrave@ucc.ie

Eschewing costly high-tech approaches, this paper looks at the experience of using low-tech approaches to game design assignments as problem based learning and assessment tool over a number of years in undergraduate teaching. General game design concepts are discussed, along with learning outcomes and assessment rubrics in line with Blooms Taxonomy based on evidence from students who had no prior experience of serious game play or design. Approaches to creating game design based assessments are offered.

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game, game design edugaming, serious games, wargame

Pedagogic uses of gaming - serious games or edugames - focuses mainly on the use of digital game technologies in education. Edugaming offers exciting opportunities to communicate effectively with 'generation X-Box.' However, for many academics there are two serious obstacles to experimentation in this field.

The first is that most academics in humanities, social sciences, business, law and many sciences, are not programmers or software engineers. Most academics do not have the skills to develope digital game based learning tools without placing themselves in the hands of computer scientists. These 'geeks' speak a language we do not understand, and work within a disciplinary framework which is foreign to many of us. Additionally, unless you can engage with computer science interested in collaborative projects with humanists, game programming costs money. There have been a number of impressive game design projects on humanities topics, but all depend either or the use of proprietary technologies or custom programming, both of which cost money. Projects like the Arden Project are examples which show what can be achieved, but only with difficulty and if you have a grant for the work[1].

The second major problem is that many academics are not gamers. There are certainly academics who play games - everyone has some basic familiarity with common boardgames like Monopoly or Scrabble; and any academic with teenage children has certainly some, often negative, experience with console games. However, the number of academics who think seriously about how games are designed and developed, how rules work and how to define conditions for winning in a game is quite limited. It is therefore quite difficult for non-gaming academics to design edugames that work. If you cannot design a game, you can hardly expect to write up a clear specification for a game design for computer programmers to implement. No amount of grant funding will fix this problem. In fact, it may or should be hard to get grant funding for an edugaming project unless you can produce at least an outline for a game that looks like it has a reasonable chance of working well when it emerges from implementation by the programming team.

In this paper, I propose, perhaps unusually for an educational technology conference, to step back from the technology and look at some types of games - wargames, boardgames, modern collectible card games - in terms of how I use them in my teaching. I will generalise from my own teaching experience and look at these games in general, at how they seek to represent differing views of reality through game components and rules, and at how we might develope pen and paper based prototypes for tested and for development into more ambitious projects.

My own gaming experience is linked mostly to two major genres - wargaming and role-playing games, and I use that experience in my teaching regularly.

The most direct application of my roleplaying game experience is in running simulations in politics and international relations courses. This is a well known type of academic gaming, and there are a number of articles and excellent books which discuss it. Some work has been done on developing digital simulations to model the sort of negotiation interactions in these games. While this is an interesting field, I do not propose to deal with it in this paper, although I plan to return to it in at a later date.

Wargaming is a fundamental part of my teaching practice in military history, and it is in this domain that I began to not only require students to play games as part of their courses, but also to design games as graded, group exercises.

In wargaming, Von Reisswitz' 1824 Kreigspeil is regarded as the wellspring of the modern wargame. It established many of the mechanics which are fundemental to the genre. A great deal of primary historical and military research to build a combat model for the game which was, given the limits of the reseaech and analysis tools at that time, quite remarkable. The game was developed around the same time as armies, greatly expanded by the widespread adoption of conscription after the levee en masse of the Revolutionary era, required a much larger number of officers who required training. For this, Von Reisswitz game was ideal, and this lead not only to it's being adopted as a training tool by the Prussian army, but also to it's being copied by many other armies over the course of the Nineteenth Century. English and American versions of the Von Reisswitz game are extent, no doubt there are translations in other languages also.

In the intervening years, the use of wargames as a training tool by the military has grown and developed. It ranges from high-level grand strategic civil-military simulations run as conference games, through exhaustive computer based operations research simulations of air defense or anti-submarine warfare to laser-based boots on the ground simulations[2]. As all the war and society become increasing digital, the relationship between game and reality has become blurred - when it was written, *Enders Game* [3] was a work of classic science-fiction, but now it has become reality. Indeed, the US military now explicitly offer a major 'first person shooter' game, America's Army, and use it as a recruiting tool [4].

Civilian hobby wargaming is divided into two main genres - miniatures game and board games. Miniatures games, using large numbers of painted wargame figures, are visually appealing but demand artistic skills, as well as space and time which mean that they are no real use in teaching in university, although they may well fill a useful role in the history curriculum at second level. Board wargames, while less visually appealing, have a much higher information density and are more useful for university teaching.

This genre traces its popularity back to Charles Roberts Tactics II game from 1958[5]. Roberts essentially modernised the basic mechanics of the Von Reisswitz game and packed it as a board game which spawned a new genre of hex and counter based board wargames. This genre flourished as a physical product from 1958 until it was overtaken by computer bsed wargames from the late 1980's on. Industry insiders estimate that as many as 20 million units of these highly complex games were sold between 1980 and 1991, and the genre lives on with several companies continuing to develope and sell limited print runs[6]. Wargame designers like Mark Herman, whose Gulf Strike game was a remarkably prescient game analysing warfare in the Persian Gulf, have taken the skills of the genre from hobby gaming to boardroom tool. Many of the early computer wargames were, in effect, no more than straight translations of these hex and counter games to the new digital environment[7].

At one level, the mechanics of these games are quite simple. A map, overlaid with a hexagonal grid to regulate movement, represents the battlefield. All units, represented by counters, have a movement allowance. Every unit may move in every turn, up to the limit of its movement allowance, with different types of terrain costing more or less movement points. These are based on historical march rates possible within the timeframe of each game turn. All units have a combat strength. In early or simple games, this is based on raw headcount, with some allowance for quality in the case of exceptional units like the Old Gaurd. Combat is resolved by comparing the attackers strengh to the defenders as a ratio, with a result being obtained by cross-referencing a random dice roll with a combat results table. Well designed wargames base their combat results on historical examples, and pay close attention to the probabilities which arise when using 1, 2 or more normal dice as random number generators[8].

In most wargames, these simple mechanics are often presented in rules written carefully and at length in order to block possible exceptions and head off 'rules lawyering', and as a result can be intimidating to the 'newbie'; and this is a perennial problem for the hobby. As the genre developed over time, many more layers of additional complexity have been added, with modern board wargames including detailed rules systems to deal with logistics, troop quality, morale, and command and control. These often sacrifice playability for realism.

There are however some wargames like *Napoleon at Waterloo* or *Drive on Metz* which are simple enough to be used as teaching examples in class. the rules are short, easy to explain, and the games are fast to play, allowing them to be used in a single class to help students come to grips with some of the problems of command decisions in warfare. In recent years a number of wargame designers have experimented with 'one page' wargames or postcard sized wargames which are successful simulations of some battles [9].

After some years of using games in teaching military history, I decided to risk moving on and asking students to design a simple wargame based on a historical battle as a graded coursework exercise. This was done in a second year undergraduate survey course in military history since 1450. In order to prepare the students for the exercise, I moved the lecture on wargames from the middle of the course to the start. In the first lecture I used the film Waterloo, the Waterloo chapter from Russell Weigley's classic *Age of Battles* and the debates on the historiography of the battle raised by Peter Hofschroer to introduce and contextualise this well known and important battle[10]. I then introduce the *Napoleon at Waterloo* game as an alternative text of the battle, and explain the basic concepts of wargaming. This set the stage for a detailed discussion of wargaming in the second lecture, and a walk-though of elements of the *Napoleon at Waterloo* game before dividing students into groups to research and design a limited wargame on a single battle.

There are a number of points which are important in the exercise. Firstly, wargaming in new to most of the students, and they are made to work in groups so that if one student has a conceptual difficulty with some part of the exercise, it is hoped that another student in the group may be able to offer a solution. Secondly all the battles assigned are classic one day battles from the period 1490-1815. They are battles which in extent cover only a few kilometres and involve limited numbers of troops, usually less than 100,000 in all, often with simple organisational structures. Thirdly, the students are required to produce a wargame for which the map and counters should fit on one A4 page, and ideally they should use no more than 50 counters to represent the units in the battle. They are clearly told that there are no marks for graphic art in this assignment; only for the content of the game. Groups that happen to have particularly artistic members do not gain unfair advantage over those who are less artistic. The exercise therefore was planned, and remains, a clearly defined, limited task which produces physical outputs comparable to a normal 1,500 word essay (one page game plus some pages of rules) which is the norm for mid-term coursework in this type of option. As is my normal practice in setting any novel coursework assignment, groups are encouraged to use discussion forums and wikis on a Learning Management System to share work, which I can monitor, and expected to send me a brief weekly progress report by email. In practice, I have become less concerned about this safety net in this exercise, since I have not had students fail badly in this task - quite the opposite in fact.

The end results of the exercise have been very good, and the process has been useful. There is a great difference between simply asking students to "Write an essay on the battle of X' and design a wargame on the battle of X. Students wiring an essay can begin with the benefit of hindsight, and rely on surveying secondary literature which often repeats the accepted academic consensus on what elements of the battle were significant. However, at the start of a wargame, the player-commander is faced with a blank canvas on which to write their own commanders intent, a wealth of tactical options between which they must chose. Making those choices requires understanding how the tactical and technological systems of the time worked - what was possible with the armies and weapons present on that battlefield on that day. Making students play wargames had already shown that wargaming as a form of active learning drew students into deeper understanding of the tactical synthesis of the era.

Designing the games takes students deeper into an understanding of warfare in a particular historical setting. Basic movement and combat over the period 1490-1815 is broadly similarly at the scale at which these games work, but does have interesting variations between the major subperioids - early gunpowder, pike and shot, linear, and revolutionary and Napoleonic. Students can therefore work from a generic rule set like Napoleon at Waterloo, and add custom, optional or special rules to tweak these to suit the particular conditions of the period, or the unique circumstances of the battle. This requires students to develope an explicit understanding of how the process of warfare works; for the rules are the expression of the game designers understanding of how war works in the simulation. Developing and playtesting the rules makes students work out a clear model of what happens in a battle in this period. Their model may be limited or incorrect, but it is certainly more clearly laid out than in a conventional essay which often merely paraphrases without deep engagement. Students do argue about rules in this exercise.

As well as making the process explicit, the exercise requires students to collect and analyse information about all aspects of the battle and its participants. On the map, every part of the battlefield must be represented, and students need to think about all of the terrain, not just the Bagration Fleches or the Pratzen Heights. Students need to research the full order of battle, to understand how the armies were organised, and consider how to represent those structures in a meaningful way within the limits of the game design. Actors and stage, as well as process, must be disaggregated and made explicit. The work implicit in the exercise is, in fact, the sort of work a game designer has to do to translate a game from rough concept to viable product, whether for paper or digital production.

The results of this teaching have been good. No group has yet failed to produce a good end product, although some have taken questionable decisions about special rules or victory conditions. In cases where students have made 'mistakes', they have generally realised that they had not come up with the best solution, but this problem has often arises in dealing with complex issues which do not admit of easy answers at any historiographical level. The process has been successful in fostering a greater level of student engagement with historical material which would otherwise often be skimmed over. Students have remarked on this, and felt that even if they were not entirely satisfied with the answers they presented in the finished product, they were pleased with the process of asking the questions of the material which they found stimulating.

A key problem for humanities scholars with writing learning outcomes is the insistence in the learning outcomes literature that 'understand' is a word to be avoided. While in some disciplines, 'understand' in a learning outcome is indeed a fig leaf to cover sloppy course design, in many humanities disciplines, disciplinary understanding is a well developed and much debated topic. This exercise allows us to unpack what we mean by understanding in terms of military history. It allows us to map it clearly to Bloom's Taxonomy of Learning, and show how the different levels are present in the task [11]. At the lowest level, knowledge, students gather basic information about a battle - the terrain, the armies, the commanders. At this level, rubrics of assessment reflect the completeness and accuracy of the research. Moving up to the mid-levels of the Bloom Taxonomy, students must show that they grasp how the armies are organised, and how the different aspects of the organisation of war in a particular period relate to each other. Here, assessment rubrics look at how successfully students express their grasp of these relationships in the presentation of the unit counters and game map. At the highest level of the taxonomy, students are expected to analyse and synthesis material, to show they know how it fits together in a holistic way, and this can be measured by their writing of special rules and victory conditions; the processes which bind the game parts together in a successful whole. All of these research and analysis would be required and would be present in a good essay. However, in an essay the different levels are lumped together in a way which makes sense to experienced practitioners of the discipline, but which do not fit the learning outcomes boxes which we are increasingly being required to tick off.

Wargames are genre of gaming with which I am most familiar and use most in teaching, but they are not the only genre of paper or boardgames, and in order to work towards the aim of offering general models of game design, we will look at some other types of modern game.

Games like *Civilization* or *Europa Universalis* seem like ideal candidates for teaching world history. Some games like *Making History* which operate on a similar level of complexity have been developed largely with the educational market in mind[12]. These computer games have been used in teaching history in secondary school, and some of this work has been the subject of careful research [13]. However, the computer versions of these games are of limited value for teaching at university. The game rules, the process model in the simulation, is encoded in the computer program, and it is hard to modify it. The biases, prejudices and assumptions made by the game designers are equally hidden in the 'black box', and may not always be divined easily.

Many of these games have spawned related boardgames in which, at least, the simulation model is clearly spelt out in the game rules which may be read, critiqued and modified. However, these games simulate complex processes of civilisation and empire building over time, and in order to be in any way accurate, the rules are often long and complex, and the physical games require many playing pieces and a great deal of book-keeping. It is hardly surprising that the computer versions outsell the board games many times over. Nonetheless, at it's heart the process in this games is simple and similar across the genre - ownership of territory on the board provides resources which the player must allocate to building and research. The game requires the player to find an optimal mix of resource allocation to maximise the return on whatever resources they control. Many of these games include game systems to model war, trade and diplomacy. Indeed, many wargames pitched at the level of theatre or global grand strategy overlap with these resource allocation-civilisation building games. Once the basic model of understood, they can be simplified. For many years, Peter De Rosa has developed and published on the web a series of simple resource allocation games covering historical cases ranging from medieval guilds to the European Parliament[14]. This paradigm of resource allocation game can be seen in the field of diplomacy in a range of games from the complex (Twilight Stuggle, Days of Decision) to the classically simple (Origins of WWII) .

Perhaps a little surprisingly, this model of resource allocation is also at the root of a recent phenomenon, the collectible card game. Beginning with Richard Garfield's *Magic The Gathering [15]*, this genre has emerged from nothing to encompass a great variety of card games related to anime settings, children's cartoons and science fiction. In the vast majority of these games, holding certain cards, basic lands in Magic, provides resources in some form or other. In Magic the Gathering, this is called mana, and the player can allocate it to deploy, within the limits of the cards s/he holds, magical creatures or spells which fight on the players behalf to weaken the enemy and defeat them. Notwithstanding the variety of theme, artwork or special rules, the basic mechanics of these games is as common across the genre as the basics of movement and combat are to all wargames.

Equally, a comparison between *Magic The Gathering* and *Monopoly* is instructive. In *Magic*, players get mana from land and use it to summon monsters to wear down their enemies life points. In Monopoly, players get money from 'passing go' and use that money to summon hotels to reduce their enemies cash balances. In both genres, when you run out of life points, or money to pay rent, you lose. *plus ca change, plus c'est la meme chose*.

One can begin to see some common features emerging from a range of games which are on the surface, very different. All games take place in some sort of arena or space, some map of a reality. This may be very realistic, in a wargame, stylised in Monopoly, or minimal in a card game or a roleplaying game. All games have actors or units - some token which represents real world people who can exist in the game world. These may be a unit counter representing the Grenadiers of the Old Guard, Napoleon's grognards, an old boot in Monopoly representing the player meeting the vicissitudes of the commercial world, or Col. Mustard in Cluedo. In all of these games, these people and places, the actors and scenes, are bound together in a process model expressed in rules which define how we understand or wish them to interact. basic rules cover movement from place to place in the game arena, and interactions between the pieces and their environment, and between pieces when the occupy the same or adjacent spaces.

Armed with this model, we can then frame a set of questions which we can use either to design a teaching game ourselves, set our students to design a game or, if we have a sufficiently generous grant, commission a programmer to implement.

These basic questions are:

- What is the game place? Where does the action take place and what is the best way to represent the space in which the game happens?
- Who is in the game? what people or groups do I need to represent in the game? What are the essential attributes of those people? In some games, the pieces have no distinct attributes,

like the old boot in Monopoly, whereas in other games they may have a complex set of attributes to define speed, strength, charisma, wealth, skills or other factors

- How do pieces move in the game? What does their movement from place to place represent? Is it realistic, or are they moving in some symbolic space?
- How do they interact with the game world
- What interactions do they have with each other? What do these mean and how do we represent these interactions as rules?
- What constitutes winning? what is the aim of the game? how is winning measured? This may be a contested issue. In a simple wargame, you 'win' by reducing the enemies fighting power so that he cannot fulfill his goals. However, in a game modeling, say, a the public health system for teaching health administrators, one could have two very different models of 'winning'. One might be that to win you must treat all the sick clients, but another, equally valid, might be that you win by keeping most of the population healthy.

One can design any number of games which could be used in the university to teach students, and it may well be desirable from a practical perspective to play some games before proceeding to designing games. I do think that the sort of analysis which we expect students at university level of perform, the sort of complex analysis which our graduates are expected to be able to perform in a knowledge society. requires us to challenge our students to design games which model real world processes.

Designing digital games is not different from designing 'real' games. If digital game based learning is to progress and innovate, we must produce designs which not only meaningfully engage with complex processes in a transparent way, but which are also pedagogically valid and which we can validly assess. Design specifications for digital learning games need to meet this requirements, and educators cannot properly write specifications for digital games unless we can breakdown the issues we want to game and map them to the parts of the game. Before we can make it work on the latest highpowered graphics cards, we need to understand how to make gaming work on good old fashioned paper.

In terms of game technology, the emphasis in commercial game design in recent years has been on improved graphics performance. Very few new game concepts have emerged in commercial gaming in recent years. The emphasis on graphical quality in educational games s certainly important in primary and secondary education where the visual impact of edugames is vital in capturing the students attention and competing with commercial games. By the time students reach university, however, we expect them to be less easily distracted by superficial visuals and more keenly interested in understanding the underlying process by which a game models and explores some aspect of the real world. It is appropriate in university to expect our students to design games as well as to play them, My own experience, and that of others, has shown that this is practical, and can be linked to the scholarship of teaching and learning, and expressed in learning outcomes and assessment rubrics.

The technological tools to support this are not easy to use. We certainly need tools which will allow our students to create simple and effective graphic elements for their games, but we also need tools to fill two critical 'back end' needs. We need databases to contain game elements, their attributes and state, and we need rules engines which make it easy to create, test and modify game rules. This requires the application to academic game design of the basic structure of client-server business applications, where data lives in a large back end database, business rules are applied to it in middleware, and the application interactions with the real world through a graphical front end. In well designed business systems, all three layers can be replaced or modified independently. In games, the graphics front end has come to be the dominant part of the paradigm. Game design tools that are available are easy and convenient for computer scientists and graphic artists, but not suitable for humanists or social scientists. Availability of a proper, free, open source toolset for academic game design would not only make it easier to use game design as a problem-based learning methodology, but also create the basis for new, creative game designs which could feed into commercial game design.

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