Distinctive Features and Game Design

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Abstract

Research on how to design better games is ongoing, and it can benefit from theoretical frameworks, such as the Mechanics, Dynamics, Aesthetics (MDA) model [1], and the Distinctive Feature (DF) framework, that we proposed in a previous paper [2]. This paper presents further research about the DF framework, which was conducted in two distinct phases. In the first phase, we created a tentative inventory of DFs, with focus on strategical analysis characteristics. In the second phase, our focus was on an inventory of DFs able to model cooperative mechanics in games. In both phases, we based our findings on empirical data, collected from participants in extension courses on modern board games. The MDA framework offered a key insight in the analysis of collected data. Accordingly, the results indicate that the MDA framework can be used as a guideline for the development of new DF systems, enabling game designers to create better products.

Keywords: game analysis, distinctive features, game design, conceptual design, systems design

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Note

In this paper, we consciously adopt an incorrect usage of an English word as a convenient shortcut. The English language lacks a word for "a playing of a game", unlike other languages (French "partie", Portuguese "partida"). We elected to use "play" in this sense throughout, whenever we use this word as a substantive (as in "1st play" and "2nd play") instead of a verb ("to play a game").

1. Introduction

It may be surprising to think of game design as a relatively underdeveloped field, at a time when so many digital games are produced and purchased; many aspects of digital game design have benefitted from in-depth studies (although the design of boardgames and other non-digital games still lag behind its richer cousin). But we contend that, as a subfield of the more general design field, the **philosophy** of game design is still in its early developmental stages.

There are still gaps in some of its meta-theoretical levels, to borrow some ideas that T. Love developed in his paper "Philosophy of design: a meta-theoretical structure for design theory" [3]. In this paper, he proposes a conceptual scale that rises from the perception of concrete phenomena, becoming more abstract on each level, until it reaches the general ontology of design.

All levels in this scale are useful to a game designer, but the mid-range levels have a more direct operational impact on the design process:

> (3) *Behaviour of elements* — The level at which the behaviour of elements which may be incorporated into objects, processes and systems is described. For example, 'a camshaft rotates at 600 rads/sec', 'headline type needs to be set closer than body text', 'the lower windows need to offset the visual weight of the portico', 'the melody returns to the tonic'. 'The hammer is made up of two parts; a head and a handle... The correct angle between the handle and the face of the hammer head is necessary for nails to be hammered in straight.'

(4) *Mechanisms of Choice* — The level of descriptions about the way that choices are made between different objects, processes, or systems, and how solutions are evaluated. For example, 'Why does a woodworker choose a claw hammer rather than a sledge hammer for hammering a small nail?'

(5) *Design Methods* — The level in which theories about and proposals for design methods and techniques are described — The theories about designing wood artefacts. 'How does one design a chair?'

(6) *Design Process Structure* — The level that includes the theories about the underlying structure of design process, and the influences of domain, culture, artefact type and other similar attributes and circumstances. For example, 'What are the processes underlying the design of Polynesian catamarans?'

[3, p. 305]

In game design, there are many protocols and studies for level 3 and for level 5. Level 4 and level 6 processes are still very tied to the experience and "feeling" of the game designer.

This situation derives in part from the lack of clearly-defined constraints and requirements, which is itself a consequence of the vast breadth of the gaming experience.

Arguably, one of the key characteristics in a game is gameplay — an elusive concept, which can be seen as the result of a large number of game elements [4, p. 199], and which lies squarely in the more general field of User Experience (UX). The lack of good formal evaluation methods for gameplay has been decried before [5], but research in this topic is ongoing, especially through UX methods[6, 7].

Besides quantifying, there have also been proposals of theoretical frameworks for the analysis of games. In this paper, we focus on two such proposals: the Mechanics, Dynamics, Aesthetics (MDA) framework [1] and the Distinctive

Feature (DF) framework, that we proposed in a previous paper [2]. Our results indicate that it may be possible to combine both frameworks, and from this combination to derive a mapping from design decisions to user experience in games.

The theory section of this paper presents both these frameworks. We begin by presenting a summary of the MDA framework, which is followed by a more comprehensive discussion of the DF framework.

The DF proposal was used as the theoretical basis for two practical activities, which provided empirical data that we then used to further refine the framework, in the light of the MDA framework. We present these activities and their results in three separate sections, followed by some final remarks.

Besides bibliographical references, we also present a Ludography section, which lists all games mentioned in the text, when either their authors or studios (in the case of digital games) can be identified.

2. Theory

2.1. Mechanics, Dynamics, Aesthetics

The design process of a game can involve a multitalented professional team — such as happens in the major digital game studios — but it can often be done by only one person in his off-hours. This last scenario is often the case if the end result of the design process is a board game, or any other kind of game which does not depend on expensive hardware.

The conceptual design of a game does not depend on its budget, however, or on the size of the team. The conceptual designer creates and develops an idea for a game; he is, in a sense, a visionary [8]. What he intends to create is, in some sense, something more than a game: he wants to create a user experience [4], through what is usally called gameplay.

In order to create an engaging user experience, the game designer works with the mechanical aspects of the game: tokens, cards, boards, rules. But gameplay is not directly under his control; it will be an emergent feature [9, p. 3] of the

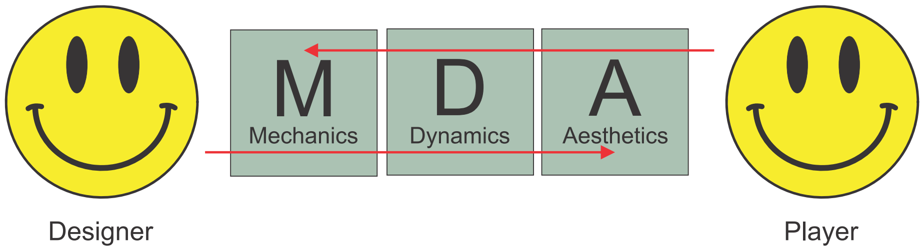

Figure 1: The MDA agency diagram [1]

game; that is, it will be produced by the synergy of the game system when played.

The game designer is thus in a peculiar position. His work will completely define and limit the scope of agency for the players; but his own agency is not enough to completely define the emergent gameplay, even if it is a result of the players' limited agency.

This tension between the scope of the designer's agency and the emergent gameplay is an important feature of "A Formal Approach to Game Design and Game Research" [1]. In this paper, the authors propose a framework for game analysis based on three layers: **Mechanics**, **Dynamics**, and **Aesthetics**. The game designer acts on the Mechanics ($\mathcal{M}$) layer; he has no direct control over the Dynamics ($\mathcal{D}$) and the Aesthetics ($\mathcal{A}$) layers, but he creates and combines the game components ($\mathcal{M}$) in order to elicit a desired behaviour ($\mathcal{D}$) or experience ($\mathcal{A}$).

The designer's agency is thus linear and unidirectional, and it is mirrored by the user's agency:

> From the designer's perspective, the mechanics give rise to dynamic system behavior, which in turn leads to particular aesthetic experiences. From the player's perspective, aesthetics set the tone, which is born out in observable dynamics and eventually, operable mechanics. [1]

The complementary agencies are illustrated by a diagram (fig. 1). However, this part of the MDA model is based on the assumption that the player will always approach a new game from the aesthetic perspective, and from there he will proceed to the other layers, discovering the game dynamics and then learning the underlying mechanics. This assumption can be debated, as we'll discuss in subsection 5.1 *Revisiting MDA*.

In Love's conceptual scale, the MDA framework lies within level 6, and it is a useful analysis tool. However, its strength in analysis is not matched by its relevance for the design process. MDA is a conceptual framework, and not a set of design guidelines. As such, by itself it does not provide any means through which a game designer can ascertain how his decisions about the the $\mathcal{M}$ layer will affect the $\mathcal{D}$ and $\mathcal{A}$ layers.

2.2. Distinctive Features

In phonology, DFs are the minimal units of the sounds of human speech, generally associated with specific articulatory or acoustic properties of sound [10]. The study of DFs was pioneered in the work of Trubetzkoy before World War II, and was developed by Jakobson in the following years. DFs served as part of the foundations of Chomsky's influential studies of linguistics [11].

In its simplest form, DFs are a lexicon of categories, created in order to represent the relevant characteristics of a phenomenon. Each lexical entry further represents a binary feature of the phenomenon ([±]), which may be present [+] or absent [–]. For instance, in a DF lexicon which includes the entries [±animate, ±human, ±feminine], the concept *cow* can be represented by [+animate, –human, +feminine] [11, p. 295].

One crucial aspect of a DF system is the determination of its feature set — that is, the enumeration of its lexical entries. The system features must not be arbitrarily chosen: they must be determined according to the characteristics of the phenomenon that are relevant to the researcher [11, p. 295]. In the case of human language, these features derive from articulatory and acoustic properties of the speech — or even from characteristics of gestures, in the case of sign languages [12].

Although language is a very complex phenomenon, phonologists have found out that DFs offer a consistent, formal representation for it. As such, it allows the effective sharing of knowledge among linguists: it is the framework of an ontology.

We contend that this system can be used in ludology, where it can be useful to represent games according to the characteristics which are relevant in each context, whether for the game researcher or the game designer. In order to show how to create such a system, we present a simple exercise — a thought experiment. We take on the roles of researchers interested in the physical implementation of games: both the media in which games exist, and how the game elements are implemented.

The first results from our fictitious analysis distinguish digital games from non-digital games. This suggests the use of a DF, which we will define as [±digital]. This DF indicates whether a game is implemented in an electronic device (whether a computer, console, mobile phone, or any other device, is not relevant here) or not. In the first case, the game is represented as [+digital]. In the second case, the game is represented as [–digital].

Thus, in this system, *Tetris* is represented by [+digital], and the children's game *Hopscotch* is represented by [–digital].

So far, so good. However, as we continue our example research, we soon find out that the border between digital and non-digital games is not clear-cut. For instance, *Chess* is an ancient non-digital board game; but it can be implemented in a computer, either as a virtual board for two human players to play against one another, or with a programmed artificial intelligence as one of the players.

Based on this proposed DF, is *Chess* a [+digital] game or a [–digital] game?

Here, as in many other theoretical approaches to games, the fuzzy borders of the game universe create a conceptual problem. The answer to this question depends on the answer to another question: is a digital version of *Chess* the same game as a physical version? Are they two instances of the same game?

This is not an idle question. Many games present variants, such as *Poker* (*Texas hold'em*, *Seven-card stud*, and others). Variants present many permutations between rules, boards, and pieces, creating a game "family".

In this sense, we can consider that the classical board version of *Chess* and its digital sibling are variants from the same game, or family of games. The digital version of *Chess* may even present some characteristics that cannot be present in the physical board game, such as highlighting the legal moves for a piece.

This allows us to go back to our question: is *Chess* a digital game, or a non-digital one? In other words, should we represent *Chess* as a [+digital] or as a [–digital] game, in our system?

In order to answer this conundrum, we propose the following axiom:

> **Axiom 1.** *A set of DFs represents one particular instance of a game, but not necessarily all instances of that game.*

In other words, according to this axiom, some DFs of a game may vary from one of its implementations to another — from one of its variants to another.

Thus, in this particular example DF system, it does not make any sense to ask whether *Chess* is a digital game or a non-digital game. Rather, this question must be asked for each particular implementation of *Chess*; some instances will be [–digital], and some instances will be [+digital].

We can further use *Chess* in order to expand our medium-related example DFs system, which thus far has only one feature, [±digital]. *Chess* is a board game, that is, a game which is played on a board, a portable version of the "magic circle" — a concept borrowed from Huizinga [13], and used as shorthand for the special place where the game takes place, and where the rules of the game take precedence over the rules of the "real" world [14, p. 95]. A board is not only the area where the game takes place; the rules of the game impart different meanings to its areas.

Some games have boards (*Chess*), and some games don't have them (*Poker*). Even though the area for playing *Hopscotch* is clearly defined, with different functions for its sections, in this system we represent *Hopscotch* as [–board], since the game area is not portable. And this distinction is not confined to

[–digital] games; there are several [+digital] games that feature virtual versions of boards, such as a [+digital] *Chess* instance, and [+digital] games that don't have boards, such as First Person Shooter (FPS) games.

This indicates that we can define another DF, namely [±board], which is independent of the [±digital] DF. The [±board] DF indicates whether the game uses a board as one of its elements.

This allows us to represent a FPS game as a [+digital, –board] game. A physical *Chess* instance is represented by [–digital, +board], and a computer instance of the classical game is represented by [+digital, +board].

A game without a board and which is not played on a computer is represented as [–digital, –board]. This is the case of a *Poker* game played by friends over a kitchen table; the table isn't a board, but merely a convenient surface to accomodate the game elements. On the other hand, a *Poker* game played in an online casino is represented as [+digital, –board].

This simple exercise showcases the strengths of the DF framework. It was not necessary to define what we mean by "game". Perhaps there is a definition of "game" that includes games as varied as *Hopscotch*, *Tetris*, *Poker* and *Chess*. But we do not need it. It is even possible, for instance, that some people do not consider *Hopscotch* a "real" game, but this does not preclude its representation in this system as [–digital, –board] — and to discuss whether it is a game or not becomes a moot point.

On the other hand, this same exercise highlights one problem with the DF framework. We started with a single DF, and then refined the framework by adding another DF. With one binary DF we had 2 categories of games, and when we added another DF we then had 4 (or 2^2) categories. The first two categories were thus broader than the four latter ones.

Are these categories enough? Perhaps we could introduce a [±cards] DF, which would represent games that feature cards (either common playing cards or custom-made cards) as [+cards] and other games as [–cards]. Thus, the kitchen-table *Poker* would be represented as [–digital, –board, +cards], and so on. We would have now 8 categories (2^3).

The key decision here is where to stop “zooming in”. Once again, this depends on the aims of the researcher: specifically, what are the features that are relevant to the investigation? This question was the basis for our first practical use of the DF framework.

3. Strategical analysis

In order to evaluate the usefulness of the DF framework, we decided to create a DF inventory for games, based on empirical data. The chosen scope for this inventory was the **strategical analysis** process — that is, the process whereby a player learns a new game, and tries to determine which steps he must take in order to win. We understand a strategy in a game as a set of moves that a player adopts in order to win the game.

Strategical analysis data were collected during a 40-hour extension course on modern board games. During most of the 4-hour sessions, enrolled participants were introduced to new games, and played them to conclusion. Before and after playing, participants were asked to fill surveys about some characteristics of the game.

The surveys were developed after a series of pilot sessions, which revealed some key elements of the strategical analysis process. These preliminary findings provided a tentative inventory of DFs:

[±**balanced**] the game offers equal winning chances for all players

[±**experience-rewarded**] playing several times can enhance a player’s strategical ability

[±**random**] random events are decisive in the game

[±**strategy-possible**] the game enables the pursuit of a strategy

[±**strategy-variable**] there is more than one worthwhile strategy available

[±**symmetric**] all players share the same abilities and objectives

[±**theme-present**] the game features a theme

[±**theme-relevant**] knowledge of the theme featured in the game helps to create a strategy

3.1. Collecting data

There were fourteen participants: eight undergraduate students, five graduate students, and one full professor. Their fields of study were varied: nine from Design, and one each from History, Economy, Arts, Information Technology, and Electrical Enginnering. Four participants were female.

At the beginning of the course, the participants were asked to provide information on their game experience. This experience was rated according to four categories: digital games, tabletop Role-Playing Games (RPGs), card games, and boardgames. In each one of them, they were asked to rate their frequence of play and also the breadth of their gaming partners. Higher values were assigned to participants that played more often, and also to those who played with people beyond family and friends.

Digital games were the most popular, with RPGs and boardgames somewhat behind, and card games were the least popular. Only four participants were familiar with modern boardgames; the other ten knew only common mass-market boardgames.

Two of the fourteen participants were committed players of digital games, but for most playing was not a usual activity — and one of the participants did not play even in a monthly basis.

The participants were separated in two five-people groups and one four-people group, according to their gaming experience, and also according to their stated interests ("light" games or "heavy" games, for instance). Thus, each group had people with roughly the same game experience level.

Seventeen games were selected for the course; each one of them was played twice, always by the same group, with at least one week between plays.

Before first playing a new game, the course moderator presented the rules, and then the players were asked to fill out the pre-game survey. This survey asked questions about the expectations of the players, what were their impressions on balance and symmetry of the upcoming game, and whether they intended to use a strategy. After filling out the surveys, playing ensued.

After playing, the players were asked to fill out the post-game survey. The questions asked for the player to evaluate his expectations, contrasting them with the actual game experience, and also to suggest changes in his strategy for future games.

The same procedure was followed for the second play of each game. The rules were briefly presented again, and the surveys were filled out before and after playing.

Several questions were framed as yes/no binary alternatives, although a few questions (such as "How do you evaluate the complexity of this game?") asked for evaluations on a five-item scale.

Most questions included some key concepts, which were explained in the surveys themselves. For instance, the pre-game survey included the following definition:

> A game is said to be **balanced** if all players have an equal chance of winning (without reference to their experience).

This was followed by the question, "Do you believe this game to be balanced?", with yes/no answers. A negative answer was followed by a space in which the player was asked to explain why he thought the game was unbalanced.

The surveys of each play were evaluated together, generating a weighted average, in which we attributed weight 1 to the pre-game survey and weight 2 to the post-game survey. After calculating the weighted averages for both the first and the second plays of a game, a new weighted average was calculated, in which we attributed weight 1 to the first play result and weight 2 to the second play result. Greater weights were thus attributed to answers which reflected actual experience.

The weighted averages for one of the DFs, [±experience-rewarded], can be seen in table 1. In the DF evaluation, we considered that a given DF was perceived as present ([+]) if the final weighted average was greater than 0.5, as absent ([–]) if the final weighted average was lesser than -0.5, and non-determined for values between -0.5 and 0.5.

The [±random] DF was subjet to a slightly different evaluation, since it depended on the answers to two questions in the surveys.

The first question was in the pre-game survey, and it asked the player to evaluate in a five-point scale the expected impact of luck in the upcoming game. We attributed values ranging from 1.00 to -1.00 to each of the answers. The second question was in the post-game survey, and it asked "Do you believe that the result was influenced by luck?" The answers to this question were evaluated as per the other binary questions, above.

In each play, the value for [±random] was calculated as the sum of the pre-game question's value and twice the post-game question's value (evaluated as per the previous binary questions). This resulted in a value varying from -3 to 3.

The calculated values for each play were then submitted to the same weighted averaging as the other DFs. The result was evaluated as [–random] if the final value was less than -1.5, as [+random] if the final value was greater than 1.5, and as undefined for values between -1.5 e 1.5.

The weighted averages for [±random] can be seen in table 2.

3.2. Analyzing the results

The consolidated DFs for each game, according to the answers in the surveys, can be found on tables 3 and 4.

Several results were puzzling, to say the least. Detailed analysis revealed many cases in which answers from a given player were mutually contradictory, or even contrary to reality.

For instance, it was surprising to see *Lord of the Rings*, a fully cooperative game, being evaluated as unbalanced by several players. In this game, either all players win together, or else they all lose together. Thus, by design and by definition (see above), this is a balanced game, and players in the first play unanimously agreed with this. However, *Lord of the Rings* is a difficult game, and in the second play three of the players declared the game unbalanced — and based their answers on the great difficulty and the great impact of random effects.

Sometimes survey answers from the same player were very hard to reconcile. For instance, in the post-game survey of the second *Ra* play, one of the players evaluated his performance as good (the second best level in a five-point scale), but on his justification qualified his performance as merely passable (using the very same word used for the third level in the same scale). We found several surveys in which the players claimed that it was not possible to formulate a strategy for the upcoming game, and in the very next question sketched what strategy they would follow.

On the other hand, there were sometimes confusion between concepts. This happened, for instance, with players' evaluation of *Room 25* with respect to [±balanced] and [±symmetric] DFs. Both concepts were spelled out in the survey, right before the corresponding questions. *Room 25* is played in two teams, with different objectives and powers, which makes it an asymmetric game. Even so, several players considered *Room 25* a symmetric, unbalanced game; when asked why was the game unbalanced, they justified this by the differences between the two teams' powers and objectives. Those players' perception led to "undefined" values for [±balanced] and [±symmetric] in *Room 25*.

Even when a characteristic was noticed, the justification presented was sometimes quite odd. In the pre-game survey for the first play of *Age of Empires III*, two out of six players noticed asymmetry and correctly identified its source (the different powers for each player). Three players did not perceive any asymmetry; the remaining player declared that the game was asymmetric "because each player does what he wants".

Some of the most surprising answers were about the games' themes. For instance, *Flash Point: Fire Rescue* is a game in which players represent firefighters trying to save people from a house aflame; but three players identified its theme differently: "logistics", "tactical military positioning", and "cooperation, team". Sometimes the theme wasn't even identified; one of the players in *Kill Doctor Lucky* — a tongue-in-cheek game about the murder of an old man — answered that the game had no theme.

Random elements were also perceived from a somewhat askew perspective. Both *Age of Empires III* and *Container* were evaluated as [–random]; but although both games' weighted averages were negative, *Age of Empires III* (-2.58) was considered less random than *Container* (-1.63). However, while *Age of Empires III* has indeed many random effects, *Container* is completely deterministic.

Some answers further illustrated the players' perception about randomness. Very often a player mentioned that he benefitted from a move by another player, and he would then say "I got lucky". Conversely, if his strategy was harmed by another player's move, he would then claim to have suffered "bad luck".

Many of these unexpected results originated in problems inherent to the data collection process. A survey is a notoriously tricky data collecting method [15], and it is probable that several answers were influenced by other players' perceptions of the games, since it would have been impractical to ask the players not to talk while playing, or afterwards.

Also, many of the enrolled participants had no experience with modern board games, or even with traditional strategy games. It was very common to hear comments like "I don't know what to do" or "I'm lost" during sessions, and the players' answers have to be evaluated according to this circumstance.

However, this lack of experience does not in any way depreciate the value of their answers. On the contrary: what we strived to do was to ascertain how some features of a game were **perceived** by players — no matter whether experienced players or complete novices.

In this sense, there were no "wrong" answers. Even so, we had some expectations about the answers, based on our experience with the games. The contrast between what we expected and what we got from the participants revealed itself as the key which unlocked the significance of our findings.

3.3. Evaluation

We have indicated above that there were several problems in the answers of the players. But some problems resulted from the proposed DF inventory itself. To begin with, some characteristics do not lend themselves well — or at all — to a binary evaluation. For instance, "is game X random?" is a very difficult question; while *Craps* clearly is random, and *Chess* clearly isn't random, what about *Backgammon* or *Bridge*?

We tried to compensate for this with five-point scales, as in the case of the pre-game survey question on expected effects of luck. But enhancing the resolution of the viewpoint ("zooming in", as it were) cannot transform a continuous phenomenon in a discrete one.

Representing a continuous reality by means of a discrete system is a well-known problem, and this will always be a limitation of a DF system.

Another problem is that any formal system — such as the DF framework — can lend itself to **overgeneration**; that is, there are situations which can be represented in the system, but which have no correspondence in reality. Thus, a game can certainly be [+balanced, +symmetric] or [–balanced, –symmetric], and there are several games that are [+balanced, –symmetric], but there can be no game that is [–balanced, +symmetric] — since any unbalance must perforce originate in an asymmetry. However, in this system, the [–balanced, +symmetric] vector is formally valid.

But there was a more subtle issue with our proposed DF inventory, which we noticed during evaluation of the results. Going back to the MDA framework, it became evident that the DFs in our inventory referenced characteristics from the three layers of game experience. Thus, for instance, [±symmetric] lies squarely in the $\mathcal{M}$ layer, since it is the designer who defines the abilities and objectives of the players. This is, then, an objective characteristic.

On the other hand, [±balanced] is a $\mathcal{D}$ layer feature. A designer may intend to create a [+balanced] game, but even a [+symmetric] game can be slightly unbalanced — witness the first player advantage in *Checkers* or *Chess*.

We even have in our inventory an $\mathcal{A}$ layer feature, [±theme-relevant]. Board games with interesting themes can attract new players; but no matter how well any given theme is implemented, it will not be perceived as [+theme-relevant] unless the player knows the theme well enough to foresee consequences to his actions, in play, from his real-life knowledge.

Our DF inventory, then, presented features from three different aspects of the game experience. The mechanical aspect is the most amenable to objective investigation, since it is itself created by objective rules and decisions. But the dynamic and the aesthetic aspects of the game experience are deeply influenced by the human factor, and the features in these layers are subjective. This dichotomy, mixing objective and subjective features in our inventory, was the origin of several problems with the results — or rather, what we perceived as problems.

It should come as no surprise that a game system can present a great degree of synergy when actually played by humans, thus creating emergent dynamics [9, p. 3]. As a matter of fact, even if the game system was to be played entirely by automata, emergent features could be expected:

> Universal codes and universal machines, introduced by Alan Turing in his "On Computable Numbers, with an Application to the Entscheidungsproblem" of 1936, have prospered to such an extent that Turing's underlying interest in the "decision problem" is easily overlooked. In answering the *Entscheidungsproblem*, Turing proved that there is no systematic way to tell, by looking at a code, what that code will do. That's what makes the digital universe so interesting, and that's what brings us here. [16, preface]

These findings motivated us to create a new DF system, again based on empirical data, but this time with another scope: the mechanics that allow cooperation between players in a game.

4. Mechanics for cooperation

Following on the insights offered by using MDA as a lens to examine our previous results, in this new DF system we decided to examine only features from the $\mathcal{M}$ layer. But we also decided to use the opportunity to evaluate the possibility of mapping designer decisions (from the $\mathcal{M}$ layer) to player actions (which are in the $\mathcal{D}$ layer). We based this phase of our work on the assumption that cooperation is an emergent dynamics, which can exist when specific mechanical elements are included in a game by its designer; our goal was to ascertain what are those mechanical elements.

The data for this iteration of our research was again collected in an extension course, with seven participants, and in which we played and discussed several games. Several of the participants had attended the previous course, and the new participants played modern boardgames regularly.

Unlike the previous course, this time we did not formulate a preliminary inventory of DFs. The DF set described in the following subsection was created following observation of the cooperative dynamics in actual play, and from the debates between players and moderator that followed each play.

4.1. Cooperation DFs

The real strength of a DF system does not lie in the enumeration of DFs, but rather in the interaction between them. In order to showcase the most relevant consequences of the DF interaction, we mention a few DF combinations and discuss their meaning; those combinations are marked with the symbol ✔.

As before, there are DF combinations that do not exist in real life, representing overgeneration. We have indicated such situations with the symbol ✘.

It is worth noting that our work depended on yet another assumption. As in any game analysis, we assume that players will act rationally. "Rationality", in this limited context, means that players will try to win by the best means available within the rules of the game.

This assumption ties in with our previous observation about objective characteristics. It is indeed possible to play games in many ways; even *Chess* can be played cooperatively, for any number of reasons. But we do not include the human factor in our analysis, since this would completely blur any possible results.

We also need to add a further consideration. First, we note that **game state** is the set of information on the game at any given moment. This set includes information on the position of counters, players' abilities, cards held by players, and any other material elements of the game. It does not include players' intentions or decisions, except when they are conveyed by some game component.

Bearing this in mind, we stipulate that the DFs in our inventory must account for all possible game states, not only those present at any arbitrary instant (such as set-up or endgame).

4.1.1. Teams

Teams are an important feature of cooperative activities. There are games played by individual players, there are games played by teams only, and there are games played by both individual players and teams. Teams can be permanent or mutable.

In this sense, we understand a "team" as a grouping of players, as defined by the rules of the game. Informal teams can appear in many multiplayer games, such as some free-form FPS games; but we deal here with teams formally defined by the game designer. It is worth noting that, in many games, a team may sometimes include just one player. This is usually the case when there are less players than the full complement (for instance, a six-player game played by just three people), although it can also happen when players change team affiliations.

We define two DFs to represent this:

[±individual]

This feature indicates whether there are players able to play as individuals, and not as part of teams.

- [+individual] represents a game in which at least one of the players can play by himself.
- [–individual] represents a game in which no player can play by himself.

[±single-team]

This feature indicates whether the game features exactly one team.

- [+single-team] represents a game in which there is exactly one team.
- [–single-team] represents a game in which either there are no teams, or there is more than one team.

From these two definitions, we can have four different game configurations:

- ✔ [+individual, –single-team] either a game with individual players and no teams, or (rarely) a game with at least one individual player and at least two teams.
- ✔ [+individual, +single-team] at least one individual player, and exactly one team.
- ✔ [–individual, +single-team] all players are in the same team.
- ✔ [–individual, –single-team] no individual players, two teams or more.
- ✘ [–individual, –single-team] can also describe a game with no individual players and no teams. We believe that it won't be easy to find such a game...

One particular aspect of team games is the feature of "traitors": players which can change their team affiliation during play. This can be represented by the following DF:

[±traitor]

This feature indicates whether a player can change his affiliation to a team.

- [+traitor] represents a game in which a player can change affiliation.
- [–traitor] represents a game in which affiliations do not change.

There is one impossible configuration from this definition:

- ✘ [–individual, +single-team, +traitor] is a game in which there is only one team, and no individual players are allowed — so it makes no sense to allow change in affiliation.

The definition of this DF does not distinguish different "treason" situations. They can be voluntary or not, and they also include situations in which one player pretends to be in a team, while he secretly plays against this team. His true affiliation can be revealed during play, or only at endgame.

4.1.2. Common defeat

Many games feature victory conditions, and there are also games in which there is no victory, as in many RPGs.

But there are some games in which all players can be defeated by the game system. We define the following DF:

[±defeat]

This feature indicates whether it is possible for all players to be defeated.

- [+defeat] represents a game in which all players can be defeated by the game system.
- [–defeat] represents a game in which at least one player must achieve victory, or in which there are no victory conditions.

✔ [–individual, +single-team, +defeat] is a prototypical cooperative board game: all players play as a single team, and they can win or lose together.

✔ [–individual, +single-team, –defeat] describes most tabletop RPGs: all players play as a single team, but there are no victory conditions.

4.1.3. Information

One widely-circulated definition of "game" includes a reference to inefficient means, or unnecessary obstacles [17, chap. 3]. Although some aspects of this definition have been contested [18, p. 18], it is quite the norm for games to create difficulties for the players.

One of the tools which a game designer can use to this end is the control of the information flow in the game, hiding or revealing elements of the game state. We can define two DFs to represent this:

[±state-info]

This feature indicates whether information about the game state is known to players.

- [+state-info] represents a game in which all information on the game state is known at all times by all players.
- [–state-info] represents a game in which some information on the game state can be unknown to players.

[±communication]

This feature indicates whether communication between players is subject to limitations.

- [+communication] represents a game in which players can communicate freely between them.
- [–communication] represents a game in which there are restrictions on communication between players.

The four possible combinations between [±traitor] and [±state-info] indicate whether a "traitor" is known to other players:

- ✔ [+traitor, –state-info] there can be hidden traitors, that is, some players can change their team affiliation unbeknownst to their team fellows.
- ✔ [+traitor, +state-info] players can change their team affiliations, but their affiliation is known at all times by all players.
- ✔ [–traitor, +state-info] players cannot change their team affiliations, and their affiliation is known at all times by all players.
- ✔ [–traitor, –state-info] players cannot change their team affiliation, but information on their affiliation may be hidden.

4.2. Results

The resultant DF vectors can be seen on table 5. It is necessary to note that two games can have the same DF vector in this system. For instance, in our data, we have three games that share the same vector: *Nosferatu*, *Saboteur*, and *The Resistance*. This is not a problem, however, since we do not intend to create a DF system capable of distinguishing every single game (or even every single cooperative game). What we strived to create was a set of DFs that can describe the $\mathcal{M}$ elements that allow for cooperation. And, indeed, the cooperative dynamics in these three games are remarkably similar.

However, although the game designer can create an environment that allows for cooperation, no game can force the players to act cooperatively; a disgruntled *Hanabi* player can easily wreak havoc with the game, if he decides to work against the team. As in any game, the players must embrace the game's ethos. Cooperation, then, is a (very) human behaviour, which can flourish when the right conditions are present.

Our results were much more tight than in the first iteration of our research, and thus, when first presenting our results, we formulated a working hypothesis: that this DF inventory was sufficient to represent any game's $\mathcal{M}$ characteristics that enable cooperative dynamics [19]. However, further work on our data revealed that there are still problems with this DF set.

The revealing data were those provided by the game *Wealth of Nations*. This is a game that simulates international trade, in a very competitive way. But the game enforces an environment of mutual needs, in which no nation can prosper without help from others. During the after-game debate, at first the players reported that they had not seen any cooperation between them during play, but on further reflection they noticed that they had, in fact, unconsciously cooperated. The game title, of course, is a dead giveaway: the game showcases Adam Smith's "invisible hand" metaphor.

The DF vector for *Wealth of Nations* is [+individual, –single-team, –traitor, –defeat, +state-info, +communication]. However, this same DF vector can be used to represent games in which there is no cooperation whatsoever — *Chess*, for instance. This system must be refined, again, in order to identify other $\mathcal{M}$ DFs that allow for cooperative dynamics.

We have not formulated our next iteration yet. But the results so far have provided several paths that may be explored, and which indicate that we may need to build a non-linear framework, unlike a linear one, such as MDA.

5. Discussion

5.1. Revisiting MDA

We have previously (2.1 *Mechanics, Dynamics, Aesthetics*) pointed out that part of the MDA model is based on the assumption that the player will always approach a new game from the $\mathcal{A}$ layer, and from there he will proceed to the other layers, discovering the game dynamics and then learning the underlying mechanics.

This is indeed true for many [+digital] games — but, critically, not all of them. Complex strategy games, such as *Europa Universalis III*, or realistic simulators such as *Silent Hunter III*, must offer comprehensive documentation, or the players will not be able to play well, or at all.

As Salen and Zimmerman point out, the implementation and the role of game rules are two of the main differences between the world of [+digital] games and that of [–digital] games:

> In a non-digital game, the rules of a game are generally something that is concretely manifest in an instruction book or in the structure of the game materials. But with a digital game, the rules are buried in layers of program code and are often difficult to identify. [14, 148]

In a [+digital] game, the rules are implemented and enforced by software, which is often both umpire and player. In a [–digital] game, the players themselves must implement its rules and mechanics. It is impossible for a *Chess* novice to learn its rules simply by moving the men around on a physycal board; there are no feedback systems for teaching him interactively.

In order to learn the rules of a [–digital] game, at least one player must read the rules. If other players do not read them, he has the task of teaching them how to play. And, during the game, all players must implement the rules. This holds as true for *Tic-Tac-Toe* as for *Chess*. In [–digital] games, the assumption adopted by the MDA authors falls apart, and with it also go the unidirectional agency paths illustrated in fig. 1.

Even the $\mathcal{A}$ layer may not be the starting point for a new player of a game; some people derive fun — which is the basis of the $\mathcal{A}$ layer in MDA — from the $\mathcal{M}$ or $\mathcal{D}$ layers themselves. For instance, there are people who are thrilled by bluffing games ($\mathcal{D}$), or by trick-taking games ($\mathcal{M}$). It is true that, as it occurs with many [+digital] games, many players will be attracted to a new [–digital] game by its theme — for instance, a game based on a famous TV show.

But the player of a [–digital] game will not be able to experience the game until he learns the rules, no matter how much he knows and loves its underlying theme. His experience will perforce start in $\mathcal{M}$, and from there he will proceed to $\mathcal{D}$ and $\mathcal{A}$.

If a player learns a new [–digital] game from other players, he may start in $\mathcal{M}$, or he may be plunged directly in $\mathcal{D}$ or $\mathcal{A}$, depending both on the game and on the social dynamics of his gaming partners.

The progression of the [–digital] game player through the MDA layers is thus not linear, and it will usually be very different from the progression of the players of most [+digital] games.

The same holds true for the game designer. Playtests are the core of the game design process, as any number of game design manuals can tell. But the designer is also the first player of his game, and his experiences and feelings about playing his prototypes, both alone and with others, will direct his efforts in ensuing iterations.

Even after a game is published, it is possible to see the interplay between the three layers. As the MDA model points out, the aesthetical experience can drive the dynamics of a game; conversely, learning to use the game rules and its dynamics can enhance the aesthetic experience.

The $\mathcal{M}$ layer can also be affected. Modifications ("mods") to [+digital] games are common, although they usually occur between plays of the game. The same is also common in [–digital] games, and this can happen even during play — either to correct a misread rule, or to address a perceived problem in the original rules. There is at least one game — *Nomic* — in which changing the rules is the object of the game.

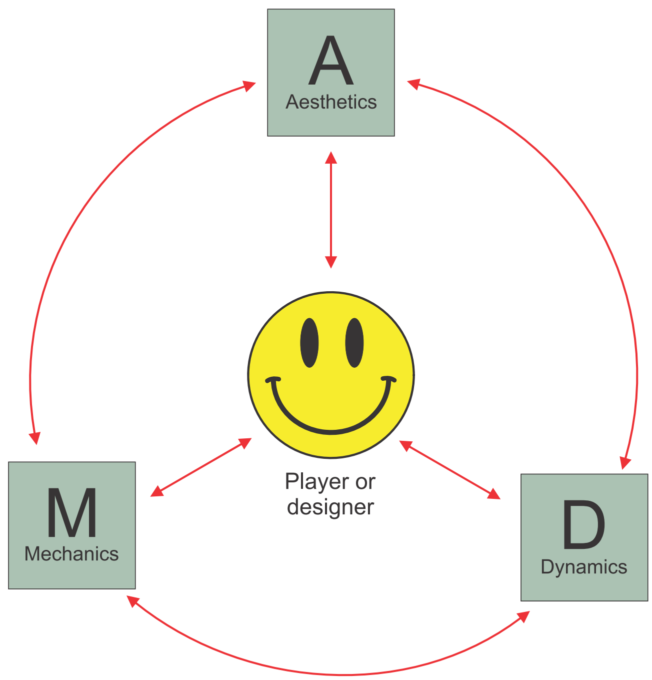

Figure 2: The modified MDA agency diagram [20]

What we have, then, is a dynamic, complex interplay between the three layers. Based on this perception, one of us proposed a modified agency diagram for MDA (fig. 2) [20].

5.2. Revisiting DFs

The DF framework, as proposed in 2.2 *Distinctive Features*, did not take into account the differences between the three MDA layers, and this resulted in some of the problems perceived in our first iteration. Using the MDA framework as a guide, we noticed that a DF inventory must include only DFs from the same layer of the game experience. Thus, a DF inventory for the $\mathcal{M}$ layer will be composed by DFs pertaining to design decisions, while a $\mathcal{D}$ DF inventory will include characteristics resulting from actual playing experience.

This begs the question: are DF inventories even possible for the two subjective layers?

Let us go back to a field of knowledge where the DF framework has been put to good use. DFs are very useful in Linguistics, due to their ability to represent sounds of human speech, with each sound represented by a unique DF vector.

But human speech goes beyond sounds — in that the emergent, dynamic features of the language system are created by the use that human beings put to the sounds. And the "higher" levels of language still resist representation of its characteristics by formal frameworks [21].

A DF inventory able to represent all games seems to be unattainable. While human speech sounds are constrained by physiological and physical imperatives, games are a result of human creativity, and thus are almost completely boundless. The database in `boardgamegeek.com` already contains almost one hundred thousand games, and this does not include digital games, RPGs, or sports games. Figuring in variants, these numbers indicate the need for several dozen DFs, on an endeavour similar to the Game Onthology Project (GOP) [22].

However, even if it seems unlikely that such a comprehensive DF inventory can ever be devised, it may be indeed possible to create a $\mathcal{M}$ layer DF inventory, perhaps a $\mathcal{D}$ layer DF inventory.

$\mathcal{M}$ and $\mathcal{D}$ DF inventories would already be useful analytical tools. But the really exciting development would be the development of a formal grammar, defining a $\mathcal{M} \succ \mathcal{D}$ mapping. This would enable game designers to more precisely craft their products, using their agency on the $\mathcal{M}$ layer to create the desired effects on the $\mathcal{D}$ layer.

Going back to Love's abstraction level scale, which we presented in the introduction, such a grammar would enable a game designer to better answer the level 4 question ("Why does a woodworker choose a claw hammer rather than a sledge hammer for hammering a small nail?") [3].

These considerations guided our second iteration, in which we limited the scope of our DF inventory to the $\mathcal{M}$ layer, and in which we were interested in evaluating how these DFs would result in $\mathcal{D}$ characteristics.

As before, our results led to a reevaluation of the framework and its assumptions. A $\mathcal{M}{\succ}\mathcal{D}$ mapping may indeed be possible, but it will be only part of a much more complex, dynamic system — and the DF framework still needs further development in order to represent such a system.

6. Final remarks

The steps of research briefly described above are but the first steps of a toddler. To achieve a comprehensive, formal representation of games is a well-known challenge. There are formal representations for many games, and there are the mathematical Game Theory representations.

Several of our concepts — strategy, game state — were based on concepts explored in mathematics; but we purposefully avoided the definitions from Game Theory, in order to avoid its strictures. We intend to use the DF framework to represent not only well-behaved and well-formed games, but also — especially! — games that misbehave and challenge preconceived ideas.

We pointed out in the introduction that the philosophy of game design still has some gaps. Although it still needs further development, the DF framework is already a useful tool for game analysis, especially when used in combination with other tools — as we demonstrated when we applied the MDA framework to our results. The DF framework can thus help bridge some of the gaps in game design philosophy, and enable game designers to design better games.

This usefulness will be enhanced if a $\mathcal{M}{\succ}\mathcal{D}$ mapping grammar can be developed; we already took a tentative first step in this direction, with the second iteration of our research.

We expect that the flexibility of the DF framework will also enable its use in other challenges of game studies and game design, and we'll be happy to discuss further inquiries about the use of the DF system.

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Table 1: Strategical analysis DFs: results for [±experience-rewarded]

Game	**1st play**	**2nd play**	**Final**	**DF**
Age of Empires III	0.67	1.00	0.89	[+]
Container	1.00	0.50	0.67	[+]
El Grande	1.00	0.50	0.67	[+]
Flash Point	1.00	0.60	0.73	[+]
Goa	1.00	1.00	1.00	[+]
Inkognito	1.00	0.00	0.33	undefined
Kill Doctor Lucky	1.00	1.00	1.00	[+]
Lord of the Rings	0.00	-1.00	-0.67	[–]
On the Underground	1.00	1.00	1.00	[+]
Paris Connection	1.00	0.50	0.67	[+]
Pastiche	0.50	-0.50	-0.17	undefined
Ra	1.00	0.50	0.67	[+]
Room 25	1.00	1.00	1.00	[+]
San Juan	0.33	0.00	0.11	undefined
Steel Driver	1.00	1.00	1.00	[+]
The Speicherstadt	1.00	0.00	0.33	undefined
Ticket to Ride	1.00	1.00	1.00	[+]

Table 2: Strategical analysis DFs: results for [±random]

Game	**1st play**	**2nd play**	**Final**	**DF**
Age of Empires III	-2.75	-2.50	-2.58	[–]
Container	-1.63	-1.63	-1.63	[–]
El Grande	-2.25	-2.25	-2.25	[–]
Flash Point	-1.90	-1.20	-1.43	undefined
Goa	-2.67	-2.33	-2.44	[–]
Inkognito	-2.25	-1.25	-1.58	[–]
Kill Doctor Lucky	-2.00	-2.10	-2.07	[–]
Lord of the Rings	2.00	2.25	2.17	[+]
On the Underground	-1.50	-1.40	-1.43	undefined
Paris Connection	-1.20	-2.63	-2.15	[–]
Pastiche	0.13	-1.25	-0.79	undefined
Ra	0.13	-2.13	-1.38	undefined
Room 25	-1.90	-2.10	-2.03	[–]
San Juan	-0.67	-0.25	-0.39	undefined
Steel Driver	-2.50	-1.63	-1.92	[–]
The Speicherstadt	-0.75	0.00	-0.25	undefined
Ticket to Ride	-1.50	-2.00	-1.83	[–]

Table 3: Strategical analysis DFs: DF vectors for each game (part one).

Game	[±random]	[±balanced]	[±strategy-possible]	[±strategy-variable]
Age of Empires III	−	+	+	+
Container	−	+	+	+
El Grande	−	+	+	+
Flash Point		+	+	+
Goa	−	+	+	+
Inkognito	−	+		
Kill Doctor Lucky	−	+	+	+
Lord of the Rings	+			
On the Underground		+	+	+
Paris Connection	−	+	+	+
Pastiche				
Ra		+	+	
Room 25	−		+	
San Juan		+	+	
Steel Driver	−	+	+	+
The Speicherstadt		+		
Ticket to Ride	−	+	+	

Table 4: Strategical analysis DFs: DF vectors for each game (part two).

Game	[±experience-rewarded]	[±symmetric]	[±theme-present]	[±theme-relevant]
Age of Empires III	+		+	–
Container	+	+	+	
El Grande	+	+		–
Flash Point	+		+	
Goa	+		+	–
Inkognito		+		
Kill Doctor Lucky	+	+	+	–
Lord of the Rings	–			
On the Underground	+	+	+	–
Paris Connection	+	+	+	–
Pastiche				–
Ra	+			–
Room 25	+		+	–
San Juan		+		–
Steel Driver	+	+		–
The Speicherstadt		+		–
Ticket to Ride	+	+	+	–

Table 5: Cooperation DFs: DF vectors for each game

Game	[±individual]	[±single-team]	[±traitor]	[±defeat]	[±state-info]	[±communication]
Battlestar Galactica	–	–	+	–	–	–
Fury of Dracula	+	+	–	–	–	–
Hanabi	–	+	–	–	–	–
Nosferatu	–	–	+	–	–	+
Red November	+	+	+	+	+	+
Saboteur	–	–	+	–	–	+
Shadows Over Camelot	+	+	+	+	–	–
The Republic of Rome	+	–	–	+	–	+
The Resistance	–	–	+	–	–	+
Wealth of Nations	+	–	–	–	+	+