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Key Aspects of Game Design

A Scoping Review

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Abstract

This scoping review presents a holistic perspective on game design research. Publications of relevant conferences on game design and associated topics have been thoroughly examined and evaluated in an iterative manner against predefined criteria. A constantly refined protocol with a priori definitions was used to provide transparent guidelines and to ensure a common understanding of criteria for publications of interest.

A taxonomy of ten categories with a total of 78 either independent or interdependent aspects of game design research is lined out. The presented publications cover either novel approaches in game design or valuable enhancements to existing perspectives and techniques. Publications are identified and listed and the contribution to the knowledge state for game design research has been explicitly covered for each of the identified aspects.

Contents

CHAPTER 1

Introduction

Although it is often pointed out that video game design has a particularly multidisciplinary nature, the number of systematic analyses of the scope and state of this relatively new research field and its different areas is scarce. In this scoping review, an overview about the current research focus and progress is given and relevant knowledge from different research areas is presented. Furthermore, wherever applicable, these key areas are linked to each other to provide a holistic perspective on game design research.

The examination of selected sources will be conducted with respect to three research questions. Due to the explorative characteristics of scoping reviews they are phrased in a rather broad manner. As Munn et al. pointed out, it is good practice to combine less precise questions, such as identifying concepts of a research field, with a scoping review. [Munn et al., 2018] The following research questions will be answered within the scope of this thesis:

1. With regards to which key aspects is game design research currently conducted?

   This research question covers the very core of scoping reviews; as mentioned within the definition by Daudt et al. it is among the aims of this type of review to establish a mapping between literature and the examined topic or research area. [Daudt et al., 2013]. Furthermore, this purpose was also presented in the first framework for scoping studies by Arksey and O'Malley on which recommendations from Daudt et al. are based. [Arksey and O'Malley, 2005] Within the scope of this thesis the recommendation of Colquhoun et al. to be consistent in terminology is followed by consequently using "Scoping Review" exclusively, since these terms are often used interchangeably. [Colquhoun et al., 2014] This blends in with the aforementioned less formal aim to provide a holistic perspective on game design research. The thesis should serve as an entry point especially for researchers who want to further develop the field of game design and as such the main objective is to identify key aspects and map crucial literature.

2. What do the identified key aspects add to the knowledge state of game design and game design research?

   Apart from the above-mentioned mapping between literature and research area, another aspect that will be examined is the impact of different identified key aspects on actual decisions that are made by game developers in practice. Wherever applicable and available, case studies will be included in this thesis to highlight what practices game design research has established. Daudt, van Mossel and Scott's inclusion of the identification of key concepts that inform practice and policy making into their definition of scoping reviews [Daudt et al., 2013] is reflected within the second research question.

3. Which research gaps are identified by scientific literature?

   Another crucial aspect that aids to improve the state of game design research is to point out on which topics publications are still required. Accordingly this thesis can serve as a guideline or thought-provoking input for novice researchers who would like to contribute. This thought is manifested in the definition of scoping reviews by Daudt et al. who explicitly included the identification of research gaps therein [Daudt et al., 2013] as well as in Arksey and O'Malley's purposes for scoping reviews [Arksey and O'Malley, 2005].

The scope of this review includes concrete concepts that influence game developers and producers to make certain decisions that shape the final products as well as game experience. Queries on scientific databases reveal that several scoping reviews on subsets of the research topic of game design have been conducted. The search terms "game design scoping review" returns several results on February 25th, 2020, including "A Scoping Review of Health Game Research: Past, present, and future" by Kharrazi et al. [Kharrazi et al., 2012], "A Scoping Review of Research on Digital Game-based Language Learning" by Hung et al. [Hung et al., 2018] as well as "A Scoping Review of Digital Gaming Research Involving Older Adults Aged 85 and Older" by Marston et al. [Marston et al., 2016] or "A Scoping Review of Video Gaming in Rehabilitation" by Ravenek et al. [Ravenek et al., 2016] The search results on Microsoft Academic, ResearchGate or OBV, all requested on the same date, show similar results.

However, several meta analyses on game design research exist. They provide a quantitative high level synthesis of topics on which research is conducted. Melcer et al. analyzed the academic landscape of games research from 2000-2014. [Melcer et al., 2015] In their publication, articles from an expert generated list of game research journals served as a basis for a co-word and co-venue analysis. Within this study data preprocessing was executed so that analysis tasks could be performed in an automated manner. As such, where missing, keywords were calculated and automatically inserted. This was done by a specially adjusted version of the *RAKE* algorithm [Melcer et al., 2015], presented by Rose et al. [Rose et al., 2010]. Melcer et al. then rendered network graphs that showed which keywords are frequent and how they are connected to each other, where nodes

represented keywords and edges their co-occurrence within articles. Respectively the same procedure was applied to venues, where a node was added to each venue and edges between two nodes represented authors who published at both conferences [Melcer et al., 2015]. Furthermore, the researchers assigned centrality and density as characteristics to each of their data nodes [Melcer et al., 2015]. Based on the statistical analyses Melcer et al. claim to have identified a research gap between technical and non-technical papers [Melcer et al., 2015].

Another notable meta analysis was conducted by Paul Martin. In his publication "The Intellectual Structure of Game Research", 24,128 conference papers and single sources were analyzed based on their keywords and citations with the aim to identify clusters of research [Martin, 2018]. This publication gives insight on these clusters, that Martin refers to as "communities", of which he found four in his co-keyword analysis, i.e. education/culture, technology, effects and medical and five with regards to co-citation: education, humanities/social science, computer science, communication and health [Martin, 2018]. Furthermore, Martin presented subgroups to each community, representing the most covered subtopics and corresponding authors with most publications [Martin, 2018].

What sets this scoping review apart from the ones available on academic platforms and existing meta analyses, is its aim to provide an overview over the exponentially growing research field [Martin, 2018] of game design as a whole, going beyond quantitative analyses by including comprehensive introductions to concepts the identified key aspects of game design research.

CHAPTER 2

Methodological Approach

As proposed by von Elm et al. [von Elm et al., 2019] defining and agreeing on an a priori protocol for inclusion and exclusion criteria and objectives was the first step towards a thorough literature research.

A list of relevant conferences and their proceedings serves as a starting point for source inclusion. These conferences either address game design research directly or interdisciplinary fields with topics linked to game design. The selection was based on prior research, including an analysis of the main sources for Paul Martin's meta review [Martin, 2018] as well as the expert generated list of game research journals by Edward Melcer et al [Melcer et al., 2015]. Further additions to the list were made according to suggestions by Fares Kayali, professor at the University of Vienna with research focus on game based learning and gamification and advisor for this thesis, as well as Martin Pichlmair, head of the ITU Copenhagen's "Games" study programme.

Additional sources are added as the research progresses if needed not only to the single sources list but also to the collection of scraped proceedings. Especially for interdisciplinary topics it is assumed that an extension of proceedings with focuses other than game design research as well as single resources will be needed to provide comprehensive introductions into all mentioned aspects.

Furthermore, publications were only included into the list of sources if published in or officially translated into a language, that at least one of the reviewers speaks fluently, i.e. German, English and Italian.

Articles neither have to be peer reviewed nor published to be included as a source, since it is not the aim of a scoping review to examine and analyze the quality of evidence, as von Elm et al. pointed out [von Elm et al., 2019], but to gather a broad collection of knowledge.

Publications and other sources have to pass a relevance analysis regarding their titles and abstract prior to being added to the list of included sources. This analysis is done by two reviewers independently to reduce bias and enhance completeness. In case of distinctions in the analysis or disagreements they are reviewed by an advisor, who decides which articles will be included.

All the guidelines mentioned within this chapter are manifested in the a priori protocol. The analyses and inclusion of publications will be conducted in an iterative manner, according to the framework for scoping reviews by Arksey and O'Malley [Arksey and O'Malley, 2005]. The following tasks will be conducted during each iteration:

2.1 Extensive Literature Review of Meta Reviews, Proceedings and Single Sources

Meta analyses like the aforementioned ones by Martin and Melcer et al. help identify crucial research aspects, as well as communities and important publications and proceedings. However, due to their quantitative methodologies they filter out less cited fields and tend to exclude interdisciplinary findings. Martin claimed that his analysis had an English language bias, due to his automated keyword analysis that restricted him to use English keywords exclusively [Martin, 2018]. Melcer et al. pointed out, that due to the automation in their analysis, publications outside of game design core venues cannot be included, since their relevance cannot be auto detected reliably [Melcer et al., 2015]. Within this scoping review also these sources should be identified and included into the research context.

2.2 Inclusion of Relevant Scientific Work

After the thorough literature review sources are analyzed with regards to title and abstract. After reviewiewing these two categories, each article is assessed and evaluated against the inclusion criteria (see 3). This process is executed in stages by two reviewers independently.

2.3 Data Charting

As a means of further reference and documentation of the aforementioned processes their results are charted, as proposed by Arksey and O'Malley [Arksey and O'Malley, 2005]. Meta information on articles are collected in a database like manner and reports for entire iteration cycles or proceedings are visualized in the shape of an appropriate chart.

Furthermore, a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow style diagram was created for every conference or single sources iteration as well as for the overall literature gathering process. This serves as a high level

documentation of the overall inclusion process for further reference. Figure 2.1 shows the master template for a PRISMA flow diagram for a single conference.

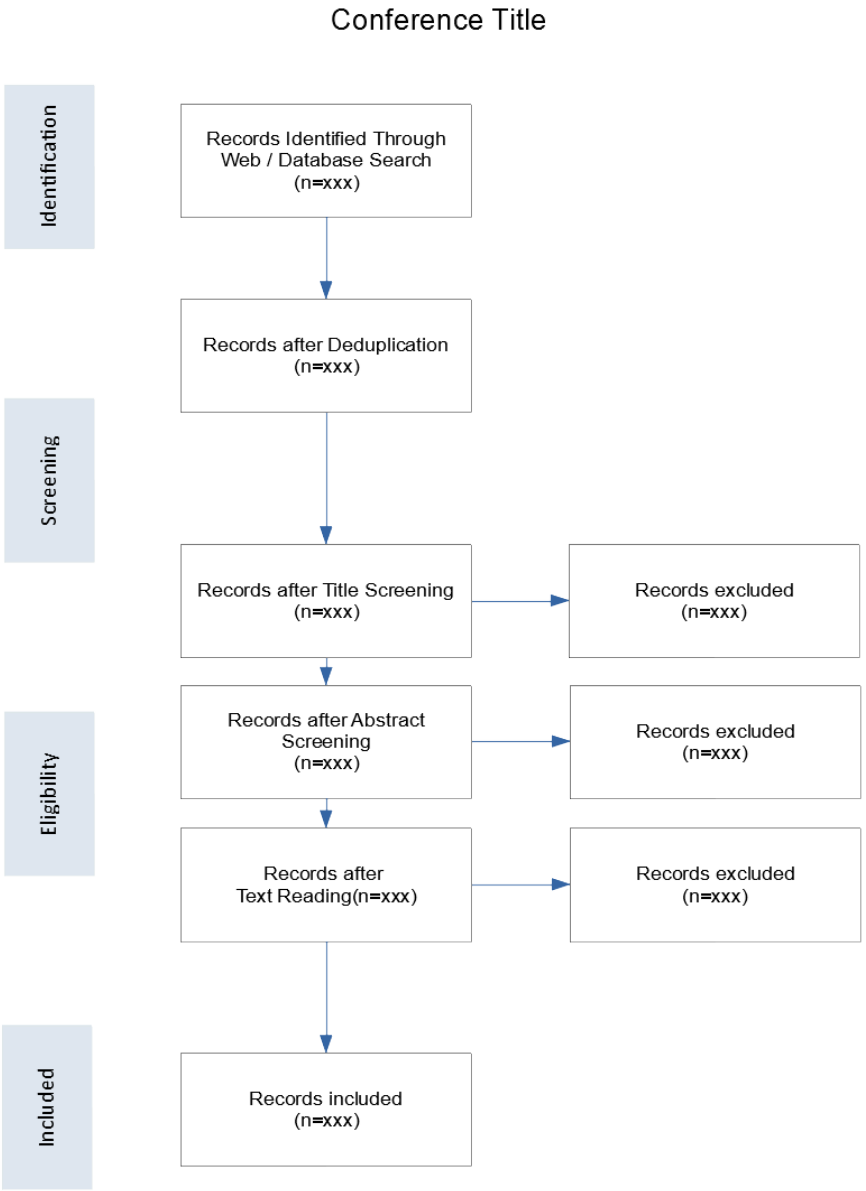

Figure 2.1: PRISMA flow diagram master template for conferences

2.4 Collating, Summarizing and Reporting Results

As mentioned by Arksey and O'Malley [Arksey and O'Malley, 2005] the collection of scientific material can be large and potentially quests for a communication and presentation strategy. They propose grouping by thematic aspects with summaries of basic common elements within a group without providing a high level synthesis of research, since this is not considered the aim of a scoping review [Arksey and O'Malley, 2005].

Nevertheless, the included articles have to be examined and presented within a greater context to achieve the mapping aim between literature and research topic. Especially within the multidisciplinary field of game design, it seems crucial to clarify the links between several groups while maintaining a clear separation as this helps to identify research gaps within the thematic groups.

Therefore, tagging and subsequent grouping of included articles, where applicable, are reviewed by the advisors to ensure the aforementioned clarity. For each group basic characteristics are then identified and outlined. Different approaches in research are then presented as well as their aims and promises. An authors assessment on the density or credibility of evidence is not provided, since this is beyond the scope of a scoping review [Arksey and O'Malley, 2005].

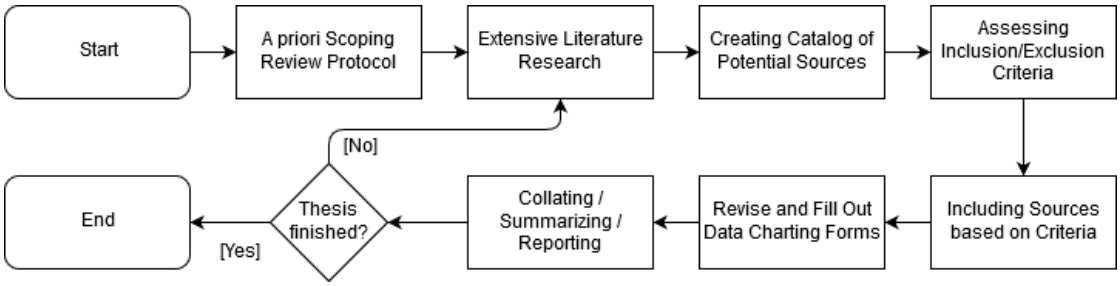

Figure 2.2: Scoping Review Framework used for this thesis

The above-mentioned tasks make for the following framework depicted in figure 2.2, which is based on the ideas of Arksey and O'Malley [Arksey and O'Malley, 2005] and slightly adapted for the game design research context. The collaboration within iterations is mostly organized remotely, i.e. using online communication platforms like Zoom or Skype, due to the measures against the spreading of Covid-19 and spatial distance between researchers and advisors.

Furthermore, an interactive representation of the results is implemented and will be accessible under `https://litrev.abendstille.at/concepts`.

2.5 Technical Implementation

2.5.1 Data Collection and Normalization

Publications are collected in a literature database for this thesis, shared among the reviewers to ensure a common and synchronized base of sources. For this task the open source software Zotero was used. It offers a browser plug-in to quickly index articles that are opened in a browser tab. Publications could be imported more or less correctly into the database, depending on their source. For some articles, especially single sources from Google Scholar or Microsoft Academic additional preprocessing steps were required to have a metadata base that is sufficing for further analysis.

Data normalization, filling in missing meta-information and deduplication of articles were the most important preprocessing steps. Zotero offers a JavaScript Application Programming Interface (API) for such purposes which was used for more complex operations. Simple tasks, e.g. publication deduplication by comparing titles could be executed directly on the underlying SQLite database file, created by Zotero, using Structured Query Language (SQL) commands. The command used for deduplication based on the publication title was executed after the inclusion of each proceeding / single source into the Zotero database. It was defined as followed:

Listing 2.1: Deduplication

```
SELECT
    v.value,
    COUNT(v.value)
FROM
    itemdata i
    INNER JOIN fieldsCombined f
    ON i.fieldID = f.fieldID
    INNER JOIN itemDataValues v
    ON i.valueID = v.valueID
    INNER JOIN itemTypesCombined ity
    ON i.itemID = ity.itemTypeID
WHERE
    f.fieldName = 'title'
    AND ity.typeName NOT IN ('attachment')
GROUP BY
    v.value
HAVING
    COUNT(v.value) > 1;
```

The results of this query were then checked manually to ensure that the identified articles were actually duplicates.

After bringing the data in a normalized and cleanly structured form, the PostgreSQL database was used to query collected articles and persist inclusion and exclusion decisions. A database function was defined that allowed for full text search on authors, titles and abstracts of articles:

Listing 2.2: Literature Search Function

```
CREATE OR REPLACE FUNCTION public.lit_search(p_query character varying)
 RETURNS TABLE(id numeric, title text, abstract text, authors text, conference text)
 LANGUAGE plpgsql
AS $function$
```

```
begin
        return query
                select
                        "ID",
                        "TITLE",
                        "ABSTRACT",
                        "AUTHORS",
                        "CONFERENCE"
                from
                        lit_db
                where
                        CAST("ID" as TEXT) ilike '%'||p_query||'%' or
                        "TITLE" ilike '%'||p_query||'%' or
                        "ABSTRACT" ilike '%'||p_query||'%' or
                        "AUTHORS" ilike '%'||p_query||'%' or
                        "CONFERENCE" ilike '%'||p_query||'%';
end;$function$;
```

2.5.2 Data Charting

Metadata for publications are collected, organized and manipulated in Zotero. Data charting protocols for single article granularity are visualized in a table format. Articles and corresponding fields are queried via SQL and converted into a Comma Separated Values (CSV) file that can easily be imported within Microsoft Excel or LibreOffice Calc for a more readable representation. A Java program was written to write the database query's result into a CSV file. This query was used to retrieve database entries, where the *${conference}* placeholder was replaced by an argument, passed into the Java program:

Listing 2.3: CSV Query

```
SELECT
    i.itemId id,
    f.fieldName field,
    v.value value,
    c.lastName || ' ' || c.firstName authors
FROM
    itemdata i
    INNER JOIN fieldsCombined f ON i.fieldID = f.fieldID
    INNER JOIN itemDataValues v ON i.valueID = v.valueID
    INNER JOIN itemCreators ic on i.itemID = ic.itemID
    INNER JOIN creators c on ic.creatorID = c.creatorID
WHERE
    i.itemID in (
        SELECT
            i.itemId
        FROM
            itemdata i
            INNER JOIN fieldsCombined f ON i.fieldID = f.fieldID
            INNER JOIN itemDataValues v ON i.valueID = v.valueID
        WHERE
            f.fieldName = 'publicationTitle'
            AND v.value = '${conference}'
    )
order by
    i.itemID;
```

and some data processing was done in Java by the following code, before writing the string to a file:

Listing 2.4: Java CSV Preprocessing

```
...
List<Long> ids = results.stream()
```

```
    .filter(distinctByKey(ResultRow::getId))
    .map(res -> res.getId()).collect(Collectors.toList());
List<Article> articles = new ArrayList<>();
ids.forEach(id -> {
    System.out.println("adding id: " + id);
    String date = results.stream()
    .filter(r -> r.getId().equals(id) && r.getField().equals("date"))
            .map(r -> r.getValue()).findFirst().get()
            .replaceAll("([0-9]*-[0-9]{2})", "")
            .trim();
    String title = results.stream()
            .filter(r -> r.getId().equals(id) && r.getField().equals("title"))
            .map(r -> r.getValue()).findFirst().get();
    ...
    String author = results.stream()
            .filter(r -> r.getId().equals(id))
            .filter(distinctByKey(ResultRow::getAuthor))
            .map(rs -> rs.getAuthor())
            .collect(Collectors.joining(", "));
    articles.add(new Article(id, date, title, author));
});
String csvStr = "ID||YEAR||AUTHORS||TITLE||ABSTRACT NOTE\n";
csvStr += articles.stream().map(a -> a.toString())
        .collect(Collectors.joining("\n"));
...
```

The resulting CSV file was then opened and edited in Microsoft Excel or LibreOffice Calc, where aim, methodology and findings of each article were added to the table after thorough examination.

2.5.3 Reporting

The above-mentioned interactive representation of the research results (see 2.4) is accessing the data in the PostgreSQL database, which was added prior to the data charting step (see 2.5.1). Included articles that are assigned to topics are exposed in Javascript Object Notation (JSON) format via a restful API. The used webserver is Postgrest and the underlying code has been implemented as a PL/pgSQL function:

Listing 2.5: Retrieve Articles for Aspects

```
CREATE OR REPLACE FUNCTION public.get_articles_for_aspect(p_aspect_id integer)
 RETURNS TABLE(id numeric, title text, abstract text, authors text,
 conference text, aspect_ids text, aspect_names text)
 LANGUAGE plpgsql
AS $function$
declare
begin
return query WITH RECURSIVE subaspects AS (
    SELECT "ID",
        "NAME"
    FROM aspects
    WHERE "ID" = p_aspect_id
    UNION
    SELECT a."ID",
        a."NAME"
    FROM aspects a
        INNER JOIN subaspects s ON s."ID" = a."PARENT_ID"
)
select ldb.*, STRING_AGG (aa.aspect_id::text, ', ') as aspect_ids,
STRING_AGG (a."NAME", ', ') as aspect_names
from lit_db ldb
join article_aspects aa on aa.article_id = ldb."ID"
join subaspects a on aa.aspect_id = a."ID"
group by ldb."ID", ldb."TITLE", ldb."ABSTRACT", ldb."AUTHORS", ldb."CONFERENCE"
order by ldb."ID";
```

```
end; $function$
;
```

The result of this function is converted into json format for web representation using this function:

Listing 2.6: Convert Articles to Json

```
CREATE OR REPLACE FUNCTION public.get_articles_for_aspect_as_json(p_aspect_id integer)
 RETURNS TABLE(j json)
 LANGUAGE plpgsql
AS $function$
declare
begin
return query SELECT articles_for_aspect_json FROM cached_aspects WHERE "ID"=p_aspect_id;
end;
$function$
;
```

This data is rendered as a tree with expandable and collapsible nodes representing the research aspects which convey the associated articles by clicking on them. The visualization is done on the client side via the Treant JS JavaScript library:

Listing 2.7: Visualization of Aspects and Articles

```
function showNodeDetails(data) {
    data = data.map(function (a) {
        return a.j;
    });
    html = data.map(function (a) {
        return '<tr>' +
            '<td>' + a.ID + '</td>' +
            '<td>' + a.AUTHORS + '</td>' +
            '<td>' + a.CONFERENCE + '</td>' +
            '<td>' + a.year + '</td>' +
            '<td>' + a.TITLE + '</td>' +
            '</tr>';
    });
    html = '<table width="100%">' + html.join('') + '</table>';
    $("#dialog-message").html(html);
    $("#dialog-message").dialog({
        modal: true,
        buttons: {
            Ok: function () {
                $(this).dialog("close");
            }
        },
        width: 500
    });
}
function initialized() {
    $('.chart .concept').click(function () {
        var aspectId = $(this).data("aspectid");
        $.post(
"https://litrev.abendstille.at/postgrest/rpc/get_articles_for_aspect_as_json", {
            p_aspect_id: aspectId
        }, showNodeDetails);
    });
}
$.get("https://litrev.abendstille.at/postgrest/aspects", function (aspects) {
    function getChildren(ID) {
        var direct_siblings = aspects.filter(function (a) {
            return a.PARENT_ID === ID;
        });
        return direct_siblings.map(function (a) {
            return {
                text: {
                    name: a.NAME,
```

```
                    desc: "",
                    "data-aspectid": a.ID
                },
                children: getChildren(a.ID)
            };
        });
    }
    var orientation = "WEST";
    switch (window.location.hash) {
        case "#v1":
            orientation = "WEST";
            break;
        case "#v2":
            orientation = "EAST";
            break;
        case "#v3":
            orientation = "SOUTH";
            break;
        case "#v4":
            orientation = "NORTH";
            break;
    }

    var tree_structure = {
        chart: {
            container: "#ConceptChart",
            levelSeparation: 20,
            siblingSeparation: 15,
            subTreeSeparation: 15,
            rootOrientation: orientation,
            nodeAlign: "CENTER",

            node: {
                HTMLclass: "concept",
                drawLineThrough: false,
                collapsable: true
            },
            connectors: {
                type: "bCurve",
                style: {
                    "stroke-width": 2,
                    "stroke": "#ccc"
                }
            }
        },
        nodeStructure: {
            text: {
                name: "Aspects",
                desc: ""
            },
            children: aspects.filter(function (a) {
                    return a.PARENT_ID == null;
                })
                .map(function (a) {
                    return {
                        text: {
                            name: a.NAME,
                            desc: "",
                            "data-aspectid": a.ID
                        },
                        children: getChildren(a.ID),
                    };
                })
        }
    };
    new Treant(tree_structure, initialized);
});
```

CHAPTER 3

Scoping

Among examining the scope of areas within scientific game design research, another crucial conception task when planning this thesis was dividing the collection of sources into publications that were taken into account for further examination and others that were considered out of scope. As mentioned in the chapter Methodological Approach, rules regarding these decisions were initially documented in the a priori protocol but as research progressed, they were extended within a process of collaborative decision making.

Publications regarding technological implementations, e.g. programming languages used for game development or hardware artifacts including specific game consoles and their requirements are generally considered out of scope, unless they provide additional knowledge to a fundamental aspect of game design or illustrate a proof or disproof for a presented thesis. Game development implementation standards or frameworks as well as technological observations or examinations of specific game elements were explicitly considered out of scope. This also includes algorithms that reduce execution times or enhance computer graphics within games. Excluding these volatile aspects of video game implementation and limiting on more persistent areas of game design research allows for a more general and liberal inclusion of published work. As a consequence, boundaries regarding the publication date of sources were not added to the formal research inclusion criteria.

Furthermore, an exclusion criteria regarding context based analyses was introduced. User studies about alternative input or output modalities to play certain games or to increase accessibility to existing games as well as analyses on games within a context that was not considered the target experience by the game designers are not part of this review. To clarify this rule, the following example can be given: An analysis on whether the Nintendo Wii Motion Controller could be used to ease access to keyboard centered games would be excluded, whereas an analysis on how the Nintendo Wii Motion Controller is used within Nintendo Wii games, designed specifically for a gaming context including

this controller would be included if it provides insights to game design decisions and considerations. This decision is justified by the main purpose of this review to find key game design principles, whereas examinations of artifacts in different contexts cannot be considered as such.

Publications on game studies that surpass game design in its narrower sense are also excluded. This rule covers, among others, findings on game production methods, behavior analyses on players or sociological analyses on gamer communities.

CHAPTER 4

Key Areas of Game Design Research - Results

The entirety of included articles which serves as the basis for the proposed taxonomy of novel game design research aspects is presented in this chapter. The structure in which they are lined out is opinionated and consists of ten different categories.

Furthermore, this chapter includes references to related aspects of other categories, illustrations that simplify the comprehension of complex concepts and descriptions of conducted studies where applicable.

4.1 Design Aims

4.1.1 Casual Game Design

Chiapello states that casual games have been largely successful (e.g. Angry Birds) due to their notion of providing accessibility for all audiences. Trefry sees Microsoft Solitaire, a card game that was pre-installed on several versions of Microsoft Windows, as the starting point of the casual game movement. [Chiapello, 2013, Trefry, 2010] Chiapello aims to provide a robust definition of casual games that she claimed to be lacking within the discourse of these games. As an example of contradictions in the understanding of casual games, she names game difficulty, which by some scholars is seen as a counterproductive element of casual games that decreases accessibility, while others do not see any connection regarding the genre. [Chiapello, 2013]

Conducting qualitative interviews with eight designers of casual games on several platforms to pinpoint essential game elements and design aspects of casual games. The chosen methodological process consists of two steps, prior to the interview, participants were presented with a booklet containing questions about still debated concepts, e.g. difficulty,

to evoke self reflection on open questions. the second step consisted of semi-structured interviews of at least one hour. [Chiapello, 2013]

Among the insights gained by analyzing the interview data the golden ratio by Csikszentmihalyi is a central issue within casual game design. The golden ratio describes the perfect balance between a challenge provided by the game and player skills. The player acceptance of golden ratio divergence is generally low, especially compared to hardcore games. [Chiapello, 2013]

Regarding the length of player sessions of casual games, the interview results show, that this is not a relevant metric for game designers, who claim that it varies strongly. It is however important, that gameplay loops are designed in a way that there is a bigger number of shorter loops within the game. These so-called "micro-loops" allow for different styles of gaming, including short and long sessions, and prevent designers from having to adapt to players' gaming habits. [Chiapello, 2013]

Among others, the above-mentioned results form the basis towards a framework that is supposed to lead to a common understanding of what a casual game consists of and how it should be designed. [Chiapello, 2013]

4.1.2 Socially Adaptable Games

Games that are socially adaptable possess the ability of functioning in changing social environments. In practice, this means that real world contexts, e.g. time or location, have to be incorporated into the design of socially adaptable games. [Eriksson et al., 2005]

Eriksson et al. distinguish between active and passive social adaptability. Active social adaptability can be achieved by sensors that create data that change in-game behavior according to the players' surroundings. Passive social adaptability is achieved, when games are designed in a way that adapts to the attention a player is willing to give. [Eriksson et al., 2005]

Causes of change of the social environment during gameplay can be divided into two groups, intra-ludic, i.e. as part of the magic circle and extra-ludic, i.e. outside of the magic circle, for example when a player is talked in real life, interrupting an in-game conversation. [Eriksson et al., 2005]

To account for these kinds of changes from a designer's perspective, Eriksson et al. propose a framework, consisting of seven components. The negative effects of adaptations of the social environments can be lowered by incorporating the following measures into the game design process: [Eriksson et al., 2005]

- Support Interruptibility

  A player should be able to pause her gameplay when extra-ludic events occur. Therefore, asynchronous gameplay modalities are a must and a reentering strategy should be considered. [Eriksson et al., 2005]

- Allow Multiple Communication Channels

  Multiple communication channels should be provided by the game designer so that communication can be continued on another channel as seamlessly as possible. [Eriksson et al., 2005]

- Consider Ambiguity

  Gameplay and in-game elements should be designed in a way so that they can be completely hidden from extra-ludic activities. [Eriksson et al., 2005]

- Design for External Events

  Extra-ludic events can happen, especially when playing a game in a public space that is shared with non gamers or other people outside of the magic circle. To prevent the gameplay from breaking in these situations, they have to be identified at the design stage and measures have to be taken to handle them at runtime. [Eriksson et al., 2005]

- Allow Modes of Play Based on Social Roles

  Participation within gameplay can be put into a taxonomy of different social roles. Depending on which gameplay style a player prefers, she is taking a social role in the gameplay context. Designers can enhance engagement by creating dependencies between social roles as well as support changing the social role of a player to account for adaptations of the social environment. [Eriksson et al., 2005]

- Minimize Social Weight

  Social weight, i.e. the decrease of social interaction between users and non users of a certain technology, should be kept at a minimum [Toney et al., 2003], especially when the same physical space is shared. [Eriksson et al., 2005]

- Analyze Intended Player Groups from Several Perspectives

  Techniques like applying player typologies or social and functional roles are proposed to account for changes in social player behavior. A taxonomy of these roles is given by Erikssen et al. [Eriksson et al., 2005]

4.1.3 Design for Participation

Digital games allow designers to present players with the ability to alter game components of various types. These range from player injected algorithms to adjust in-game behavior to graphical elements or sounds to modify aesthetics. [Isaac, 2014] As Moshirnia and Walker point out, user-content generation and modification possibilities are getting increasingly common in commercial video games [Moshirnia and Walker, 2007] and modding communities like Nexus Mods have more than 25 million members. [Scott, 2022]

While providing means to generate game content exists for at least about 40 years, the agency of players in this aim varies and often the hierarchy between game designers and

players is maintained by limiting the possibilities of exchanging game components, for example by incorporating the process of generating content into the game by providing a user interface with a small set of actions [Van Den Bosch et al., 2011], e.g. a level editor.

In a study that consists of in-depth interviews and an online survey, Van den Bosch et al. examined what motivates players to create game content. The selection of participants was limited to players of the video games *Spore* and *Little Big Planet*, that are known for enabling creative user-content generation by providing level editors and the possibility to share generated content with other players. [Van Den Bosch et al., 2011]

The findings of Van den Bosch et al. show that there are two main motives for creating user-generated content. Some players state creating content as their main aim to play or buy video games. Experiencing gameplay orchestrated by game designers serves as creative input for this kind of player. [Van Den Bosch et al., 2011] Building game content can be seen as a ludic layer on top of a game for this group of players.

Secondly, the challenge of building high quality content that is regarded by a community of gamers was mentioned by participants of this study. Consequently, a motivating aspect of creating game content is the satisfaction of getting positive feedback by other players. [Van Den Bosch et al., 2011]

To assist players in their aim to generate content, Lenhart presents the ludic "mashup / remix / assemblage" approach. According to this paradigm, games are supposed to be understood and composed as rearrangeable module blocks. This would enable designers and players to assemble a unique and personalized gaming experience. In a further step, standards of modular blocks would be defined to allow interchangeability between different games. Lenhart states that each possible custom assemblage creates new meaning and is greater than the sum of the single parts. [Isaac, 2014]

This approach is an extension to the current understanding of user-generated content, e.g. as sandbox creation environment examined in the study of Van den Bosch et al. [Van Den Bosch et al., 2011], enhancing the size and accessibility of the pool of content blocks that creators, i.e. game designers and players, are able to pick from.

User-Generated Content in Educational Settings

Moshirnia and Walker examined the benefits of game modifications in a more serious setting. As pointed out, modifications contain their creators believe system, preferences or political opinions. This is referred to as digital existentialism. [Moshirnia and Walker, 2007]

Historical representations in games can be subjective or inaccurate for various reasons, e.g. abstraction or limited development resources. In their publication they examined flag mods in the game Civilization that were created to enhance realism and authenticity in the game. In this particular example, soldiers of the Continental Army were holding the American flag, which is not an accurate representation for all the colonies it consisted of. A mod was published that recreated the actual inconsistency in the design of the flags

used by the Continental Army. Moshirnia and Walker see user generated modification as a crucial concept to enhance the educational value of video games. Furthermore, these modifications can provoke a reflection process on a player's cultural bias. [Moshirnia and Walker, 2007]

4.1.4 Value Based Design

Games for Social Change

Swain states that games design that evokes social change can be achieved by letting players experiment with complex real world problems through play. A framework of eight steps is provided, based on Swain's experiences as a game designer: [Swain, 2007]

- Define Intended Outcomes

  Quantifiable objectives should be defined and documented beforehand. These can be for example the number of emails sent to some party or an amount of money collected for a certain cause. [Swain, 2007]

- Integrate Subject-Matter Experts

  In addition to the different domains of knowledge needed to create an entertaining game, a domain expert for the covered real world problem should be part of the development team. [Swain, 2007]

- Embrace Wicked Problems

  Social problems are difficult to model and the coding of certain outcomes of these problems is often popular with one group of stakeholders and unpopular with another. Therefore a strong communication base between stakeholders has to be established to gain a common understanding and to embrace dialogue between them. [Swain, 2007]

- Partner with Like-Minded Organizations

  Partnering with credible organizations with aims that converge with the game aim helps to reach a broader audience. [Swain, 2007]

- Build Sustainable Community

  Especially when developing games for social change that are niche products a sustainable community can help spread the cause, where the game may function as a meeting or focus point around which the community is built [Swain, 2007]

- Maintain Journalistic Integrity

  Similarly to traditional journalism, games that cover complex real life issues should provide a truthful and objective representation. [Swain, 2007]

- Measure Transference of Knowledge

  In addition to the outcomes as defined in stage one, transference of knowledge should also be measured, which can be efficiently done by in-game surveys or through focus groups. [Swain, 2007]

- Make it Fun

  Meaningful games that deal with complex real life issues are difficult to be designed in an entertaining manner. Designers have to decide between a realistic representation which presents a clear message but is not as fun and a more abstract representation which is more accessible and fun to play but does not transmit the message as clearly as its realistic counterpart. [Swain, 2007]

Design Tools for Value Based Design

Belman et al. developed a design tool to help create ideas that incorporate values into games. The Grow-a-Game card deck consists of cards of four different types, i.e. values cards, verb cards, games cards and issues cards. [Belman et al., 2011]

Players draw cards to then engage in a brainstorming session to discover new gaming ideas. The number of different categories determines the complexity of the design problem. A game card serves as a starting point, providing the player with a known game to modify. This card can be complemented by a verb card to focus on a specific action that should be executed within a game, e.g. negotiating. The value cards set the value constraints that designers have to promote within their design proposal, e.g. sustainability. Issues cards reveal current social issues that have to be addressed within the game idea. [Belman et al., 2011]

Another approach of design cards for value based design was presented by Flanagan et al. in 2007. The proposed tool can be incorporated into the three stages of the Values at Play project:

- Discovery

  Values are often embedded implicitly into design artifacts. The discovery of values in a certain game or scene is therefore not necessarily trivial. Flanagan et al. distinguish between *definition values*, which are part of the project scope, *collateral values*, i.e. values that emerge in the design process, *designer values*, which represent the designers' personal beliefs and *user values*, i.e. the values of players which can be discovered through classical research methods, e.g. by interviewing players. [Flanagan et al., 2005]

- Translation

  Translation is the designer's task to shape a game in order to expose a certain value to its players. [Flanagan et al., 2005]

- Verification

  Verification consists of assessments on whether values have been successfully incorporated into game artifacts. It can consist of an extensive series of research, e.g. internal testing, interviews, questionnaires, etc. [Flanagan et al., 2005]

The value cards deck consists of 14 different cards, each containing a certain positive social value. The game's aim is to draw a card and then find an example of a game or a game scene that incorporates the shown value, by explaining how it is translated into the game. Flanagan et al. present another usage of their value cards, i.e. think of a game and explain how it violates the drawn social value, which as pointed out, has been considered easier. The value cards are supposed to strengthen the ability of analytically discussing and designing video games. [Flanagan et al., 2007]

Moral Judgment in Games

Based on the "Minnesota Approach" by Rest et al. [Rest et al., 1999], Ryan et al. developed a framework to design games that evoke players' moral engagement. The following four lenses were borrowed by the Four Component model, presented and extended by Rest et al.: [Ryan et al., 2016c]

- Moral Focus

  Moral focus is the degree of players' commitment to their moral values and choices. Ryan et al. name execution of responsible actions, willingness to help others and cooperating as skills associated with moral focus. A high level of moral focus can compromise the ludic experience, therefore designers have to assume that gamers are not used to play in a morally focused way. Equipping players with moral identity and incorporating moral assessment through Non Player Characters (NPC) are techniques to strengthen moral focus within video games. [Ryan et al., 2016c]

- Moral Sensitivity

  Moral sensitivity is the capability to identify and classify morality, especially other people's moral decisions in a real world scenario. Player skills regarding moral sensitivity are identifying emotions, taking perspective or controlling bias. The designer's challenge to incorporate moral sensitivity into a game is to not make moral decisions too obvious while keeping them discoverable, as presenting them in a scripted way with an apparent outcome prevents players from exercising in making these decisions. [Ryan et al., 2016c]

- Moral Judgment

  Moral judgment is the comprehension and ability to reflect about moral concepts. Players who are skilled in moral judgment are able to identify codes and judgment criteria and create a morally reflective connection between process and outcome, as Ryan et al. point out. Designers may incorporate moral judgment into games

through moral temptations, where the morally correct option is evident, but choosing it results in a disadvantage for the player or through moral dilemmas, where each outcome can be considered morally correct depending on perspective. [Ryan et al., 2016c]

- Moral Action

  Moral action is the capability of not only choosing the morally right over tempting alternatives but also to act accordingly. Associated skills are leadership, courage and initiative. Designers can implement this principle into games by making players face risky situations after choosing morally right actions, that may be difficult to overcome. As Ryan et al. state, the high difficulty levels may decrease or increase players' motivation. [Ryan et al., 2016c]

Ethics of Competition

The main game design setup for competitive games consists of two or more players who combat each other in various ways. Based on Immanuel Kant and philosophical views, Herman distinguishes between two kinds of wrongs, the wrong of coercion, i.e. controlling the will and the wrong of violence, i.e. obstructing the will. [Herman, 1989, Nguyen and Zagal, 2016] These definitions would apply to nearly all types of competition in video games, since hindering another player from executing their will is a crucial part of the ludic experience. [Nguyen and Zagal, 2016]

In a real world scenario this definition of violence has to be considered in a more holistic manner, since players are willingly putting themselves in positions, where their will may be obstructed. Nguyen and Zagal propose two processes that transform violence in games, i.e. consent and social contracts as well as putting a player's violent actions in relation to another player's willingness to struggle for a ludic outcome. [Nguyen and Zagal, 2016]

In video games there are certain approaches to competition that are considered unethical, as pointed out by Nguyen and Zagal, e.g. ganking, spawn camping or trash talking. Similar concepts are known from sports and are covered by studies about ethics in sportsmanship. [Nguyen and Zagal, 2016]

Nguyen and Zagal propose to work on design patterns that amplify the positive transformation of violence instead of focusing on design patterns to avoid in order to create an ethical challenge, referring themselves to previous approaches of creating design patterns for ethically "good games", e.g. by Staffan Björk [Björk, 2010]. The aim of these patterns should be to strive for developing a "perfect competitive game". [Nguyen and Zagal, 2016]

4.1.5 Design for Surveillance

Being associated with mostly negative scenarios of governmental and economic abuse, surveillance can be a desired and effective ludic element in video games and in their surrounding environments. As Devers and Wilson pointed out, multiple gaming systems offer elements of surveillance within their gaming experience. [Devers and Wilson, 2009]

Devers and Wilson identified two types of surveillance within gaming systems, i.e. participatory surveillance, where players agree to be tracked to a certain extent by other players and mutual surveillance, where the surveillance is bidirectional. [Devers and Wilson, 2009]

Three functions of surveillance in games are outlined by Devers and Wilson:

- Surveillance in Play

  To enhance a shared ludic experience between players, certain surveillance techniques can be used. A webcam is offered by many modern gaming systems to help players engage and communicate in a more explicit manner. Webcams can also be integrated into the ludic context, e.g. a picture that is taken of a player in a specific situation within the game and shared within the multiplayer group. [Devers and Wilson, 2009]

- Complicit Play & Third Places

  The notion for surveillance does not end at play sessions. Players may feel a higher sense of engagement with the game by tracking their online gaming partners which usually happens in online forums and applications. Notifications and status icons can enhance and support complicit play. [Devers and Wilson, 2009]

- Community-Oriented Surveillance

  Surveillance can be embedded with the main aim to build and maintain a community around a certain game. In this case, surveillance helps to lower the participation barrier and the shared information enables players to get to know the individuals of their community better and to thereby strengthen the bond within the group. [Devers and Wilson, 2009]

4.1.6 Human Condition in Games

Doris Rusch claims that games that make use of human condition can enhance their players' understanding of themselves. She presents three devices, that designers can use to incorporate human condition in games: [Rusch, 2009]

- Fictional Alignment

  Rusch claims that aligning game and fiction can help enhance the player's relation to the game. A successful integration of fiction into the game helps players relate the avatar's goals to their own. [Rusch, 2009]

- Procedurality

  Making sense of rules and processes of observations in real life scenarios and making them the basis for a game system can be a powerful tool to elaborate human condition in games. These observations are highly subjective and if presented in an

accessible manner, they help players understand how actions in games work. [Rusch, 2009]

- Experiential Metaphors

  The metaphors used by a designer should evoke recalls of players' real life experience. These metaphors are expressed through a game's aesthetics. [Rusch, 2009]

4.1.7 Appropriateness in Games

There seem to be taboo subjects that are hardly ever covered in games. To bridge this gap, Harrer and Schoenau-Fog investigate the game Jocoi, which deals with loss and grief, by projecting miscarriage into its gameplay. Dealing with sensitive topics in games raises the question of appropriateness, which is a problem that has to be dealt with during the design stage. [Harrer and Schoenau-Fog, 2015]

Harrer and Schoenau-Fog reflect about two paradigms of emotion in games, the stimulus response paradigm and the interaction paradigm. In the stimulus response paradigm emotional messages are transferred from the game to the player with the game as a conveying medium. This model has been seen as too simplistic to deal with a sophisticated topic like emotion, therefore the interaction paradigm has been developed as a counter model, which sees games as a medium to initiate an ongoing dialogue on emotions by player interaction. [Harrer and Schoenau-Fog, 2015]

Jocoi was developed by collecting input from mothers who lost a child and translating it into game elements. To ensure appropriateness, an ongoing dialogue was initiated on how to adequately integrate loss in video games. In Jocoi, the feeling of loss is conveyed by a metaphoric language. [Harrer and Schoenau-Fog, 2015]

Focus group evaluation showed that the dialogical design process with an expert group in workshops aids designers to find a suitable metaphor for taboo issues. The responses by the evaluation group fit the interaction paradigm. [Harrer and Schoenau-Fog, 2015]

4.1.8 Subversive Game Design

Mitgutsch and Weise examined the relation between subverting players' expectations by modifying common design elements and recursive learning. Human learning is strongly based on past experiences that shape how we perceive reality. Based on this principle, gamers are more likely to perform well at a game they have never played before, due to past experiences in other games that can be applied. [Mitgutsch and Weise, 2011]

Examples of common and uncommon design patterns were collected in order to create a new game that incorporated both elements. One difficult aspect was to find a balance between liberty of interpretation through players and giving hints to aid players in comprehending uncommon game mechanics. Mitgutsch and Weise showed that a recursive learning process was achieved by applying uncommon design patterns. [Mitgutsch and Weise, 2011]

Another approach to subvert mainstream game design is a game essay, i.e. a game that provides questions about its own nature or cultural surroundings. Game essays as so-called meta games or games on games are usually non commercial, not complete games, but can be seen as experiments evoking dialogue or discussion. [de Smale, 2016]

De Smale examined *Necessary Evil* as an example of a game essay, where the stereotypic convention of a white male protagonist is made clearly visible. Necessary Evil provides a critical, self reflexive perspective on common game aesthetics by subverting them, making manifested design practices explicit. [de Smale, 2016]

4.1.9 Emotional Design

Design for Affective Gaming

Gillaede et al. propose a collection of techniques for affective gaming, which is called Assist me, Challenge me, Emote me (ACE). Affective gaming is the act of emotive adjusting of conventional games. [Gilleade et al., 2005]

The *assist me* part of the framework consists in identifying a player's causes of stress and frustration and by evaluation adapting gameplay so as to eliminate negative gameplay experiences. [Gilleade et al., 2005]

Challenge me is related to difficulty balancing. Players should always feel challenged while never reaching a state of frustration due to an excessive difficulty level. Difficulty balancing can be done in a dynamic manner, see *dynamic difficulty balancing*, or by providing a wizard or dialog in which the player auto-assesses her gaming abilities. [Gilleade et al., 2005]

The *emote me* principle deals with getting emotions across from the designer to the player. Gillaede et al. propose an adaptation of game content in order to evoke certain emotions, based on the emotional state of a player, which can be obtained by measurements. [Gilleade et al., 2005]

Framing of Affection in Games

Two models for the framing of affection, i.e. the expression of love in games are proposed by Grace in 2017, i.e. a courtship model and a hierarchy of needs approach. [Grace, 2017]

The courtship approach consists of a sociological and psychological field of research. Courtship describes humans' communication of interest in others. The courtship approach considers affection as a part of courtship and therefore, non-digital courtship activities are translated into the video game world. [Grace, 2017]

Maslow proposed the hierarchy of needs in 1943. It consists of five layers that are typically represented as a pyramid, as seen in figure 4.1. [Maslow, 1943]

Grace states that many gameplay aims can be directly mapped to this pyramid. She states that especially in the past, games were mostly concerned with the two layers of

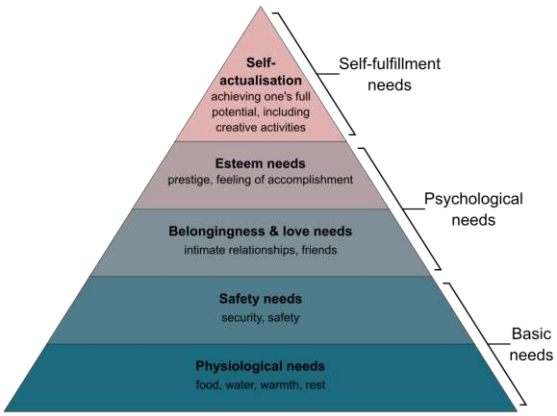

Figure 4.1: Maslow's Pyramid of Needs

basic needs, i.e. keeping avatars alive by collecting resources like food and protecting them against enemies. Within the hierarchy of needs approach, as presented by Grace, featuring affection in games is the logical consequence of the mapping between Maslow's needs and gameplay aims towards the final aim of self actualization. [Grace, 2017]

In an analysis of game distribution platforms (Google Play Store and Kongregate), Grace showed, that affection games were getting more attention within the time span from 2015 to 2017, by comparing search hits for the terms *flirt*, *hug* and *kiss*, as these actions are typical for affection games. [Grace, 2017]

Another way of designing affection in video games is via their interaction dynamics. These contain affection interaction possibilities, either between two in-game characters or between two players in online multiplayer settings. [Grace, 2017]

Emotional Expressiveness

Telling an emotional story requires credible graphical representations of emotional scenes. Seifi et al. propose a painterly algorithm to modify the expressiveness of an avatar's face, merely by changing the composition of colors (see *Use of Color in Games*) and lighting. [Seifi et al., 2011]

Similar to an artist, who transforms context information of a scene on a canvas, the developed algorithm works by being provided with context information and calculates color and lighting information of a scene. The context information consists of the following four categories: [Seifi et al., 2011]

- Geometry

  Information about the position, appearance and movements of facial points.

- Mood

  Information about an avatar's short-term emotions.

- Personality

  Information about individual characteristics, mainly based on facial cues.

- Knowledge

  Information about behavioral rules and stimulus-response association and required actions.

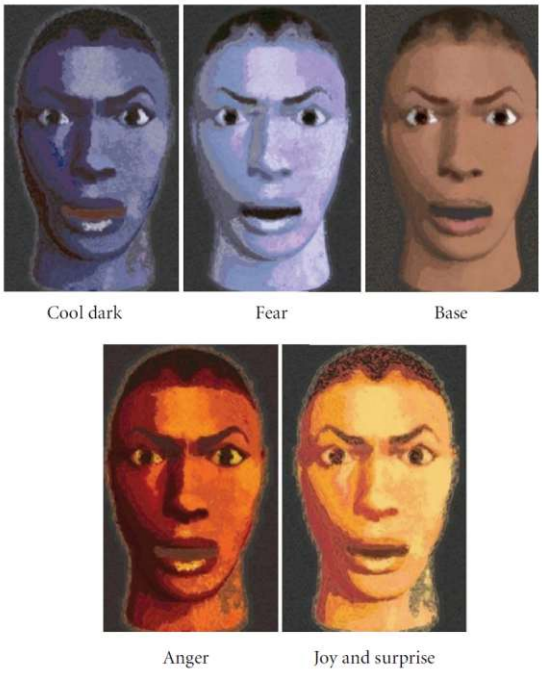

Figure 4.2: Emotional Expressions based on different color pallettes [Seifi et al., 2011]

To provide these parameters, an xml based file format as well as keyframe files are used. Color palettes that were created based on scientific research are then applied to the scene, which aesthetically transmits an emotional expression to the player, as seen in figure 4.2. [Seifi et al., 2011]

Emotional Design through Depth Psychology

Rusch examined how game designers can serve as modern soul guides and create what she calls emotionally resonating experiences for players through a depth psychology perspective. [Rusch, 2018]

This model is based on Rusch's definition of myth as a communication link of what humans think and what humans feel. Myth amplifies messages from our deeper selves through emotional resonance. Rusch describes the necessity of incorporating myth into

games, due to its decreasing presence in other fields, caused by science, religious doctrine or social customs. [Rusch, 2018]

According to Rusch, designers should dig into their deeper selves or consult others in order to create awareness for myths in their games to evoke emotional resonance. [Rusch, 2018]

4.1.10 Persuasive Design

When transmitting a message within a game, designers have to take into account that players build up a psychological barrier against these messages, as pointed out by Kaufman et al. Therefore, messages have to be cleverly hidden in order to circumvent these defenses. [Kaufman et al., 2015]

The embedded design model contains three strategies to integrate a message into game design, so that it has a higher probability to be perceived by the player as designed: [Kaufman et al., 2015]

- Intermixing

  Mix contents with a high degree of message integration with contents with a low degree of message integration, so that the message is not presented in an overwhelming manner.

- Obfuscating

  The usage of framing devices can help, shifting the focus away from the message or persuasive aspect of a game.

- Distancing

  Fiction and metaphors are essential tools for a designer to increase the perceived distance between players' ethical identities and a game's persuasive message.

Svahn proposes a model based on the dual process model to which persuasive games can be mapped. It distinguishes between a systematic and a heuristic approach in games. In the systematic approach, players try to fully understand the game when solving situations, whereas the heuristic approach describes the solving of situations by applying judgment based on previous experiences. [Svahn, 2009]

Within Svahn's model, a game can be mapped to a coordinate in a 3-dimensional space. The x-axis in this space represents the subjective complexity, i.e. if the game is perceived as being easy or difficult. The y-axis presents the above-mentioned distinction between the heuristic and the systematic approach. The z-axis represents the integration of a message into the game, i.e. the factor of persuasiveness in a game. This model as seen in figure 4.3 serves as an entry point for the analysis of persuasive games. [Svahn, 2009]

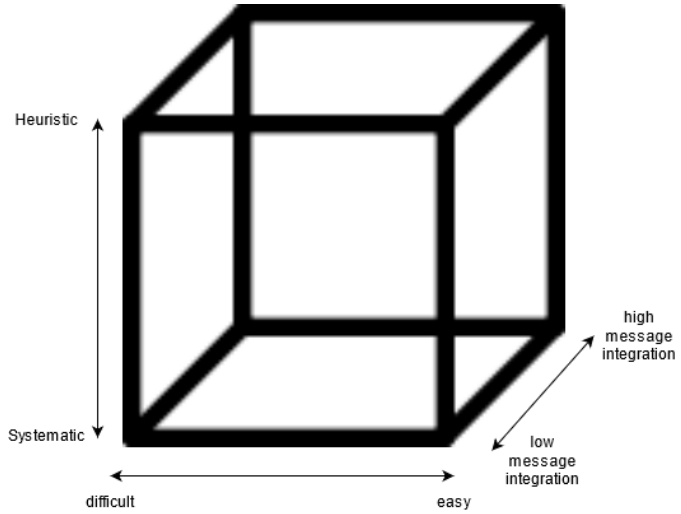

Figure 4.3: Persuasive Game Space according to Svahn [Svahn, 2009]

4.1.11 Nostalgia in Games

Retro games have the ability and arguably the purpose of evoking nostalgic feelings. According to Garda, retro games range from the creation of emulators or remakes of old games for new platforms to the integration of retro styles in new games. [Garda, 2014]

Garda proposes a distinction of two types of nostalgia: [Garda, 2014]

- Restorative Nostalgia

  Even popular games cease to exist at some point as the evolution of hardware is progressing and game console systems or operating systems drop support for old software and games. The main aim of restorative nostalgia is to preserve game artifacts and extend their lifespan by porting them to newer systems. While possibly preserving the cultural importance of game characters and titles, they may be perceived in a different way by newer generations of players. [Garda, 2014] An example of restorative nostalgia are the new *Crash Bandicoot games*, that offer the same game elements as the original game but providing executables that run on the PlayStation 4 and polished graphics.

- Reflective Nostalgia

  As stated by Garda, the aim of reflective nostalgia is borrowing styles or elements from old titles and remixing and reintegrating them into new games within a creative process. An example of reflective nostalgia is Nintendo's series of *Mario* games, that integrates the character and at times his actions and abilities into new games. Reflective nostalgia does not necessarily borrow from games, *Hotline Miami* is an homage to the neo-noir film genre. [Garda, 2014]

Sloan claims that games do not need to have historical references in them to evoke feelings of nostalgia. He states further that nostalgia encourages players' curiosity and assists explorative gameplay. [Sloan, 2016]

Nostalgia is subjective and its effectiveness depends on the situation in which it is perceived. Sloan cites Zhou et al., who claim that nostalgic feelings, e.g. fond memories or remembrance are experienced in a stronger manner when their percipient is in a negative mood. [Sloan, 2016, Xinyue et al., 2008]

Since nostalgia enhances the willingness to explore in many players, it can be used as a tool by designers to support explorative gameplay. Guiding players to think about their youth, by creating a specific mood and setting through scene design (see mise-en-image) can trigger the feeling of nostalgia while playing games. [Sloan, 2016]

4.1.12 Motivational Design

On modern gaming systems, reward systems have become an increasingly popular means of presenting game progress or achieved aims to provide an extrinsic motivation element. Wang and Sun examined reward systems as a main factor for player motivation. In a dual axis model, as seen in figure 4.4, different usages of rewards are presented: [Wang and Sun, 2011]

- Self-Others

  This axis represents whether players use rewards as personal and intrinsic motivation or if they are motivated by sharing and comparing them with others.

- Casual-Progress

  The casual-progress axis represents whether the primary motivation of a player is casual fun or gaming performance.

The *advancement* area covers the usage of rewards to further progress in the game. Examples include items or points to enhance an avatar's abilities. [Wang and Sun, 2011]

The usage of rewards as collections is represented in the *review* area. Players who use rewards in this manner typically like to open and review their collection of rewards. [Wang and Sun, 2011]

The *sociality* quadrant represents rewards as social tools. Styling an avatar for a change of appearance in online play or showing off received achievements are actions associated with this quadrant. [Wang and Sun, 2011]

Players who use rewards in the *cooperate / compete* manner either share with others for cooperative play or keep powerful rewards to have an advantage over others. [Wang and Sun, 2011]

Figure 4.4: Dual Axis Model of Usages of Rewards [Wang and Sun, 2011]

4.1.13 Dynamic Difficulty Balancing

Game designers have to expect that different players with different abilities and properties will play their games. Therefore an inclusive approach is needed to provide a pleasant gaming experience. Game designers therefore seek to normalize the game experience as much as possible, to avoid player frustration or boredom.

Hawkins et al. propose a statistical calculation model to dynamically adapt to the players' ability and willingness to take risks. The proposed model is based on particle filtering and risk profiles for players, in which they claim that risk seeking players need to be provided with higher levels of reward in the game to be satisfied, whereas risk averse players have a more balanced distribution, i.e. they are more easily satisfied with lower rewards and hardly feel less excited for high rewards. [Hawkins et al., 2012]

Particle filtering as a computational model has a significant advantage over other methods when used for real-time processing, i.e. they are low on resource consumption. [Hawkins et al., 2012] It consists of a sequence of Monte Carlo processing and allows for Bayesian probability distributions to be calculated recursively. [Djuric et al., 2003]

Difficulty balancing has been an issue long before research on sophisticated adaptive difficulty was conducted and the required calculations were feasible. As Hawkins et al. point out, the simplest solution a game designer can choose is to delegate this decision to the player. This is usually implemented by providing a difficulty setting and has been a solid standard in games for decades. [Hawkins et al., 2012]

A more elaborate approach is to dynamically adjust the AI's performance according to

the player's abilities. This technique, called *rubber-banding*, has been frequently used in the past, especially in racing games, where the game kept the distance between cars low, tying them together as if they were connected by a rubber band. The adjustments that can be applied to the game usually consist of enhancing or decreasing the protagonist's or the NPC's abilities. As Hawkins et al. point out, these adaptations to gameplay should be applied in a way that is transparent to the player. [Hawkins et al., 2012]

In order to develop a sophisticated difficulty balancing AI, Hawkins et al. developed a rather simple decision making game to gain data to later feed into the system. A 5x4 matrix of squares filled with water, represented by blue dots, was presented to the players, who had to choose which rectangle was filling the fastest. For every execution of the *game loop* there was a certain probability that a new water drop would appear within a rectangle. The target rectangle had a probability of 50%, several squares, called *distractors* filled with a probability of 40% and the others remained blank throughout the game. [Hawkins et al., 2012]

While risk averse players required more evidence, i.e. time to select the target element, risk seeking players were quicker to respond with lower accuracy. The used model contained data of 59 players, i.e. 8000 selections of squares. [Hawkins et al., 2012]

As can be seen in figure 4.5, the decision making process can be modeled using particle filtering with multiple time steps. The number of particles represents the player's ability, i.e. more particles equal more experience based evidence, where each particle represents a hypothesis regarding the target element. Each evidence increment within the game is one turn, in which squares fill with water. The particles at the first stage are distributed more or less equally. After each evidence increment, the distribution calculation is executed again, modifying the particles accordingly. At each state, players have a hypothesized target, i.e. the square with the highest number of corresponding particles. Risk is modeled by a threshold that when exceeded ends the particle filter processing. [Hawkins et al., 2012] A risk seeking player would probably have stopped collecting evidence after the third or fourth time step, with a target probability of 60% or 80%, by choosing the fourth square, which is not the correct target. The threshold of the player model depicted in figure 4.5 is greater than 80%, since the calculation did not stop after the fourth time step.

Knowing the properties of the particle filter model by Hawkins et al. [Hawkins et al., 2012], it is trivial to map ability and risk to parameters that can be controlled by the game designer or, more specifically, by the game *AI*. In order to adjust the player profile to a player's ability, the number of particles can be altered and the willingness to take risk is modeled by the decision threshold. [Hawkins et al., 2012]

Furthermore, Hawkins et al. present how their particle filtering model can be effectively used to alter game properties to normalize ability and risk. They describe the example of a risk seeking low ability player with a mean response time of four seconds and an accuracy of 48%. In order to reach the desired values, e.g. 60% accuracy and eight seconds of response time, the accuracy and the response time have to be raised at the

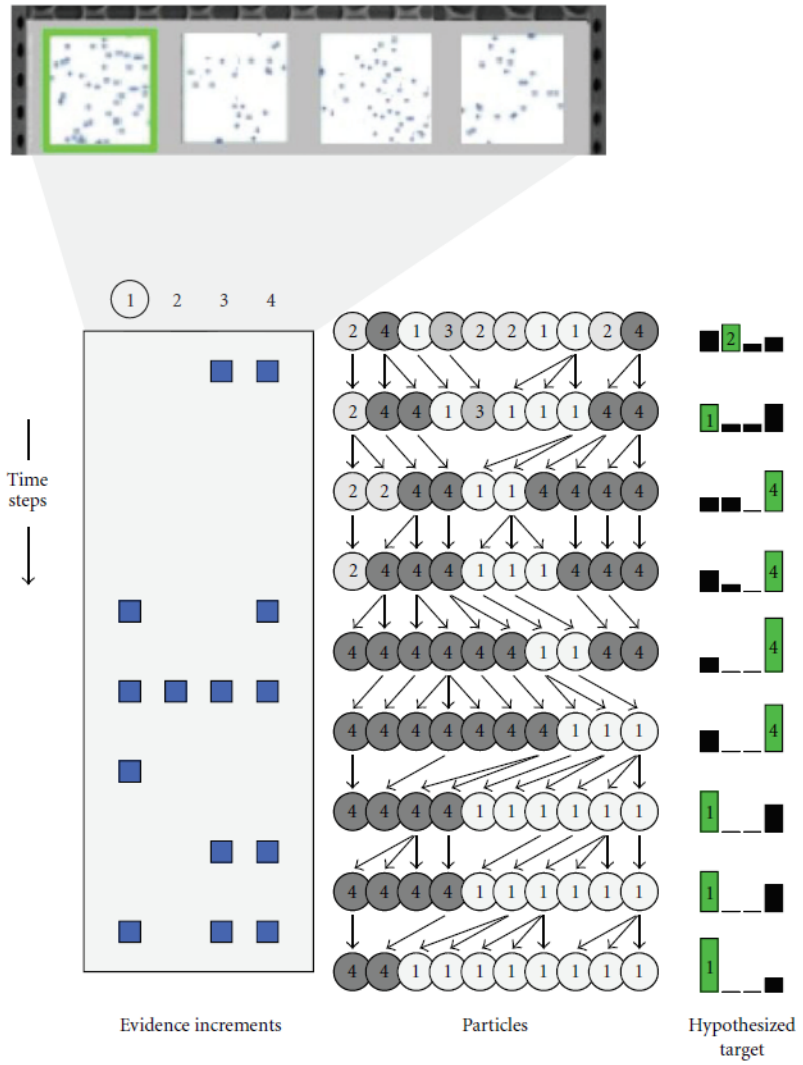

Figure 4.5: Particle Filter by Hawkins et al. [Hawkins et al., 2012]

same time. Consequently, in the example game of Hawkins et al. the adaptive actions would be to reduce the fill probabilities equally for all squares, i.e. lower the game speed, and to increase the difference between the *distractors* and the target element, so that the decision making becomes easier. [Hawkins et al., 2012]

4.1.14 Juicy Design

Juicy design is a buzzword, which is often used within descriptions of appealing properties in games, but lacks a clear definition. Hicks et al. developed a framework with the intention to clarify what juicy design is and how it can be achieved. [Hicks et al., 2018]

The researchers used a methodological approach to create and refine their framework. As a first stage, game designers were asked to provide their inputs on what juicy design is. An analysis of their answers followed, which served as a basis for the first draft of the framework. In the refinement stage, findings were evaluated against games that are considered juicy in order to be able to provide concrete steps towards juicy design that are proven to be effective. [Hicks et al., 2018]

Hicks et al. cited several approaches to define juicy design, stating that all of those are too vague to be effectively used in game development [Hicks et al., 2018]. Schell's book The Art of Game Design: A book of lenses [Schell, 2008a], which is a standard reference for aspects of game design defines "The Lense of Juiciness" [Schell, 2008b], which is primarily based on the feedback that a player is provided with by the interface while playing a game [Schell, 2008b]. Hicks et al. furthermore state definitions that create a connection between juiciness of a game and a good game feel. [Hicks et al., 2018]

In order to get a clearer idea of the common understanding of juiciness, an online survey on juicy design and game feel, separated into two different sections that took approximately 30 minutes to complete was submitted by 17 professional game designers (n=17, 65% male, avg. age 29 years). Before completing the section on juiciness participants were provided with two definitions of juicy design and two animated GIFs, showing the same game scene, once with and once without juicy effects. For the section on game feel, the participants were asked about their own definition of game feel and how to achieve positive and negative game feel. [Hicks et al., 2018]

To gather insight into the vastly diverse qualitative data, the researchers divided the broad pool of answers into statements and clustered them into categories to create an affinity diagram as a visualization of the clusters. The resulting three-tiered affinity diagram serves as the basis for the juicy design framework. [Hicks et al., 2018]

The resulting framework was a checklist of questions of five categories, *game characteristics, direct feedback, slickness, dimensions of experience* and *game state*. In the refinement stage, these questions were evaluated by game designers against known juicy games. The first evaluation game was the popular game *Candy Crush Saga* (see figure 4.6). Each researcher played the game for thirty minutes before answering the framework questions. Within the first refinement stage, the researchers got a better understanding of which elements are essential, which elements had to be refined in their formulation and which elements are too broad or too specific for usage within the framework. [Hicks et al., 2018]

For the second refinement stage the game *Downwell* was used, a 2D action platformer. Within this stage vaguely formulated element's terminology was further refined and non-actionable elements, e.g. impactful feedback was removed, since players determine the impact of feedback. [Hicks et al., 2018]

The final version of the juicy design framework by Hicks et al. contains three categories: *game characteristics, game state* and *direct feedback* and 13 questions that designers have to reflect on when aiming for juicy design. The findings of Hicks et al. include a holistic understanding of juiciness, manifested in the *thematic coherence* section of the framework,

Figure 4.6: Candy Crush Saga Image taken from Google Play Store [King, 2022]

i.e. juiciness cannot be achieved by randomly applying game elements but by putting them into the game context and choosing those that fit into the game world. [Hicks et al., 2018]

The researchers noted that the number of participants in their study (n=17) and their diversity was rather low. Hicks et al. suggest further examination with a broader and larger group of participants that also include perspectives from professions other than game developers. [Hicks et al., 2018]

4.1.15 Playability

As can be seen in presented game concepts, there is a more or less vague but common understanding of what makes a game and what components a game is made of. Leino argues that these are rules, players, goals, challenges and winning conditions and uses playability as an umbrella term. He examined how different components can be purposefully omitted in so-called *Art Games*. Naming several examples, e.g. the walking simulator Proteus.

Leino states that omitting playability in a game, mostly leads to it being a mere interactive installation, as can be frequently seen in museums or can become an in-joke with a short life cycle for gamer communities. Leino furthermore claims that games with an artistic focus, or so-called *Art Games* need to have what he calls playability in order to be classified as video games. [Leino, 2014]

4.1.16 Abstraction in Games

Jesper Juul frames abstraction as a concept that serves three purposes: [Juul, 2007]

- Abstraction as a Core Design Element of Video Games

  According to Juul, game design can be described by the degree of abstraction of in-game actions. In case of a jump, this can be either one action, or a sequence of flexing leg muscles, squatting and releasing by raising the arms to direct the energy

upwards. Depending on whether the game maps a jump to the press of a button or to a sequence of actions, different actions can be executed by the player, i.e. the level of abstraction determines what the player can do. [Juul, 2007]

- Abstraction as an Element that has to be Decoded

  The game titles within a genre have certain game elements in common. Experienced players are able to decode the in-game abstractions more easily than inexperienced ones, e.g. experienced players of platform games are more likely to identify obstacles that have to be avoided, due to a skill level of abstraction decoding that they built over time. [Juul, 2007]

- Abstraction as Player Optimization

  Juul furthermore states that abstraction may be a result of strategy optimization. Players who want to progress within a game and reach proficiency start to abstract the fiction of a game by focusing merely on the main dynamics in order to develop a winning strategy. [Juul, 2007]

4.1.17 Critical Design

Critical design can be understood as a counter concept to affirmative design, which enhances manifestation of common design principles. As such, the aim of critical design is to evoke thought processes in which players question these principles. [Barr, 2016] This can be achieved with what Anthony Dunne refers to as *constructive user unfriendliness* within the category of *(in)human factors* of design [Dunne, 2006]. Barr furthermore quotes Bardzell and Bardzell, who define properties of critical design: "the ability to shift the perspective of the audience, a speculative or subjective nature, a dialogic methodology, encouragement of skepticism and sensitivity in interpretation, and reflexive awareness of limitations" [Barr, 2016, Bardzell and Bardzell, 2013]. As Barr pointed out, the principle of critical design has already been ported to videogames within the scope of usage as well as theoretical analysis [Barr, 2016].

4.1.18 Adversarial Design

As a subcategory of critical design, adversarial design also has the main aim to encourage thought processes in its artifact's consumers. Adversarial design however focuses on political issues by conceptualizing, producing and experiencing products, as Carl DiSalvo points out. According to DiSalvo, applied adversarial design consists in reconfiguring the remainder, which means creating new connections between standards design and technical practices to highlight hidden aspects. [DiSalvo, 2012, Barr, 2016]

4.1.19 Risk in Games

Brian Schrank claims that it becomes increasingly difficult for individuals to deal with risks, due to a tendency to avert risks wherever possible. At the same time, risk becomes

more global, i.e. not bound to spatial parameters, and includes more unknown factors, therefore it is impossible to be controlled and only to be minimized. Schrank claims that not only within society but also within the scope of contemporary games the exposure to danger, injury or loss is not present anymore. [Schrank, 2016]

The design goal to face risks in games was incorporated into his game *Bust a Cup*, where players have to protect a cup, while a hammer and a chain can be used to destroy the opponents cup, which leaves players vulnerable to physical injuries. [Schrank, 2016] Games often take place within the secure boundaries of a sandbox defined by the game itself. Furthermore, the aspect of savable game states even reduces the risk of losing game progress. Schrank compares his game to the traditional duel, where, if analyzed as a game, risk was an obvious driver in its gameplay [Schrank, 2016].

4.1.20 Ambient Gaming

The idea of ambient games is based on Brian Eno's description of ambient music, that must be as ignorable as it is interesting. [Richardson, 2002, Eyles and Eglin, 2008] Eyles and Eglin explore how Brian Eno's vision can be incorporated in video games, regarding design, production and technology. As Eyles and Pinchbeck stated, ambience in games make the boundaries of a game and the real world blur. [Eyles and Pinchbeck, 2012] The commitment of time and learning capacities is a shared attribute of most games, as Eyles and Eglin point out. Different games require different levels of commitment, the strategy game Civilization and the word guessing game Hangman are mentioned as two extremes along the scale of commitment, where Civilization has a steep learning curve that requires lots of the player's attention whereas Hangman is easy to learn and to get used to for new players. Another property that most video games have, is that players are limited in the playing locations, as many game consoles as well as computers are difficult or impossible to move around while playing a game. Pervasive games may allow players to move around more freely, often however demanding a certain amount of movement from the player. As Eyles and Eglin point out, one key component of ambient games is that players can choose their level of commitment and movement themselves. [Eyles and Eglin, 2008]

Progress Quest is mentioned as an example for a game with next to no necessary player actions, but the game has to be actively started by players in order to function, which is already too much conscious interactions to classify as an ambient game according to Eyles and Eglin. In order to remove this interaction, the researchers claim that an actual ambient game would have to run itself. Collected real-time data can be used as an input, so moments of inactivity provide enough data for the game to run itself, whereas conscious actions actively influence the progress of the game, therefore creating direct player involvement. [Eyles and Eglin, 2008]

It is important to point out that just like other games, ambient games provide players with a framework of rules. Goals can be individually defined and differ from player to player. An essential paradigm in ambient games is that the gameplay is in an idle state,

waiting for the player to interact with it. Eyles and Eglin consider this pull instead of pushed technology, since players have to actively interact with game information to perceive it, instead of getting it pushed at them. [Eyles and Eglin, 2008]

The actual implementation of an ambient game either requires players to carry ambient gaming devices with them or requires the game to be seamlessly embeddable into the player's surroundings. Either option must be unobtrusive to allow players to completely ignore the game. An ambient game's purpose is to create a mood in an environment. Eyles and Eglin claim that ambient intelligent environments ideally fulfill the prerequisites of ambient games. Although gaming in the environment is currently dominated by Augmented Reality (AR) integrations in games, current implementations are too obtrusive to be used within the confines of ambient games. [Eyles and Eglin, 2008]

Eyles and Eglin see the potential of ambient games not only as entertainment driven but also in more serious contexts as so-called ambient utility games. The researchers point out the necessity of conducting further research to evaluate their potential to modify their players behavior and locate use cases in the increase of productivity of their players and the improvement of repetitive tasks. Other use case examples from positive computing are mentioned, e.g. promoting healthier lifestyles. [Eyles and Eglin, 2008]

In later work of Eyles and Pinchbeck ambience in games was examined based on three ambient games. In *Ambient Quest: Pedometer*, players control the movement of an in-game character by the number of steps of their movement in the real world. The measurement was implemented by a pedometer that could communicate with the game. As Eyles and Pinchbeck pointed out, a GPS Tracking device, e.g. a smartphone, would be the better solution, but when the first part of the study was executed, smartphones were still very expensive and therefore rare. The player's commitment in *Ambient Quest: Pedometer* is dynamic, i.e. the game is still active when the player shows no engagement at all and commitment can change over time. [Eyles and Pinchbeck, 2012]

After incorporating feedback from the first part of the study, the *Ambient Quest: Pedometer* game was further developed and a new study was conducted and a second round of qualitative player feedback was collected. For the third study an entirely different approach was chosen, where the connection between the game and the real world is established via RFID tags that players carry around with them. Furthermore, a more elaborate story line was implemented. The researchers called the game *Ambient Quest: Pirate Moods* [Eyles and Pinchbeck, 2012]

The first version of *Ambient Quest: Pedometer* was presented at a games conference and the researchers noted that visitors who were handed a pedometer to interact with the game did change their real world behavior, e.g. some participants of the feedback round declared, that they would walk to the conference instead of using other transportation means to see the in-game effects. [Eyles and Pinchbeck, 2012]

For the second version of *Ambient Quest: Pedometer* enhancements regarding graphical representation of the game and data entry control were made. After the main feedback topics were improved, broader and more complex themes emerged within the second

study, e.g. use of equipment, cheating (players figured out that by shaking the pedometer the in-game character would move very quickly) or general game complexity. [Eyles and Pinchbeck, 2012]

Eyles and Pinchbeck noted, that the players' perception of *Ambient Quest: Pedometer* varied a lot, depending on whether they considered a short period within the game or the game experience as a whole. This is also caused by different granularity of players' objectives. Short term objectives include completing an in-level quest, medium term objectives include completing a level and long term objectives include completing the game. [Eyles and Pinchbeck, 2012]

The aim of the third study, including the game *Ambient Quest: Pirate Moods*, was not primarily to further refine feedback from the second study but to verify that findings from the first two studies would be applicable in another context, i.e. in a completely different ambient game. In *Ambient Quest: Pirate Moods* an octagon shaped system of panels with mounted posters and RFID readers is constructed and when players' RFID tags establish a connection with one of the readers, an in-game action is triggered, i.e. resources for pirates are collected. One of the panels has a mounted monitor for players to get feedback on the in-game state and game behavior. The game's aim is to move around the octagon and thereby collect resources according to the need of the in-game pirates to improve their mood. [Eyles and Pinchbeck, 2012] In the ambient context it is important to state that RFID tags need to be carried visibly so that the reader picks up their signal in any case, whether players actively want to interact with the game or when ignoring it.

4.1.21 Ambience in Games

Based on their findings and collected data, Eyles and Pinchbeck created a schema for ambience in games, see figure 4.7: [Eyles and Pinchbeck, 2012]

As can be seen in figure 4.7, the ambience in games schema consists of processes and a game state, containing player activities and game elements that are connected by arrows, that represent a "drives" relationship, e.g. discovery drives player invention and player engagement. The aforementioned elements are coupled within the bounding context. [Eyles and Pinchbeck, 2012]

The context is strongly dependent on player properties, e.g. emotions or experience. Considering the above-mentioned ambient games, also the play location and time affect the elements within the context. [Eyles and Pinchbeck, 2012]

Discovery can be either pre-coded, i.e. discoverable game elements invented by the game designer or player constructed, i.e. game aspects that players discover for themselves, that are highly individual, sometimes unforeseen by game designers and often discovered by coincidence. [Eyles and Pinchbeck, 2012]

As the game's discovery progresses and players start knowing the game behavior well, player invention starts, which is the process of players who design their own activities

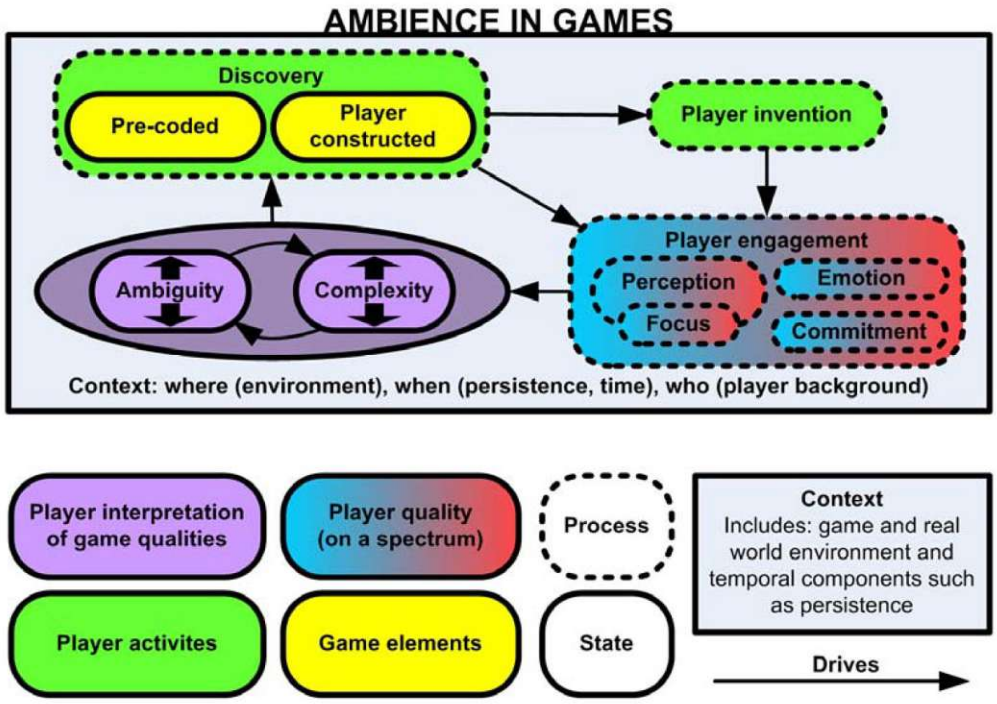

Figure 4.7: Schema for Ambience in Games by Eyles and Pinchbeck [Eyles and Pinchbeck, 2012]

and play the game in their own way. [Eyles and Pinchbeck, 2012]

Inventing actions and evaluating them within play requires focus, therefore invention drives perception, emotion and commitment and focus, i.e. player engagement. Ambiguity and complexity are part of the game state, i.e. properties incorporated into the game. Player engagement is required to observe the game state. Ambiguity in games means that a game and in-game components, e.g. rules, can be interpreted in different manners, i.e. players make their own individual rules. Complexity on the other hand may be experienced either by game difficulty or by game unpredictability. It is important to state that ambiguity as well as complexity change over time. A high complexity can prevent a low level of player engagement, therefore Eyles and Pinchbeck propose a low level of complexity for ambient games. Complexity was a concern for testers of the *Ambient Quest: Pirate Moods* game, with one player stating that lacking complexity prevented a long term engagement. Consequently more engagement triggers more ambiguity which quests for more complexity. Therefore complexity and ambiguity are coupled and drive player discovery through engagement. [Eyles and Pinchbeck, 2012]

Eyles and Pinchbeck consider the ambience in games schema a suitable pragmatic framework to assess which type of player experience is offered by a game, especially when designing for the ambient game genre. Furthermore, it will help gaining knowledge about

the current state of ambience in commercial games. [Eyles and Pinchbeck, 2012]

4.1.22 Playfulness

While playing video games is usually a ludic activity, there can be elements of paidia or layers in the interaction between the player which allow for playful experiences.

Engeli distinguishes between three types of meaning concerning games: [Engeli, 2005]

- Meaningful Play

  Games have to convey meaning in themselves in order to enable players to experience gameplay. This meaning is bound to the timely interval of a game session. [Engeli, 2005]

- Meaning beyond Play

  Meaning that persists after the game session has ended, e.g. reflecting about game meaning afterwards is summarized under the umbrella term *meaning beyond play*. [Engeli, 2005]

- Creatively added Meaning

  Certain games allow for modifications through their players, which range from exchanging sound tracks and effects to sophisticated mods. [Engeli, 2005]

Engeli presents game modifications as a learning process in art and design which provides another layer of meaning for players, which is comprised of the creation process itself as well as the evaluation of created content. Engeli frames this process by introducing the term *playful play*. [Engeli, 2005]

Ferri et al. analyzed urban play as a playful interaction modality with the players' surroundings, similar to the above-mentioned concept of playful play. An emerging genre of spatial planning and designing in games allows players to develop a feeling of agency and awareness towards their places of residence allowing them to interact with their cities in a playful way. [Ferri et al., 2016]

4.1.23 Disruptive Game Design

Peter Howell proposes a framework for schematically disruptive design, i.e. guidelines to disrupt players' expectations and produce gaming experiences, in which it is not sufficient to solely apply previously gained gameplay experiences. Claiming that modern games rely on the gratification principle, Howell states that the amount of help players get in games has been increasing lately. [Howell, 2011]

While not being unfair to the player, as opposed to e.g. abusive game design, the design aim of disruptive games is to provide players with consistent cognitive challenges. Research on this framework has been executed by applying disruptive elements into a

commercial game to collect accurate real world data. The aim of Howell's framework is to combine alienating moments, e.g. an enemy, who does not lose energy when attacked, but can only be destroyed by other, non intuitive means, with classical concepts, like an extensive feedback loop. Critical design principles that must not be broken in disruptive game scenarios are presented. [Howell, 2011]

4.1.24 Economic Design

From Subscriptions to an Item Selling Based Payment Model

It is safe to say that freemium games with in-game monetization models are manifested within the current video game landscape. The continuous hosting and maintenance of web servers for online gaming induced the development of business models that ensured a constant stream of income after distributing the game.

In 2007, Oh and Ryu conducted research on reasons for the rapid decrease of subscription payment models in favor of item selling based payment models. In 2006 the majority of online games were still based on subscription models, usually with fees around 15 USD per month. Oh and Ryu named World of Warcraft as a very successful game following this business model. [Oh and Ryu, 2007]

Accessibility is a major limitation of the subscription business model, since it excludes players from entering other games that they do not own a subscription for, as stated by Oh and Ryu. Furthermore, monopolization in the field of subscription based online games led to competitors having to provide discounts on their services up until the point where pivoting to the novel business model of item selling became more profitable. [Oh and Ryu, 2007]

One of the distinct features of item based selling models are the conversion of real world currency into an in-game currency. Oh and Ryu state, that this conversion aims to enable different payment routes, as the acquisition of in-game currency can also be embedded into a reward system. [Oh and Ryu, 2007]

Creating Product and Brand Awareness in Games

Herrewijn and Poels examined the effectiveness of in-game advertisements in relation to players' experiences. The research aim was to verify that previous findings, that prove a strong relation between the recipient's emotions and the effectiveness of advertising in other media formats, also apply for in-game advertisements. [Herrewijn and Poels, 2011]

99 participants played a video game with in-game advertisements and billboards placed within the game world, that was specifically designed for this study, in an uncontrolled environment. After finishing a game session, they answered a survey regarding their emotions and experiences. In addition players were asked to specify which products, brands and billboards they remembered. [Herrewijn and Poels, 2011]

Data regarding emotions and experience were collected by standardized means, i.e. in-game Game Experience Questionnaire (iGEQ) and Self-Assessment Manikin (SAM). Based on prior research, providing a mapping between game difficulty and player experience, Herrewijn and Poels could verify that easier games will lead to better brand recognition. In advance, a positive relation between low difficulty in games and brand likeability could also be confirmed. [Herrewijn and Poels, 2011]

Developer Ethics in Freemium Games

Jordan et al. examine common free-to-play or freemium practices and their effects on gameplay. Among those practices, constantly redefining game rules is presented as a problematic issue, as it is taking agency from the player and thereby interfering with the magic circle. [Jordan et al., 2016]

Freemium games are usually accompanied by a direct and immediate rewarding system, that can be enhanced, i.e. amplified, by micro-payment transactions, as pointed out by Jordan et al. Furthermore, they explicate, that this creates an unfair competition situation, since players who do not participate in micro transactions are systematically discouraged and usually unable to compete with others. Another issue, that Jordan et al. point out, is that calculations of real money transactions are frequently interfering with the players' gaming experience. [Jordan et al., 2016]

Observing freemium games, using two qualitative methods, Jordan et al. constitute, that developers are capable of shifting power relations in order to benefit paying players. It is stated that implicit contracts between game designers and co-creators regarding monetization by gameplay are not comprehensible for players which results in a disruption of the magic circle. Being part of the magic circle, developers have the ethical duty to avoid questionable and aggressive economic strategies in game design. [Jordan et al., 2016]

Effectiveness of Real Money Trade in MMORPGs

Park and Lee state that Massively Multiplayer Online Role-Playing Games (MMORPGs) differ from games of other genres, because extending and enhancing the own character is a type of fun, incorporated into this kind of games. In terms of flow theory, this means that the narrative of MMORPGs include the collection of items and corresponding challenges where they can be used in order to provide players with intrinsic motivation to progress in this matter. [Park and Lee, 2017] The importance of economic design and game marketing in MMORPGs is reflected by them being among the strongest driving forces of the game market within the last few years. [Statista, Inc., 2018, Wang and Yu, 2017]

After observing data of the Korean MMORPGs market regarding game time and real money item trades for four years Park and Lee state that this business model does not suit each game in the same way. It is supported by the observed data, that real money trades are perceived as more likable in MMORPGs, that have a more flexible narrative

structure. The explanation for this observation, given by Park and Lee, is that players who quest for achievements and immersion prefer games with a more predetermined narration and mainly dislike real money trades. [Park and Lee, 2017]

Wang and Yu used a mixed methodology based on self-reported and game metric data to map players' value systems to player attributes, among others the willingness to spend real money while playing a MMORPGs game. Building on the value model of Graves [Graves, 2005], the value type of the model that applied most to each player was determined by a self-assessment questionnaire. Wang and Yu recruited 1.577 participants within the game Ghost II to take part in the study. By examining in-game behavior data in relation to players' value type, Wang and Yu statistically proved a strong correlation between the red value category (i.e. egocentric and self expressive) [Graves, 2005, Wang and Yu, 2017] and in-game consumption. These players' motivated demands are fulfilled by leveling up of avatars' abilities and optical appearance quickly, which goes along with a higher level of consumption, i.e. real money trade. [Wang and Yu, 2017]

4.2 Design Process

4.2.1 Ideation

A study conducted by Hagen in 2009 is aiming to clarify how game ideas are created. Based on interviews with four Swedish game developers regarding 25 games they developed Hagen provides four domains, each with multiple sources: [Hagen, 2009]

- The Game Domain

  Ideas that are based within the game domain itself are taken from a game genre or a different game. [Hagen, 2009]

- Narratives and Visual Art

  Ideation that is based on the domain is borrowing from other media types, e.g. film or theater. [Hagen, 2009]

- Human Activities

  Human activities may serve as a source for game design ideas, e.g. in the form of a sports game. [Hagen, 2009]

- Human Technology and Artifacts

  Game ideas based on this domain have their roots in history or technology. [Hagen, 2009]

Ideation Tools

Several tools and techniques have been developed in order to aid designers to come up with exciting new ideas and avoid repetition. An ideation tool that is developed or

adjusted to a certain need or situation accelerates ideation, enhances its quality and suitability for the given requirements. [Kultima and Alha, 2011]

One such design tool is VNA cards, where three categories of cards are presented to the game designer. The designer withdraws a card from each category, getting a verb, a noun and an adjective as a source for ideation. Consequently, a game design idea has to be developed, based on that source. As analyzed by Kultima and Alha, this method is highly effective for developing theme-related and interesting ideas. [Kultima and Alha, 2011]

Wetzel et al. present a similar ideation tool focused primarily on mixed reality games but usable also for other game genres or media types. Analogously to the VNA ideation tool, game designers are presented with three mixed reality game cards, representing an opportunity, a question and a challenge that has to be incorporated into the game design idea. For theme-related contexts, additional theme cards may be used in the same manner. [Wetzel et al., 2016]

A different approach for collaborative and iterative ideation is the Design Box, as presented by Altizer and Zagal. In this ideation technique, game designers are presented with random design constraints and have to pitch a game idea with the aim to present a convincing concept. The box geometry with its four sides is used as an analogy for four design constraints, e.g. technology, aesthetic, audience and play/question/theory. Within several pitching iterations, these design constraints' specification becomes clearer, making design ideas more concrete until they can be used to be implemented as a game. [Altizer and Zagal, 2014]

4.2.2 Prototyping

Manker states that the main aim of a prototype is effective negotiation between stakeholders. Based on the concept of rhetorices partes within the academic field of rhetorics, Manker distinguishes between six stages within the negotiation process: [Manker, 2011]

- Intellectio

  The planning stage.

- Inventio

  The preparation and prototype definition stage.

- Dispositio

  The structuring of the prototype.

- Elocutio

  Development of the prototype.

- Memoria

  Documentation stage, where conclusions are drawn from the prototype.

- Actio

  Active usage of the prototype.

According to Manker, drawing parallels between game prototyping and the theoretical model of rhetorics may have a beneficial effect on game development in practice. [Manker, 2011]

4.2.3 User Centered Design

In 2003, Pagulayan et al. state that user centered methods are underrepresented in game design and advocate for an incorporation of classic business software development process into game development. [Pagulayan et al., 2003] As Sotamaa pointed out in 2007, there has been an increasing interest in slightly adapted user centered design methods for games, usually framed under the term player centered design. [Sotamaa, 2007]

Participatory Design

A paradigm that goes beyond applying classic user centered design methods is participatory design. Supporting game modifications created by players is one of the measures game designers can apply to deliver a personalized gaming experience or to add game elements that extend the game design scope (see 4.1.3).

Furthermore, participatory design aids to incorporate social and cultural contexts into a game, e.g. when designing for a certain target group. In a study conducted by Lochrie et al. a mobile game for a digitally excluded target audience was developed applying participatory design. [Lochrie et al., 2011]

As Lochrie et al. point out, knowledge of user characteristics of the target audience as well as a clear definition of the motivation for applying participatory design are beneficial towards reaching the desired final outcome. In the above-mentioned study by Lochrie et al. players' design input was continuously collected, ranging from the development of a game concept and creating mock-ups to playtesting and giving feedback on prototypes. [Lochrie et al., 2011]

Lochrie et al. state that in order to achieve effective participatory design results, a base of trust has to be established between the game designers and the involved community. [Lochrie et al., 2011]

Affective User Centered Design

In 2014, Ng and Khong examined the usability of two Human Computer Interaction (HCI) principles affective design and user centered design in a game design context,

subsuming their findings under the umbrella term affective user-centered design. [Ng and Khong, 2014] As pointed out by Ng et al. integrating player affection into game design plays a key role in the interaction experience between player and game interface. Affective user-centered design has the aim of focusing on a player's affective state by applying user centered design methods. [Y'ng et al., 2018]

In an evaluation of affective user-centered design methods published in 2018, Ng et al. presented a framework of fifteen recommendations for a successful implementation of affective user-centered design. [Y'ng et al., 2018] An in-depth analysis of each recommendation or design element for affective user-centered design is beyond the scope of this scoping review, one key principle when designing for player affect with this method however is to obtain a deep knowledge of players' needs beforehand to account for inevitable biases throughout the design phase. [Y'ng et al., 2018]

The Relation Between Player and Designer

Sotamaa distinguishes between five different relations between players and designers: [Sotamaa, 2007]

- Designer as Player

  According to Sotamaa, game design proficiency is based on the designer's personal gaming experience. Playing a wide variety of games of different genres helps designers draw inspiration. Relying too much on individual player experience when creating a new game however can result in a lack of creativity and genuineness. [Sotamaa, 2007]

- Player as Designer's Muse

  Players may serve as a main source of creativity when designing a game. In this case, an artifact is designed towards an imaginary target audience. Designers should be aware that their target audience might remain too abstract and idealized throughout the design process. [Sotamaa, 2007]

- Player as Designer's Patient

  This relationship is based on the observation of gameplay sessions. Designers collect data of the interaction between players and a certain game while focusing primarily on an analysis of the problems players encounter to create a diagnosis of how the situation can be improved. As Sotamaa points out, this relationship resembles a doctor patient relationship. [Sotamaa, 2007]

- Player as Designer's Advisor

  In this relationship players' feedback plays a major role within the design process. This can be achieved by applying methods of user centered design and participatory design (see 4.2.3 and 4.2.3). One method which is explicitly emphasized by Sotamaa is the use of focus groups. [Sotamaa, 2007]

- Player as Designer

  Giving players the opportunity to modify game content can be a means of engaging players and providing them with agency (see 4.1.3). This relationship blurs the lines between creators and consumers. [Sotamaa, 2007] As Füller et al. point out, advanced software tools provide a large audience with the ability to create video games, since programming skills are no longer needed, enabling creators to design games as a form of self expression with unique and individual games as a result. [Füller et al., 2005]

4.2.4 The Model of Designing by Lawson

Game development and designing processes are not necessarily bound to game design specific methodologies, frameworks or norms. Scholars and game designers have been purposefully applying classical design thinking techniques within a computer game design context. Holopainen et al. published an article where a video game was analyzed using Lawson's model among others [Holopainen et al., 2010].

In Bryan Lawson's book "How Designers Think: The Design Process Demystified", he names five groups of activities and skills that are essential for his model of designing where each is needed for a successful outcome: *formulating, moving, representing, evaluating and reflecting.* [Lawson, 2006]

Formulating

Formulating covers the understanding and communication of a design problem. According to Lawson this skill quests for advanced designing experience and consists of two different stages. The *identifying* section of formulating describes the process of structuring wicked problems, where a designer is able to name an abstract problem by making it explicit. The *framing* section is more of a technique than a skill, where the identified problems are looked at from different perspectives, called frames, so that different viewpoints are included into the design context, while temporarily excluding different problems that are outside of the current frame's scope. Contradictions in specifications and affordances can then be negotiated. [Lawson, 2006]

Moving

The process of moving or making design moves includes the creation of design solutions. These solutions may consist in a whole new concept for a given design problem or a refinement of an already existing solution. As a first approach to making a design move, it is common to create primary generators, which are early design solutions, that were created before the process of formulating is completed, i.e. at a time when the problem is not yet completely understood by the designers. The aim of moving is to lower the distance between the design problem and a form that can be realized as an artifact, therefore moving these two states closer together. [Lawson, 2006]

Representing

Lawson describes that in practice design problems are almost always externalized, i.e. documented by descriptions, sketches, models or other kinds of representations. These representations serve as inputs for the thought process. Apart from visualizing abstract design problems, they also enable designers to rearrange different externalizations to gain insights from other perspectives. [Lawson, 2006]

Evaluating

When it comes to evaluating design it is tricky to make judgments about what good and bad design is, since there are no common metrics to describe the quality of design. This task quests for particular tools for every designer that incorporate subjective and objective evaluations. According to Lawson it is critical for good design to know when and how to evaluate, especially when working in groups. [Lawson, 2006]

Reflecting

As Lawson points out, there is a distinction between two types of reflection, *reflection in action* and *reflection on action*, where the former consist of a combination of the above-mentioned categories with constant focus on design problems and tasks. The latter describes a critical reflection of the design process itself. [Lawson, 2006]

4.2.5 Three Levels of Abstraction by Löwgren and Stolterman

As stated by Holopainen et al., similarly to Lawson's Model of Designing, the design model by Löwgren and Stolterman also includes externalizations of abstract design problems to approach gradually more concrete descriptions [Holopainen et al., 2010], but its three stages of design are focused more on the states of the artifact instead of the designer's tasks.

Vision

According to Löwgren and Stolterman a design process starts out as a vision, which is created by designers when they are first exposed to the given problem. Design experience helps to create visions at earlier stages, since often similar problems can be solved by similar solutions. A vision is the first organizing principle towards a solution, but should be formulated in an abstract manner. [Löwgren and Stolterman, 2004]

Operative Image

Operative images are explicit forms of visions. While the first operative images are usually very diffuse, over the course of the design process they get more explicit as the understanding of the design problem enhances. Löwgren and Stolterman describe the relation between the vision and the operative image as a dialectical play, since

developments in one of them emerge progress in the other. [Löwgren and Stolterman, 2004]

Specification

The specification is the least abstract state of the design process. After the above-mentioned dialectical play between vision and operative image, the externalizations get gradually more explicit and ultimately the operative image can be translated into the specification of the final design. [Löwgren and Stolterman, 2004]

4.2.6 Modelling Experimental Game Design

Holopainen et al. used the design models by Lawson as well as Löwgren and Stolterman to analyze and examine the design process of an experimental game. The researchers collected documentation of the design process and created a mapping according to the different stages of the design models. For the particular game, called NOCSH, that was examined by Holopainen et al., the researchers decided that a coding according to the levels of abstraction by Löwgren and Stolterman does not provide enough insight, since the large amount of documentation in the operative image space led to a major disproportion. [Holopainen et al., 2010]

Holopainen et al. claim within their analysis, that even seemingly unstructured design process can be mapped to design models, for example the ones provided by Lawson as well as Löwgren and Stolterman, which give insight into the applied practices and a better understanding thereof as opposed to traditional linear or iterative approaches. The researchers state that, while not being aware of these models, they can help designers of experimental games to raise awareness on their own design methods. Holopainen therefore advocate applying design models to game design processes due to the enhancement of design practice awareness. [Holopainen et al., 2010]

4.2.7 Modelling, Communicating and Documenting Game Behavior

Araújo and Roque consider visual communication an essential part of software design, including game design. The use cases of visual representations in the design process include the identification of use cases, modeling the transitions between screens, defining sequences of events and representing relationships of actors. Visualization in form of diagrams are essential in design processes with multiple actors, since natural language is difficult to review and to understand. The researchers state that game system modeling practices are strongly limited, proposing petri nets as an alternative to solve common issues in game modeling. [Araújo and Roque, 2009]

Multiple sources quoted by Araújo and Roque indicate that visual communication is very common in game design, including the modeling of flow (i.e. state transitions, not the psychological flow experience introduced by Mihály Csíkszentmihályi). UML and flowcharts are among the common visualization standards for game design, both

of which seem unable to completely fulfill the modeling requirements for game design as pointed out by Araújo and Roque. [Araújo and Roque, 2009] One approach based on a series of diagrams in UML notation was presented in 2009 by Montero-Reyno and Carsí-Cubel. [Montero-Reyno and Carsí-Cubel, 2009]

The UML standard consists of several diagrams for the modeling of different perspectives on the same system. The second version of UML consists of 13 diagrams within six groups. Araújo and Roque state that each of these diagrams serve a different purpose and to get an overview of a UML modeled game system, multiple UML diagrams have to be understood by the involved designers and developers and the missing of formal semantics and their complexity hinder model analysis and validation. [Araújo and Roque, 2009]

Flowcharts, like decision trees, can be used to model transitions like player decisions and triggered game behavior. Araújo and Roque do however not consider them the best game state modeling option, due to their lack of support for concurrent systems. For events that happen concurrently, a separate model is needed to cover every possible case. [Araújo and Roque, 2009]

Consequently Petri nets are proposed by Araújo and Roque as an alternative that provides a unified modeling language for multiple purposes and concurrency support. As a mathematical and graphical modeling method, Petri net models enable static analysis of modeling problems, e.g. deadlocks and starvation in concurrent systems. [Araújo and Roque, 2009]

Petri nets consist of four basic graphical symbols, places, transitions, arcs and tokens. Figure 4.8 shows all of them, the circles being places, the gray square is a transition, the arrows are called arcs and the black dot in the place P1 is a token.

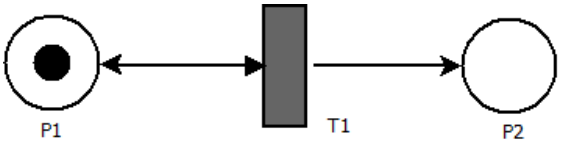

Figure 4.8: Petri net with two places and a transition

To transition T1, place P1 is the only input, which is indicated by the arc (incoming arrow). Since all inputs have tokens, the transition T1 can fire and create tokens at the output places P1 and P2. The visualized state after T1 has fired can be seen in figure 4.9.

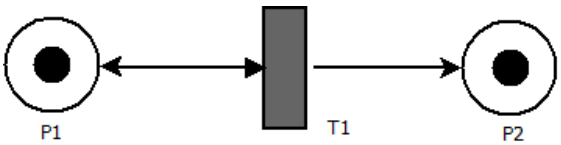

Figure 4.9: Petri net of system after T1 of Figure 4.8 fired

Since the condition for the firing of T1 (all inputs have tokens) is fulfilled again, T1 could be executed a second time at this stage. [Araújo and Roque, 2009]

Araújo and Roque present several extensions to the original Petri nets that enhance the functionality of the modeling language, e.g. inhibitor arcs (represented as arcs with a dot instead of an arrow), that can trigger transitions without a token, reset arcs (represented as dashed lines), that clear all existing tokens upon transition firing or weighted arcs (represented with the number of the weight in parentheses), that require multiple tokens from the connected place. All of the mentioned extensions for Petri nets are visualized in figure 4.10. [Araújo and Roque, 2009]

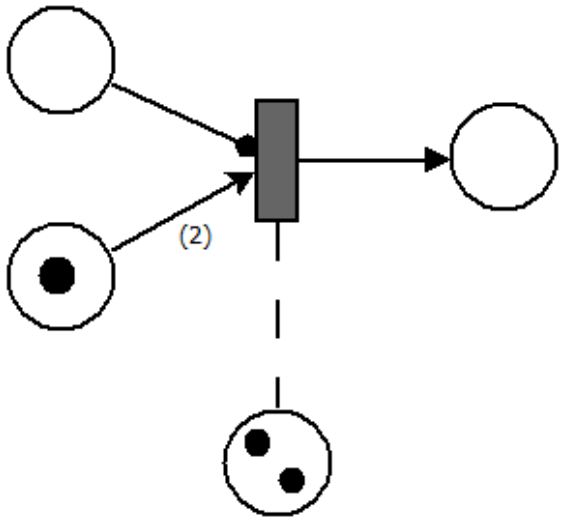

Figure 4.10: Petri net with weighted arc, inhibitor arc and reset arc

Depending on the context, different levels of abstractions are necessary to make the model easily readable. In high level visualizations hierarchies of Petri nets are used, where sophisticated parts are abstracted as a transition, which in itself is modeled by a Petri net. These transitions are represented by a magnifying glass icon within the transition, that indicates expandability. This technique can help to maintain readability in complex diagrams. [Araújo and Roque, 2009]

Araújo and Roque used Petri nets in practice by modeling the behavior of a real game they designed and summarized the advantages and limits of using this modeling language. The shortness of text and the unified and powerful modeling language with a simple notation, especially compared to UML were appreciated by the researchers. The hierarchical model was also considered a positive aspect, allowing for flexibility regarding model granularity. Other positive aspects are existing documentation of the modeling of concurrent processes and conflicting states and the availability of tools to verify, validate and simulate models. This enables designers to find flaws at an early stage, before the development phase begins and therefore enhancing efficiency. [Araújo and Roque, 2009]

One of the experienced limitations in the modeling of game behavior with Petri nets was

that a more detailed granularity was required for a well-functioning simulation of the model. While modeling the game scenario of a ship that is damaged when hit by high waves, rocks or cannon shots, Araújo and Roque had problems modeling this behavior in one transition as a Petri net while preserving the information that a cannon shot causes more damage than a wave. One of their approaches to resolve this situation was the use of weighted arcs, which would however have led to a modeling error, where the transition would not fire if not enough tokens were present. They proposed an extension for tokens with attributes, represented by different colors to model this situation. While presenting a very positive picture of the usage of Petri nets as an alternative for UML and flowcharts, the researchers stated that they will continue their research by focusing on more complex situations to evaluate if their hypothesis on a more efficient economy of representation using Petri nets holds for these scenarios. [Araújo and Roque, 2009]

4.3 Gameplay

4.3.1 Mechanics

Game mechanics are the sum of game elements and algorithms including game rules that are assembled as components to form a game. [Hunicke et al., 2004]

Meaningful Change of Game Mechanics

Aytemiz et al. point out that an important part of understanding game mechanics is observing them as an artifact with a time property. Game mechanics can be used in order to accompany the game narrative. [Aytemiz et al., 2019]

As an example, Aytemiz et al. explain how the game mechanic in the puzzle game *Florence* is used in order to transmit a message to the player that goes along with the in-game story. In one of the game levels, a player is presented by two in-game characters who are going on a date. The player has to align the pieces of a puzzle in order to progress, which causes the in-game characters to get to know each other and they increasingly get along. Unlike typical difficulty balancing, in which the difficulty constantly increases, the pieces of the puzzles decrease over time, resembling a difficult conversation gradually getting easier and more relaxed. [Aytemiz et al., 2019]

Changes in game mechanics can be used in order to achieve different goals, among others they can be a meaningful element in the player's understanding of a video game. [Aytemiz et al., 2019]

Power Ups

Lange-Nielsen considers power-ups special game mechanics, since they represent a game objective as well as a means to solve other game objectives. Essentially power-ups are either enhancements or modifications for existing mechanics or introduce new mechanics into a game. [Lange-Nielsen, 2011]

Power-ups are unique due to their ability of shifting play towards ludus or paidia play. They can either increase the factor of paidia in a game if a player obtains the ability to interact in additional ways with her in-game surroundings or the factor of ludus, if a power-up is used to successfully complete an in-game mission. [Lange-Nielsen, 2011]

Mechanics and Game Design Patterns

As pointed out by Olsson et al., game mechanics are often associated with the concept of game design patterns as presented by Björk et al. [Holopainen and Björk, 2003] in 2003. According to Olsson et al. the separation between game mechanics and game design patterns is difficult due to semantic similarities, e.g. comparing the game design pattern *aim and shoot* versus the game mechanic *aiming and shooting*. A conceptual relationship model is presented to clarify the boundaries between the two categories based on a separation of concerns. [Olsson et al., 2014]

The conceptual relationship model suggests that instances of game design patterns are created through contextualization and structured as units of game mechanics, as can be seen in figure 4.11. [Olsson et al., 2014]

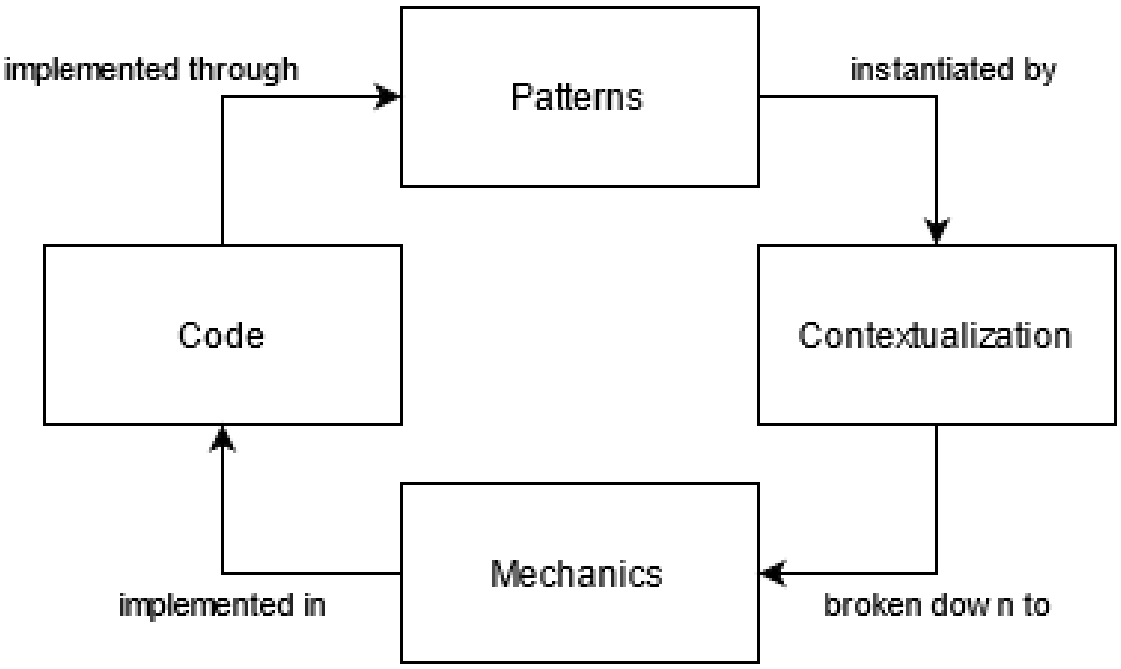

Figure 4.11: Conceptual Relationship Model

Rules in Video Games

DeLeon analyzed the role of rules in digital games by declaring what distinguishes them from rules in non-digital games. In sports or board games, rules are often a social contract, which defines the boundaries of what players are allowed to do. [DeLeon, 2014]

It would physically be possible to bring a trampoline to a basketball game in order to reach the basket more easily, but this would interfere with the social contract that players have agreed to when playing basketball. The laws of physics are additional rules that are added to every non-digital game. In most circumstances they do not require additional attention by the player and do not have to be negotiated, due to not being modifiable. [DeLeon, 2014]

In video games the laws of physics are often simulated and presented to the player in an implicit manner but are not implicit to the developer. In a basketball computer game a trampoline cannot be brought to a basketball game because it does not exist as a game object, i.e. the limitation is a property of the in-game world and not a social contract.

The above-mentioned properties of rules in digital games imply less flexibility in altering them but offer the ability to transcend boundaries of physics within games. [DeLeon, 2014] Designers have the possibility to model constraints of physics (e.g. time) in an unrealistic way or to parameterize them (see 4.4.4).

4.3.2 Dynamics

Game dynamics describe the actions and behavior of game elements in response to player input. [Hunicke et al., 2004]

Emergent Gameplay

Kazmi and Palmer presented a concept of adapting game dynamics in first-person shooters based on the player's skill level. As pointed out, many implementations of *emergence* in games are primarily based on dynamic difficulty balancing (see 4.1.13). [Kazmi and Palmer, 2010]

The concept of Kazmi and Palmer consists of two stages. In the first stage a player's skill is classified based on predefined characteristics. In the second stage the knowledge gained through this classification is used to modify the NPC tactics. The examples given contain changes in NPC pathfinding for experienced players as an additional challenge for players who wait for enemies to arrive in order to kill them with a sniper rifle as well as changes for amateur players, e.g. reducing the blast radius. [Kazmi and Palmer, 2010]

As pointed out by Kazmi and Palmer, these techniques are already applied in other game genres, naming the NPC artificial intelligence of *Pro Evolution Soccer 2008* as an example. [Kazmi and Palmer, 2010]

Dynamic Game Rules

Togelius presents a prototype of a game that adjusts its rules (i.e. mechanics) to the actions and inputs of its player. One of the main motivations of different approaches of generic rule generation has been the computer aided generation of new games, as pointed out by Togelius. [Togelius, 2011]

In an approach to achieve generically applied rules, Togelius states that several base rules have to be defined in order for the prototype to be comprehensive, i.e. input-output mapping and basic game objects. In this example multiple objects of different colors move along the screen. The player is able to input commands associated with a color and according to the state the game system has to come up with a rule system and select one of the objects of the given color based on this system, i.e. detect which object the player wanted to modify. This is done by monitoring game events, e.g. collisions, between the game object and guessing which event caused the player to respond with the input command, i.e. making common sense of a game rule system. [Togelius, 2011]

It is however up to debate, whether a game that has no clear winning condition or progress can actually be considered a game as Togelius points out. Furthermore, the technological state of existing approaches is not yet stable, i.e. players have to expect interruptions in their game experience. [Togelius, 2011]

Quest Generation in Procedural Game Worlds

Ashmore and Nitsche examined how quests work in procedurally generated game worlds. Increasing hardware abilities demand bigger and more detailed game content, which also increases the necessity for proceduduralityin video game development to keep content production costs manageable. [Ashmore and Nitsche, 2007]

The game world in the observed project called charbitat uses three approaches to generate its game world. Firstly, fractal algorithms are used in order to create maps and terrain information. Secondly, the generation of interior spaces is bound to explicit constraints. The third approach which is used for the generation of the game world is a city planning simulation tool, which calculates infrastructure requirements. A synthesis of these three approaches is applied in Charbitat. [Ashmore and Nitsche, 2007]

As described by Ashmore and Nitsche, quests must be defined by the game and communicated to the player. Furthermore, the quest must be embedded in the game world and it must be secured that the quest is actually fulfillable while the player should still feel challenged. In the examined case, quests were structured in a key-lock scheme. In practice key-lock quests are more effective, when combined with new elements in gameplay. [Ashmore and Nitsche, 2007]

Two major challenges had to be tackled in order to generate quests at runtime in a generated world. Firstly, current game engines rely heavily on code optimization of static assets. Therefore, the functionality of Unreal Tournament 2004 had to be extended and performance optimization tweaks were made necessary. Secondly, algorithms had to be implemented in order to evaluate if quests are fulfilled, which is a non-trivial task in a dynamic environment. [Ashmore and Nitsche, 2007]

4.3.3 Aesthetics

Game aesthetics are anticipated emotional responses that occur when interacting with a computer game. [Hunicke et al., 2004]

Aesthetic Innovation

While technological or functional innovation usually follows a predefined path, aesthetic innovation is much harder to define as a scientific field. [Arsenault and Coté, 2013] In fact, specifically technological innovation is often framed as a research field that follows Moore's law, which is based on an analysis that the number of transistors in integrated circuits on semiconductors doubles approximately every two years. [Moore, 1998] Even though the time interval in which technological progress was happening has not always been keeping up with Moore's observation in 1965, it seems as if the objective of technological progress has been to enhance the calculation capabilities of technologies. It is therefore trivial to define technological progress as something that is capable of doing more in less time.

When it comes to aesthetics this becomes a non-trivial task. Arsenault and Côté equate aesthetic innovation with aesthetic variation, citing Jauss, who defines aesthetic variation as a deviation from our expectations and as an element that surprises its consumers. [Arsenault and Coté, 2013, Jauss, 1982] As such, the aforementioned, predefined path cannot be identified, as different situations let players assume different aesthetic settings. Therefore, an evaluation of aesthetic innovation has to consider the context in which aesthetics are presented.

Graphical Regime

Arsenault and Côté introduce the idea of the graphical regime as the imaging of gameplay. [Arsenault and Coté, 2013] Game designers control the perspective with which a player perceives the gameplay, as well as the degrees of freedom to manipulate it. [Arsenault and Coté, 2013] The context in which a game is played, e.g. the genre of a game, the capabilities of the console, etc., influence player's expectations of the aesthetic representation.

Technological innovation enriches the set of possible graphical regimes a game designer has at his/her disposal to choose from, still different graphical regimes can be used as a stylistic property. [Arsenault and Coté, 2013] Examining modern game remakes, e.g. *Crash Bandicoot N. Sane Trilogy (2017)*, it is easily notable that designers explicitly limit players with the 2D graphical regime of the original game, even if the expected representation for a new and graphically polished game would be a freely moving 3D perspective, evoking a nostalgic gaming experience. Arsenault and Côté bring in examples of their own, e.g. in one level in *Batman: Arkham Asylum (2009)*, the protagonist finds himself in a nightmare, where the game projection changes to a 2D representation for the only time in the game. This design implementation transports the player into the graphical regime of his enemy [Arsenault and Coté, 2013], while communicating the

experience of not being in control of a situation, therefore transmitting an aesthetic message and triggering the player's emotions.

Mise-en-Image

Arsenault and Côté propose the mise-en-image, a paradigm known from film studies, which in its original is called mise-en-scène. [Arsenault and Coté, 2013] The idea behind the mise-en-scene is, that the director is provided with a script and uses assets like actors, props, lights, effects and other means to create the final image, that is perceived by consumers. [Gibbs, 2002] The mise-en-image paradigm proposes, that game designers finish their concept for gameplay first and apply tools and skills to develop a matching visualization. [Arsenault and Coté, 2013] This layered perception of game design corresponds with observations of Hunicke et al, who state that designers perceive aesthetics through mechanics and dynamics. [Hunicke et al., 2004]

Järvinen et al. provide a conceptional categorization of audiovisual styles that can be useful when designing scenes:

- Photorealism

  Photorealism simulates environments from films or real life.

- Carticaturism

  Caricaturism simulates environments from cartoons and comics.

- Abstractionism

  Abstractionism displays basic visual and aural forms.

Non-Euclidian Object and Space Representation

Video games usually rely on more or less realistic representations of space in two or three dimensions, where objects are described points and vertices that construct either areas in 2D worlds or meshes in 3D worlds. These representations almost exclusively follow euclidean laws and are described by euclidean mathematics.

This circumstance makes it hard for game designers to incorporate non-euclidean objects into games, describing them solely by euclidean geometry. Despite this difficulty, game designers have been experimenting with non-euclidean game worlds since before 2D worlds were representable with gaming hardware [Canossa and Petrovits, 2013]. One of the most well-known examples of game worlds that do not follow euclidean laws is Pac-Man, where the game figure enters the game world seen in figure 4.12 from the left when exiting on the right and vice versa. This portal-like functionality is representable because the player's viewpoint is fixed throughout the game [Canossa and Petrovits, 2013].

A simple and well-known non-euclidian object is the *Penrose Triangle*, invented by Oscar Reutersvärd [Canossa and Petrovits, 2013], as seen in figure 4.13. The Penrose Triangle

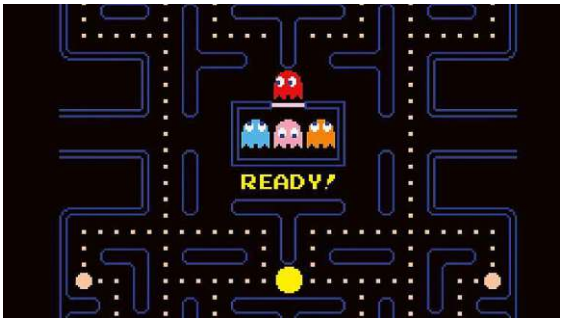

Figure 4.12: Pacman Gameworld

cannot be explained by applying euclidean laws even though it can be depicted on a 2D canvas [Canossa and Petrovits, 2013]. When moving an object along one of the surfaces, it is impossible to understand where the object will wind up, after a maximum of two turns. According to Petrovits and Canossa and Petrovits, this illusion only works when the viewpoint is fixed, but as soon as the perspective changes, the illusion disappears [Canossa and Petrovits, 2013].

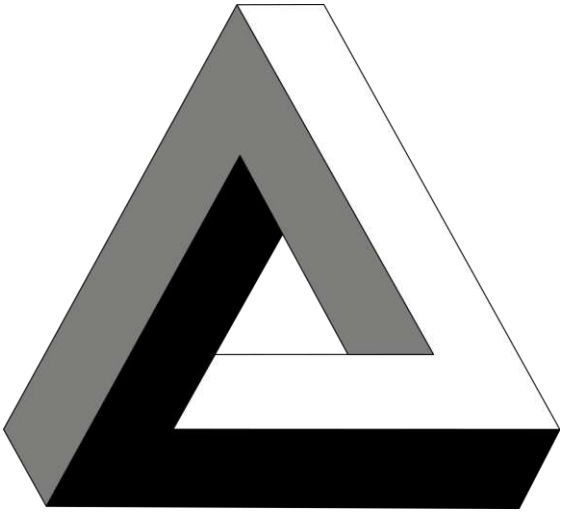

Figure 4.13: Penrose Triangle

Mathematically, this means that defining a 3D vertex with a common three-dimensional vector with Cartesian coordinates v1=(X1,X2,X3) is impossible for the Penrose Triangle, since the coordinates do not exclusively relate to their position within space, but also depend on the face they belong to. Depending on the face of the triangle, every vertex would need two sets of coordinates or a vector representation of four dimensions or higher, which cannot exist in a 3D space [Canossa and Petrovits, 2013].

The representation of non-euclidean objects in 3D space is however achievable. The non-euclidean representation in Pac-Man worked because the player's perspective was

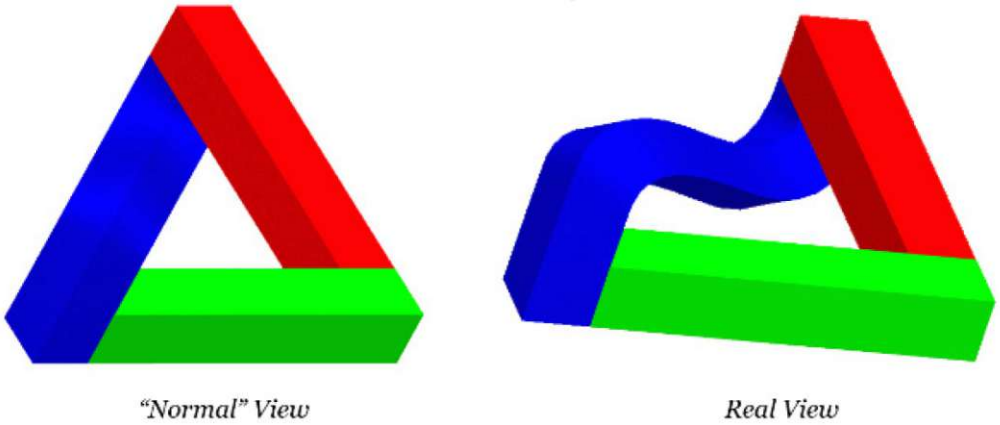

Figure 4.14: 3D representation of a Penrose Triangle

fixed. Canossa proposes the same solution for the representation of the Penrose Triangle in 3D space, while preserving the illusion, that was intended by Reutersvärd. When the Penrose Triangle itself is manipulated, so that one of the sides of the triangle actually is curved, the 3D representation with cartesian coordinates is possible, as seen in figure 4.14, created by Petrovits and Canossa [Canossa and Petrovits, 2013]. To keep the illusion working however, the constraint of a fixed viewpoint cannot be violated and the view angle has to be adjusted so that the curved side of the triangle seems straight. [Canossa and Petrovits, 2013]

There are other approaches to create non-euclidean illusions within games by manipulating the projection of the space, as can be seen in a project on Github [HackerPoet, 2020]. This game engine uses a combination of portals, where the player's camera location is seamlessly translated to another point in the 3D world, and live generated 3D textures to achieve Escher-like effects [CodeParade, 2018]. Figure 4.16 by CodeParade shows two tunnels, where the right tunnel is long on the inside and short on the outside and the other tunnel is the opposite.

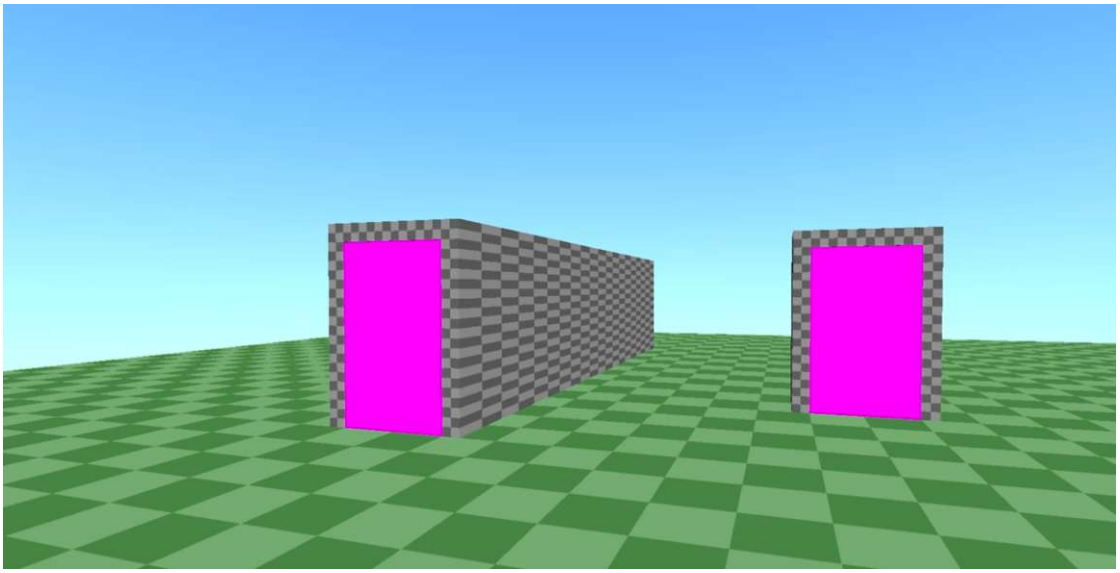

Figure 4.15: Non-Euclidean Game Engine Demonstration Textures

Figure 4.15, also by CodeParade, shows how this has been established with normal euclidean geometry and cartesian coordinates. Where the pink rectangles are shown, a virtual camera rendering of the entry or exit of the respectively other tunnel is projected onto the rectangle and when touching the rectangle, the player is teleported to the corresponding rectangle of the other tunnel without noticing it. Therefore the illusion of non-euclidean objects is created [CodeParade, 2018].

It should be noted that these objects are rather simple, using the same technique for objects like the Penrose Triangle would be very sophisticated, especially preserving the light and occlusion of each point of the triangle.

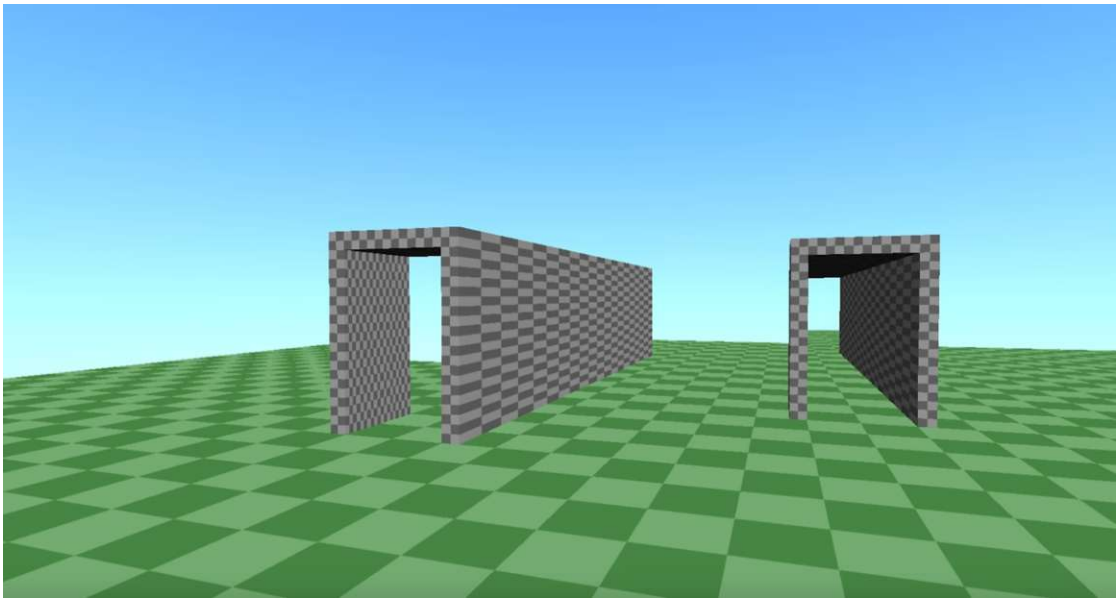

Figure 4.16: Non-Euclidean Game Engine Demonstration Rendering

The Role of Audio in Games

As Dominguez points out, Music can be used to set a theme within a game [Domínguez, 2017]. A theme within the aesthetic context of a video game can be understood as a medium for the transmission of triggers of emotion. Dominguez summarizes this with the umbrella term atmosphere [Domínguez, 2017]. Therefore, music that is associated with a certain scenic image or emotional state can be used to underline the game aesthetic. Dominguez implies this when explaining the example of using music, inspired by Ennio Morricone's arrangements to transport the atmosphere of a game set in the wild west [Domínguez, 2017].

Parker and Heerema claim that even though music is hardly ever a crucial selling point for a game, games that make poor usage of sounds and music will not succeed. Within professional video game production teams, there are either musicians amongst the designers or music composition is outsourced. In both ways, music in games is a fundamental part of game development and takes up a big amount of development budget. [Parker and Heerema, 2008]

Audio in games can currently be divided into four categories. Background music in games keeps players connected to the game world and reminds them that they are playing a game when losing focus on the game world or when the game is in an idle state. Speech in games is used to transmit information to a player, e.g. by humanoid NPCs. Sound effects support the narrative and cause emotions in players and sound input can be used as an alternative or additional input modality for a game. [Parker and Heerema, 2008]

According to Parker and Heerema music in games has a *continuity aspect* that keeps

players involved in the game, an *emotion aspect* that sets the scene of a game (e.g. horror or adventure) and a *tempo aspect*, setting the pace of the game. Certain musical pieces are thereby often tied to certain characters or activities. [Parker and Heerema, 2008]

Speech in games is often used to tell a story around which the game evolves. In this use case dialogues between the protagonist and NPCs as well among NPCs are common. Another main functionality of speech in games is to communicate hints to the player. Often those are given by NPCs to players to put them on the right track towards a solution to progress in the current game scene. [Parker and Heerema, 2008] It is also often used in the form of monologues of the protagonist. Parker and Heerema state that sometimes speech in games is used merely for entertainment. [Parker and Heerema, 2008] Spider-Man games are well-known to feature this kind of speech usage.

Sound effects can assist the narrative of a game in the sense that they make players more aware that certain events within a game did actually happen, e.g. the sound of an explosion assists its visual representation. This is achieved by adding reality and presence to a game scene. The same effects can be created for events that are about to happen, e.g. in a scene set in a forest players hear bushes moving, so they anticipate that something will jump out to attack them soon. [Parker and Heerema, 2008]

Sound Input in Games

There are two main categories for sound input in games, voice and non-voice. For voice input, freely available software can map voice commands to keystrokes [Parker and Heerema, 2008] or in game actions. Parker and Heerema name *Game Commander* as one software solution to achieve sound input on existing games that are not designed for this kind of interaction, they do however consider its usage sometimes frustrating. [Parker and Heerema, 2008]

Speech as input is often implemented, restricting the domain of natural languages. Parker and Heerema explicate that a limited domain of speech, i.e. limited vocabulary and phrases following a defined syntax is needed for proper functionality. Systems for detection of words often match the input audio with different sound samples, therefore a smaller variability of words lowers the error rate and increases performance. The defined syntax, as Parker and Heerema point out, is a communication technique frequently used in the military, where phrases consist of the *identifier*, *precautionary*, *cautionary* and *executive* parts. According to the researchers, this technique has been further stripped down to a minimal level in *Star Trek*, where communication consists of an *identifier*, an *acknowledge* part and a *command*. [Parker and Heerema, 2008] This seems to be the established concept of speech input devices, considering products like *Amazon's Alexa* or *Apple's Siri*, where users call the products by their names, then receive an acknowledging feedback and then formulate their demands in a commanding form.

Non-voice input for games or computer applications in general has hardly been researched as Parker and Heerema point out. One of the use cases for this kind of sound input that is available as an application is accepting musical input signals and matching it

against sound samples to give musicians feedback on their playing or singing abilities. In basic versions of those applications, rhythm and pitch are evaluated, where rhythm is measured by matching the input signal to the timeline of the music sample and pitch is measured by calculating the main frequency of the input signal and matching it to the frequency on the same point on the timeline of the sample. Additional properties of the like are intonation and expression. [Parker and Heerema, 2008]

Manipulating Sounds in Games

Manipulating sounds in games is not a widely used concept by designers, even though multiple games in which players create or recreate music have been made in the past. Popular examples are *Music* or *Music 2000* for the PlayStation 1, where players were provided with a playfully designed *DAW* where they could use their creativity to combine and manipulate music samples to create their own songs. Parker and Heerema state that the problem of such games is that clear goals can't be designed, since evaluation of creative actions is mainly subjective. [Parker and Heerema, 2008]

An academic game, that deals with manipulating sounds in games is *PC Conductor* by the Digital Media Laboratory of Calgary. Parker and Heerema state that *PD Conductor*'s game goal is to conduct an orchestra. Similar to the role of a conductor of an actual orchestra, the player uses movements to manipulate audio tracks. This game is not designed to become a sellable end product but to evaluate different types of input modalities for this use case. Different pressure sensors have been evaluated in this context, from a computer keyboard as a simple pressure switch with two states to piezo sensors that capture a wide range of different pressure levels. Among the evaluated sensors, a matrix-like array of piezo sensors was put into the shoe of players to capture the player's stomping and its hardness to manipulate the in-game music accordingly. A different input approach for this kind of game is visual input, where stomping and arm movements are not captured by pressure sensors but by computer vision and motion pattern detection. [Parker and Heerema, 2008]

Immersion through Sound

Sound in games can have an immersive role (see 4.3.8), as Grimshaw and Schott point out. They do however state that the level of immersion is controllable and predictable only up to a certain degree by game designers. Relative loudnesses between channels of sound and the used hardware play a crucial role in the level of immersion in-game sounds are able to produce. [Grimshaw-Aagaard and Schott, 2008]

The sounds that offer immersive properties help players identify with their character as well as in-game environment and actions. Grimshaw and Schott distinguish between *proprioceptive sounds* with a high level of immersion, i.e. an in-game character who is breathing and *exteroceptive sounds*, which put the in-game character and environment into a shared context. [Grimshaw-Aagaard and Schott, 2008]

Diegetic Use of Music in Games

Music in games is diegetic, when the source of music is located within the scene [Domínguez, 2017]. Dominguez claims that the effects of atmospheric resonance are amplified in this manner, naming Wolfenstein: The new Order as a game example for this thesis [Domínguez, 2017]. Within this game, the nazis won the second world war and try to gain cultural influence in the United States. This atmosphere is transported by German soldiers listening to Volksmusik containing propagandistic lyrics [Domínguez, 2017].

4.3.4 Historical Resonance

When portraying historic contexts or settings within games, historical resonance between the game and the local context (the players history knowledge) occurs, if the historic representation is close enough to the player's perception of the same setting [Chapman, 2016, Domínguez, 2017]. As a counter concept historical dissonance can also occur, if the historic representation within a game differs from their player's local context. [Chapman, 2016] These parameters can either be determined by the game design or by the player's behavior. Chapman stated the game Civilization as an example, in which the extent of historical resonance and historical dissonance is within the control of its players, therefore making it an important design element [Chapman, 2016].

4.3.5 MDA Framework

The MDA Framework by Hunicke et al. is a formal high level approach on game design. It is based on the three pillars mechanics, dynamics and aesthetics. Furthermore, it includes the interplay of how designers create and how players consume a game. Hunicke et al. see the importance of a high level understanding of games in their distinctive nature of being consumed in an unpredictable manner, which sets them apart from other media or entertainment artifacts. [Hunicke et al., 2004]

Each of the three pillars of the MDA Framework acts as a lense which is coupled to the others in a way that manipulations in one of these layers or lenses cause changes in others. Designers experience a game within the design process through the game mechanics lense, that can directly be altered and affect the dynamics lense which affects the game aesthetics. Players on the other hand experience game mechanics through the two lenses of game aesthetics and game dynamics. Hunicke et al. consider it helpful to take both perspectives into account, so that the interplay and cascading of changes between the layers can be better understood. [Hunicke et al., 2004]

Aesthetic Models

Hunicke et al. suggest thinking of game aesthetics as a concrete emotion instead of an abstract term, such as fun. They provided different examples, such as *fellowship*, *discovery*, *competition* or *fantasy*. A clear description and taxonomy of game aesthetics

help designers define their goals and understand why different games appeal to different target groups.

For games that are based on creating competition aesthetics, designers should strive to create a game that keeps a competitive scenario throughout the game, so that players stay emotionally invested in the game, since an unbalanced situation makes the winning condition unclear and thereby destroys the competitiveness and the emotional investment for losing parties. [Hunicke et al., 2004]

Dynamic Models

As Hunicke et al. pointed out, different game dynamics cause certain game aesthetics. Using the above-mentioned example of a competitive game, e.g. Fifa, increasing time pressure and opponent ball possession creates a challenging game aesthetic for a player that is losing. [Hunicke et al., 2004] The same dynamic creates other aesthetics for the winning player.

Analogously to game aesthetics, the MDA Framework recommends game dynamics to be as precisely defined as possible. Therefore models of predicted gameplay dynamics should be created to have an overview of what the gameplay could look like. For turn-based games where dice are thrown, it is easy to predict different movements and their probability and therefore different possible ways of how dynamics may unfold within gameplay. [Hunicke et al., 2004]

Mechanics in the MDA Framework

As stated earlier, designers have control of the mechanics, they afford players with. They can be used as a handle to support certain game dynamics. A shooter game with sniper rifles will result in game dynamics that differ significantly from a shooter game with pistols and knives. [Hunicke et al., 2004] A common usage of mechanics to directly change game dynamics are power-ups or bonuses, e.g. clocks that players can collect to extend the remaining time of an in-game countdown.

4.3.6 Subversive Play

Games are designed in order to meet the needs and expectations of implied players, which is not different in other media types, as Tanenbaum points out. Furthermore, game designers also tend to design for (or against) implied pervasive players, who are often seen as obstacles that try to disrupt the designer's intention. [Tanenbaum, 2014]

Unanticipated actions can be executed in most games, which can be exploited by players to play a game in an unintended way. Therefore, it can be concluded that trying to subvert the system can be a desirable experience for players. Tanenbaum presents two design strategies in order to prevent subversive player behavior: [Tanenbaum, 2014]

- Lockdown

A designer prevents unforeseen player actions by limiting the degree of freedom within a game. [Tanenbaum, 2014]

- Sandbox

  The opposing paradigm to lockdowns are sandboxes, where the designer tries to give players as much freedom as possible, therefore losing control of a pre-designed player experience. [Tanenbaum, 2014]

Tanenbaum states that mostly players are interested in experiencing a game in the way it was meant to be played by the designer. The main aim for subversive play is giving new meaning to an existing game. According to Tanenbaum, the designer's role is not to prevent subversive play, but to understand players' experimentation with games. [Tanenbaum, 2014]

4.3.7 Flow

Four Channels of Flow

In a survey of 253 online gamers, Teng and Huang examined the Four Channels of Flow (FCF) theory by Csikszentmihalyi and Csikszentmihalyi in an online gaming context. The FCF identifies three dimensions in gameplay in addition to flow, i.e. boredom, frustration and apathy. [Teng and Huang, 2012, Csikszentmihalyi and Csikszentmihalyi, 1992]

A player's skill and the game's challenge affect all four channels in an either positive or negative manner. The survey conducted by Teng and Huang, presents a more detailed insight into the interplay between skill, challenge and the FCF by investigating the hypotheses presented by Csikszentmihalyi and Csikszentmihalyi. The measurements for skill, challenge and flow were taken from scales, that were originally presented by Novak et al. [Teng and Huang, 2012, Novak et al., 2000]

Based on the survey data, the following results were presented: [Teng and Huang, 2012]

- Skill increases flow
- Skill increases boredom
- Skill decreases frustration
- Skill decreases apathy

  This result is not significant, and therefore not supporting the hypothesis. [Novak et al., 2000, Teng and Huang, 2012]

- Challenge increases flow
- Challenge increases boredom

  This result contradicts the hypothesis presented by Csikszentmihalyi and Csikszentmihalyi. [Csikszentmihalyi and Csikszentmihalyi, 1992, Teng and Huang, 2012]

- Challenge increases frustration
- Challenge decreases apathy

A Pattern Language for Flow Experiences

Lemay proposes a modeling language to the design of experiences, especially flow, in games. Its purpose is to make designers understand gamer experiences and incorporate them into their designs. The proposed patterns of the language contains a pattern name, a problem statement, a context, a problem solution, forces affecting the problem and examples [Lemay, 2007]

Lemay distinguishes two types of patterns that assist in understanding flow experiences: [Lemay, 2007]

- Patterns of Experiences

  These patterns are based on knowledge of psychologists and human studies and describe how games are experienced. [Lemay, 2007]

- Patterns for Experience Design

  These patterns deal with a designer's tools and abilities to create and maintain flow experiences. [Lemay, 2007]

The following connections between dimensions of emotion and flow experiences have been drawn by Lemay: [Lemay, 2007]

- Sensation

  This experience is linked to sensory stimulation. [Lemay, 2007]

- Emotion

  This experience is linked to different kinds of fun. [Lemay, 2007]

- Cognition

  This experience is linked to challenges as well as game state and its changes. [Lemay, 2007]

- Behavior

  This experience is linked to a players skills when solving tasks. [Lemay, 2007]

- Social

  This experience is linked to competition or common goals of multiple players. [Lemay, 2007]

Based on this theory of player emotions and flow experiences, Lemay presents four examples of patterns as a starting point for the proposed pattern language: [Lemay, 2007]

- Challenging Tasks Balanced with Appropriate Skills

  Designers have to present players with the right amount of challenge in order to not create emotions of boredom or anxiety. The proposed solution is a monitoring widget that matches the level of challenge to the player's level of competence. [Lemay, 2007]

- Path to more Challenges

  If the same challenges are repeated there is a process of habituation, which leads to an increased feeling of boredom. The proposed solutions contain adding more complex tasks or adding time constraints. [Lemay, 2007]

- Feedback from the Environment

  Feedback is a crucial factor to help players assess their actions. As pointed out by Lemay knowledge of the player is needed in order to provide the most fitting and effective type of feedback, since its perception is subjective. [Lemay, 2007]

- A Responsive System

  In order to experience a flow state, the game experience should not be interrupted by performance issues. It is therefore the designer's task to determine and communicate system requirements to players in order for them to assess the capability of their gaming system for a certain game. [Lemay, 2007]

4.3.8 Immersion and Presence

Immersion as a concept is not exclusively applicable to games, but has also been examined with regards to film and television and other media types [Micallef, 2016, Brown and Cairns, 2004]. However, within the examined academic landscape, it is strongly tied to game design research and widely analyzed throughout different publications from different publishers and conferences.

Brown and Cairns tried to structure the broad concept of immersion by proposing different stages. Within this structure, player engagement is the first stage towards immersion. To be immersed into a game, players have to want to interact with the game and show the willingness to concentrate to play. Engagement is a prerequisite for the second stage of immersion, engrossment. When players are engrossed by a game, its design elements have direct effects on their emotions. Finally, according to Brown and Cairns, the last stage of immersion is total immersion, where players are present within the game and stop to perceive the real world around it. [Brown and Cairns, 2004] As Wirth et al. pointed out, the model of immersion is unidirectional and as such limited to design properties and parameters of a game that are provided to its player. In contrast, presence is the

experience of a player who is immersed, and therefore represents the other direction of this phenomenon [Wirth et al., 2007].

Micallef however states that the state of total immersion, in which players do not perceive anymore that they are actually playing a game, is nonexistent. As an extension to the current knowledge state of self presence, he proposes objective self presence, in which while being affected by the aforementioned principles of immersion and self presence at any stage still perceive themselves as an entity that is interacting with game technology. [Micallef, 2016]

As a proof of concept, Micallef created the game *illusion master*, which tries to keep the player in an immersed state throughout the game by using design elements characteristic for immersion. An objectively self-present perspective is needed to finish this game, since the only way to win it is to stop playing it, an action that takes place in the real world, requiring players to escape from their immersive state in the virtual world. Micallef claims to have proven that even in immersive games, players are able to perceive themselves as subjects in the real world while playing them. [Micallef, 2016]

Immersion and Gameplay Experience

Örtqvist and Liljedahl examined how immersion and gameplay experience are connected, claiming that research on immersion focuses specifically on gameplay experiences. The researchers claim that immersion has an effect on gameplay experience. This effect differs, based on certain characteristics of the individual gamer. These claims serve as the base for a contingency framework. Örtqvist and Liljedahl evaluated four hypotheses to verify the validity of their framework: [Örtqvist and Liljedahl, 2010]

- Immersion is (a) conceptually different from but (b) positively related to gameplay experience.
- Increases in immersion have a more positive effect on older gamers.
- Increases in immersion have a more positive effect on gamers with less gaming experience.
- Increases in immersion have a more positive effect on gamers with less game understanding.

To examine these hypotheses, a study with 48 participants (n=48) was conducted in a controlled environment. The participants were formed by four groups of equal size from students of different academic organizations with different research focuses (high schools and universities). The participants were asked to play a game for approximately ten minutes and to submit a questionnaire, composed of 24 questions, 18 thereof quantitative with a Likert scale mapping and six open ended ones, immediately after. [Örtqvist and Liljedahl, 2010]

In order to receive meaningful data, Örtqvist and Liljedahl chose an audio based game with a flat learning curve. To ensure normalized conditions for the participants, the computer and headphones were provided and test sessions were supervised by the researchers. [Örtqvist and Liljedahl, 2010]

To evaluate the collected data against the defined hypotheses, different regression analysis methods, e.g. principal component analysis and simple regression analysis, were used. The hypotheses testing with these methods was done in isolation. [Örtqvist and Liljedahl, 2010]

Örtqvist and Liljedahl verified that immersion is conceptually different from but has a positive effect on gameplay experience. The hypothesis that increasing immersion has a bigger positive impact on older gamers (19-25 years in comparison to 12-18 years) could also be verified. Furthermore, data showed that the immersion impact on gameplay experience is stronger for players with a low understanding of the game. In addition, the researchers found out that the level of immersion in a game has a hardly notable impact on players with an advanced game understanding. For gamers with different levels of gaming experience the difference was only slightly significant, so that Örtqvist and Liljedahl classify their third hypothesis as partly verified. It could however be shown with marginal significance that players with little gaming experience relied more on immersion to experience gameplay in a positive manner. [Örtqvist and Liljedahl, 2010]

These results are only proven to be valid within the examined context as Örtqvist and Liljedahl point out. The researchers believe that their hypotheses hold true in similar context but state that further research has to be conducted to examine the generalizability of the study findings. [Örtqvist and Liljedahl, 2010]

Van den Hoogen et al. examined the effects of immersion on gameplay by measuring changes in players' physical movements, i.e. force on button press and controller movement in game situations, in a more and in a less immersive game setting. [Hoogen et al., 2009]

Based on findings of several scientific sources, van den Hoogen et al. used Field of View (FOV) and sound pressure as a controllable means to increase or decrease the feeling of immersion. While the pressure on gamepad buttons has been related to increased game difficulty before(e.g. by Sweetser and Wyeth [Sweetser and Wyeth, 2005]) and controller movement and other body gestures in sync to visual gameplay stimuli has been linked to immersion (e.g. by Bianchi-Berthouze [Bianchi-Berthouze et al., 2006]), Hoogen et al. provide an insight on the intensity of these relations. [Hoogen et al., 2009]

Furthermore, players self-assessed how immersed they were by the game for the different FOV and sound settings. When comparing the different screen sizes (20" vs. 42") and sound pressure levels (60db vs. 80db) to these self assessments van den Hoogen et al. found a significant relation between these parameters and the level of immersion of players. Increased sound pressure also enhanced a player's feeling of dominance as shown by this study. [Hoogen et al., 2009]

The hypothesis that player movements in synchronization with visual stimuli would

increase if they were more immersed did not hold true, neither for changes in FOV, nor for different sound pressure levels. A positive correlation of immersion and the pressure with which buttons are pressed was supported. [Hoogen et al., 2009]

4.3.9 Affordances in Game Design

Affordances are a crucial concept in designing technological artifacts. As Cardona-Rivera and Young point out, this concept plays an important role in the academic world of game design research. Semantics do however differ based on the context in which the term affordance is used. [Cardona-Rivera and Young, 2014]

Cordona-Rivera and Young tried to create some semantic uniformity regarding the term affordance in a game context by creating a cognitivist theory based on relevant academic publications. An important root of the concept of affordances is a publication of 1979 by Gibson, which frames it within the confines of ecological psychology. Gibson states that objects are perceived through their affordances, he does however explicitly claim that the affordances of an object are not dependent on their percipient. [Gibson, 2014]. Gibson's definition of affordances was later extended by Vera and Simon, who created a theory involving mappings between declarative representations and actions, adding cognitive approaches. [Vera and Simon, 1993, Cardona-Rivera and Young, 2014]

Gaver realized the importance of affordance in exploratory behavior [Gaver, 1991]. Considering these concepts together has been highly influential to the world of HCI. Norman later states that affordance gives the percipient an idea of what to do with and object they have no experience with, further claiming that the important part of affordance is what the percipient perceives as possible, rather than an absolute set of actions that an object defines, as stated by Gibson. [Cardona-Rivera and Young, 2014]

The above-mentioned definitions of affordance are not explicitly tailored to game design. Mateas applied Norman's insights to game design and distinguished between two different kinds of affordances, *material affordances*, i.e. possibilities of actions presented to players and *formal affordances*, that motivate players to perform a particular action. Linderoth distinguished between *exploratory actions*, which communicate knowledge about affordances and *performatory actions*, that realize them. [Cardona-Rivera and Young, 2014]

Among the two psychological directions, Cardona-Rivera and Young consider the cognitive approach to be the only feasible way to cover learning and perception processes of players, therefore declaring insights that are merely based on ecological psychology out of scope for their theory. They name three main components of their affordance theory, all of them to be understood within the realm of game design: [Cardona-Rivera and Young, 2014]

- Real Affordances

  Real affordances are actions, that are actually executable by a player, i.e. real affordances are supported by the game.

- Perceived Affordances

  The actions that players consider possible are perceived affordances. It is notable, that they can intersect or dissect with real affordances. In rare cases, also dissections can be wanted game properties by the game designer.

- Feedback

  Player feedback can be used as a controlling element to manipulate the ratio of overlapping between perceived affordances and real affordances. In many cases designers want to have a mostly overlapping model, therefore the real affordance model is insinuated by feedback.

The three components identified by Cordona-Rivera et al. are tools game designers should consider, although perceived affordances cannot directly be manipulated. [Cardona-Rivera and Young, 2014] Designers should strive to maximize the probability that players perceive real affordances. [Cardona-Rivera and Young, 2014]

4.3.10 Input/Output Modalities

Buttons

Buttons have been a substantial part of games for a long time. Breyer et al. state, that mapping actions to buttons is a non-trivial task, especially due to the number of different actions that can be executed in modern games. In the past, this problem was generally solved by adding the quantity of buttons on game controllers, as Breyer et al. point out, but this can only be done to a limited extent. [Breyer et al., 2014]

Breyer et al. present different button patterns in order to be able to handle a high quantity of gameplay actions with the usage of buttons: [Breyer et al., 2014]

- Press Pattern

  The simple press of a button should be used for simple and elementary game actions. [Breyer et al., 2014]

- Rhythm MultiPress Pattern

  Pressing buttons in a certain rhythm should be used to alter the actions of the simple press pattern. Multiple occurrences of this pattern can be chained together for combinations of actions. It is essential to give feedback so that players know whether they have executed the rhythm multipress pattern correctly. [Breyer et al., 2014]

- Hold Pattern

  Holding a button should be mapped to actions that have a longer duration. While the button is held, the action remains enabled and when the button is released

the action ends. Mapped actions should be triggered in every context and game designers must keep in mind that holding a button in certain positions can be uncomfortable for players. [Breyer et al., 2014]

- Hold and Release Pattern

  In this pattern, an action with long duration is executed when the button is held for a certain period and then released. The time for which the button has to be held should be proportional to the intensity of the triggered action. [Breyer et al., 2014]

- Precision Press Pattern

  Contextualized actions are often combined with the precision press pattern. In a certain scenario a player has to press a button at the right time in order to trigger a special action. In case of failure, players often have to face penalties. [Breyer et al., 2014]

- Quick Time Event Pattern

  Actions that require fast player reflexes can be implemented using this pattern. In a game scene, a button symbol pops up, that has to be pressed quickly, so that an action is triggered in a critical moment. [Breyer et al., 2014]

- Time Limited Hold Pattern

  This pattern is used for long actions, that require low effort in a game. The major difference of this pattern and the hold pattern is that actions are triggered only if the button is held for a certain period of time, while actions in the hold pattern are executed throughout the whole time the button is held down. [Breyer et al., 2014]

- Pump Pattern

  For longer action that require great player effort, the pump pattern can be used, in which the same button has to be pressed repeatedly and very quickly. A player cannot interact in other ways while executing the pumping pattern, so concurrent actions are not supported. [Breyer et al., 2014]

Rumble

Vibrational impulses have been accompanying video games for a long time, especially on game console systems. Apart from video games, computer-aided trainings for professionals represent another field of use for this kind of haptic response. Willumsen and Jaćević examined the role of rumble, i.e. vibrational player feedback in video games. [Willumsen and Jacevic, 2019]

Willumsen and Jaćević analyzed the usage of rumble in PlayStation games in two different ways, i.e. play sessions of one hour where every occurrence of rumble was reported in a *rumble log* and general play sessions of variable duration, where players focused specifically

on rumble and documented uses of rumble they considered worth analyzing. [Willumsen and Jacevic, 2019]

In their analysis, Willumsen and Jaćević distinguish between two dimensions of rumble, i.e. the *feedback source* and the *level of operation*. The feedback source describes where the source of the rumble, i.e. what causes the vibration and the level of operation describes the purpose of the rumble. [Willumsen and Jacevic, 2019]

Willumsen and Jaćević distinguish between four types of feedback sources: [Willumsen and Jacevic, 2019]

- Environment

  Actions in the game world, e.g. explosions or falling trees can be a source of rumble. [Willumsen and Jacevic, 2019]

- Objects

  Weapons being fired can be sources of rumble. [Willumsen and Jacevic, 2019]

- Interface

  Menu or Heads Up Display (HUD) settings or simple vibration strength tests can be sources of rumble. [Willumsen and Jacevic, 2019]

- Body

  An avatar's body actions or properties, e.g. jumping, climbing, heart beats or emotional shocks can be sources of rumble. [Willumsen and Jacevic, 2019]

Regarding levels of operation, the following three categories are presented: [Willumsen and Jacevic, 2019]

- Ludic

  System states or actions are indicated by rumble. [Willumsen and Jacevic, 2019]

- Dramatic

  Narrative or interactive realism are augmented by rumble. [Willumsen and Jacevic, 2019]

- Technical

  The rumble hardware is adjusted, or its function is demonstrated. [Willumsen and Jacevic, 2019]

Brain Computer Interfaces

Ko et al. claim that player input through Brain Computer Interface (BCI) is more convenient than traditional input devices. [Ko et al., 2009]

As pointed out by Ko et al. in 2009, BCI devices are not yet manifested in the digital game market [Ko et al., 2009], which is a statement that still holds true in 2021. In other fields, however, e.g. in healthcare, BCI are already in effective use. [Ko et al., 2009]

Brain controlled input is a skill, which a rather steep learning curve, when compared to pressing a button, which has to be acquired. In order to efficiently apply brainwave signals to digital actions, users have to be able to apply them in a controlled manner. The ability to reproduce these signals in a way so that they are distinguishable from other signals enables game designers or software developers to map a signal to an action which is then executed in the digital space. [Ko et al., 2009]

Three BCI devices are presented by Ko et al., i.e. *NIA*, *EPOC* and *Mind Set*, which detect brainwaves from two categories: *expressions* and *emotions*. For an evaluation in the video game context, Ko et al. focused on two emotions, i.e. attention (immersion (see 4.3.8) in a BCI context) and meditation (relaxation). [Ko et al., 2009]

In a study (n=20), Ko et al. compared a specifically designed video game, which was played in two groups, where one group used BCI input and the other group was presented with classical input modalities. The game had different aims that could be reached by applying different brainwaves, e.g. game objects appeared when players had a high level of meditation or enemies could be defeated by a high level of concentration. [Ko et al., 2009]

A Likert questionnaire with questions regarding confidence, intuitiveness and fun was given to the two groups and a statistical t-test showed that the BCI version had a significantly higher score and a lower standard deviation. [Ko et al., 2009]

In addition, Ko et al. claim that introducing BCI into an already existing PC game setting can increase intuitiveness and immersion. [Ko et al., 2009] However, as stated above, BCI devices did not yet have notable commercial success and no BCI interfaces are available for the most used gaming consoles as of 2021.

Biometric Feedback

Dekker and Champion examine how biometric data which can be collected by sensors attached to the players' body can be used in video games to enhance gameplay. Through changes in game dynamics and aesthetics based on biometric information "cinematically augmented horror affordances" [Dekker and Champion, 2007] can be created.

According to Dekker and Champion biometric data cannot only be used to react to it as mentioned before but may also be used to evaluate the effects certain parts of the game story have on a player. [Dekker and Champion, 2007]

The data that was collected by Dekker and Champion was heart rate variability, measured by an electrocardiogram and galvanic skin response. Both of them were measured by low cost devices with programmer interfaces. It was found that audio effects caused notable biometric responses and the more players like the game genre the more they responded to the gameplay adaptations. It was found that the horror genre was especially suitable for these adaptations given that players enjoyed the genre. [Dekker and Champion, 2007]

4.3.11 Pervasive Games

Computer games are not bound to static locations of gaming systems anymore, as modern hardware is portable and potent enough to power complex and demanding video games.

Video games that transcend the boundaries of the digital world and the real-world are commonly referred to as pervasive games. The most well-known types of games that are usually associated with pervasive games are AR and Virtual Reality (VR) games.

Many characteristics of pervasive games exist and therefore an exhaustive definition or taxonomy is difficult to establish. Björk and Peitz applied game design patterns to 120 different pervasive games in a bottom-up approach and used a clustering algorithm to group different types of pervasive games for an overview. [Björk and Peitz, 2007] However, a detailed examination of the different sub-genres of pervasive games are beyond the scope of this scoping review.

Objectives of Pervasive Games

The motivation of developing pervasive games, as presented by Davies and Innocent, can be examined through these three lenses: [Davies and Innocent, 2017]

- Play as Response to Environment

  Within several pervasive games, the real world environment is a critical element. Games narrate a story around existing landmarks or historic buildings. In some cases, knowledge of the real world is needed or recommended in order to solve in-game riddles. [Davies and Innocent, 2017]

- Play as Exploration of an Alternate Reality

  Commonly, in pervasive games, objects in the real world are mixed with in-game objects. As explicated by Davies and Innocent, nature is often re-encoded in games with other meanings and implications. In *Pokémon Go*, players have to be near water to catch water Pokémon, therefore giving water an alternative meaning in the virtual Pokémon world. [Davies and Innocent, 2017]

- Play as Decoding Infrastructure

  Players often try to experiment with constraints or to subvert designers' intentions (see 4.1.8). In pervasive games, the real world is encoded in the game, that allows

> players to test the boundaries of reality by testing the boundaries of a game. Players experience existing rules and systems in a playful manner, therefore gaining a new, decoded perspective on realty. [Davies and Innocent, 2017]

Pokémon Go is considered the most successful pervasive game, but according to Davies and Innocent, the pervasive elements in the game are a sub-par implementation of what a pervasive game should aim for. Davies and Innocent point out that in *Pokémon Go* the virtual world is merely an overlay, that lies on top of the real world, whereas the objective of a pervasive game should be to mix with reality, forming an encode-decode relationship. [Davies and Innocent, 2017]

Navigational Interfaces in Pervasive Games

Lammes examined the role of maps within location based games. Even though the idea of location based games originates from geocaching, the virtual world is completely absorbed, which is a major distinction to its origin. In geocaching, when objects are found, players return to the real world to physically touch these objects, whereas in many location based games, the map is the game-board that sets the boundaries of the geographical game scope. [Lammes, 2011]

Maps in location based pervasive games form a new social space, as described by Lefebvre (see 4.4.1). Maps usually serve as the base game-board on which, according to context, layers of information are augmented digitally. Therefore, maps do not only function as a game-board, but also as a playground, where spatial activities are perceived through a lense of gamification (see 4.10). [Lammes, 2011]

This hybridization of game-board and playground, which forms a new Lefebvrian social space highlights the performative character of a map and provides players with new levels of agency as a navigator within the game map. [Lammes, 2011]

Urban Play

Urban environments as a play theme are becoming increasingly popular. In many cases, the purpose of urban play transcends mere entertainment and game ideas are often created by urban planners or architects. Therefore, the design process of pervasive urban games is a difficult task in many cases, since the game is often considered a generator for motivation to solve city planning problems. [Ferri et al., 2018]

Ferri et al. state, that in order to enhance the design of urban games, shared analytical concepts as well as a shared language between city planners and game designers have to be established. The spectrum of games with an urban play theme is vast, ranging from pervasive games, to mobile games without a pervasive character to city planning games, e.g. *Sim City* or games for the city community, e.g. games to raise awareness or to strengthen community building. According to Ferri et al. a distinction of games in cities, games for cities and games about cities is not precise and an obstacle for efficient collaboration between city planners and game designers. [Ferri et al., 2018]

Different conceptional models of game design already exist, e.g. MDA (see 4.3.5). According to Ferri et al., those models could be reused as a common base for communication to better define requirements of urban games if they would allow to be extended by additional layers of contextualization, in this case by a city theme. In order to resolve the problems of missing resolution and scalability of conceptual frameworks in the urban play domain, Ferri et al. developed an urban game extension for the PLEX model, called *PLEX/CIVIC*. [Ferri et al., 2018]

Context Information in Pervasive Games

Information presented in pervasive games is highly contextualized. Paavilainen et al. dinstinguish between the following categories of context in pervasive games: [Paavilainen et al., 2009]

- Environment Context

  Elements of environment context include temperate, cloudiness and lightness. This type of context information is easy to understand for players, since information sources are easily observable and convenient for game designers, since information is easy to obtain and use. [Paavilainen et al., 2009]

- Spatio-Temporal Context

  This type of context information is used, if information about location and time is collected and used to trigger game action. This information can either be mapped directly to real world data or it can reflect virtual game time and location. [Paavilainen et al., 2009]

- Proximity Context

  Proximity context is used, when a game uses distance information of technological devices. These devices could be mobile phones of other players as well as WiFi or mobile network access points. [Paavilainen et al., 2009]

- Social Context

  Games that use social context information change their behavior based on the relationships between players. This type of context information is often used in games on social media platforms. [Paavilainen et al., 2009]

Paavilaninen et al. conducted a study (n=15) with a game, that used context information of all four categories. Six participants gave feedback in in-depth interviews on the perception of the different types of context information in the game. [Paavilainen et al., 2009]

In general there was a positive feedback regarding the use of context information. 60% of the participants found the use of spatio-temporal context information exciting.

Environment and proximity context information were however not considered interesting by the participants. Furthermore, Paavilainen et al. point out that players need to understand the purpose of context information in order to perceive it as an interesting feature. [Paavilainen et al., 2009]

Tangible Interfaces for Pervasive Gaming

Jung et al. created a proof of concept of the technical integration of novel input mechanisms in a pervasive gaming context. Pervasive games allow for extensions and alternations in peripheral devices and user input. In their framework Jung et al. make use of Phidgets in order to create Tangible User Interface (TUI)s that are simple, available and cheap to build. [Jung et al., 2005]

Phidget devices include sensors for RFID signals, pressure and rotation as well as led lighting with an easy to use interface. According to Jung et al. pervasive games encourage tangible interaction as well as physical activity and social interactions of players. Furthermore, they also engage non-players in conversations about gameplay, since pervasive games are often played publicly (see also 4.3.11). [Jung et al., 2005]

Pervasive Cheating

According to Glas the social media application Foursquare combines elements of gamification (see 4.10) and pervasive gaming. In this application, users can earn badges, which function as a form of achievement (see 4.6.1) system, for checking in at different places. [Glas, 2011]

Pervasive cheating, which is a term coined by Glas for cheating in pervasive games, has broader implications than cheating in video games. Pervasive games and other applications rely on a high level of involvement of user input, which makes it easy to cheat by inputting false information. Glas states that pervasive games offer a great variety of cheating regarding form and severity. [Glas, 2011]

As mentioned before, Foursquare offers achievements for players in order to compare their data. Users of Foursquare receive the *mayor badge* for a certain place, if they have visited it several times. Glas states that players who received these achievements without cheating experience feelings of frustration for putting in lots of effort that cheaters circumvented. [Glas, 2011]

Cheating can have different sources of motivation. While some players only want to avoid the hassle of completing a challenge, subverting rules (see 4.3.6) and achievement systems can also be a cultural phenomenon, as was the case with Indonesian Foursquare players, who considered cheating status-enhancing, as a response to the strict Suharto regime. [Glas, 2011]

Foursquare can be used in a non ludic context as well. Glas pointed out, that he was awarded the *I'm on a boat* badge for checking in at Amsterdam Central Station, because a cheater tagged it as being a boat. This form of cheating does not only involve players

who are using Foursquare as a game, but also users, who use it for other purposes and surprisingly get faulty badges become involved in cheating. This gives non-players a playful identity and equips cheating in pervasive gamified applications or games with a special role. [Glas, 2011]

4.3.12 Interaction Modalities

Biotic Games

Within the last years the scope of video game interaction was extended by biological materials, which include living organisms. This approach to video gaming is fairly new and several questions remain unanswered at this stage. Gerber et al. outline new design spaces for biotic games and recommend a hardware architecture as well as design guidelines for this new type of video games. [Gerber et al., 2016]

The main idea behind biotic games is that instead of virtual objects players interact with microbes (or other living beings). This can be established by sending phyiscal stimuli that make the microbes respond in a certain way, just like a button press would make an in-game object behave in a certain way. This interaction is mediated by a computer and a screen which provides the possibility to add virtual objects for augmentation into the games. [Gerber et al., 2016]

Gerber et al. outline several use cases for biotic games: they can help to teach biology, they can be a valuable addition to life science research, they can replace real-time simulations where computation is very complex or infeasible, they can help to spread first hand experience with biotlogical material for general education and they can probably be used on smartphones in the future due to sensor for diagnostic purposes that will find their way into mobile phone specs soon. [Gerber et al., 2016]

The diversity and possibilities of biotic games becomes easily visible when analyzing the design space. From a high level perspective, there are two actors in traditional digital media, humans and technology, i.d. the design space consists of two nodes with different possibilities of edges between them. Compared to classical media like TV, games are special due to the bidirectional interaction between the two actors. Biotic games bring a third actor into this equation which results in a more complex and more flexible design space. Precisely the possibility of drawing bidirectional, unidirectional or no edges between three nodes provides designers with a design space of 64 different interaction types. [Gerber et al., 2016]

Figure 4.17 shows an example of a design space diagram. In this example digital content is generated based on biological inputs and human players can consume biological inputs while interacting with the digital space.

Gerber et al. consider 21 of those design space options to be especially important, as they enable a meaningful interaction between human, digital and biology. They share three properties: direct stimulation of at least one other component, one-directional or

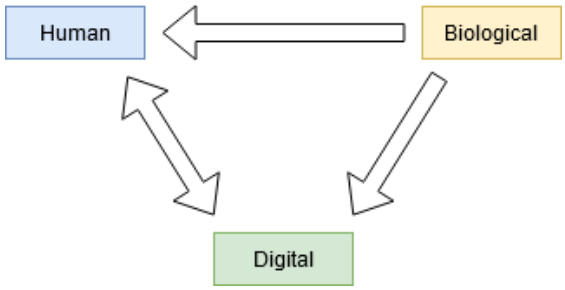

Figure 4.17: Biotic Games Design Space Diagram

bidirectional connection between biology and digital and human players take in inputs from both the biological and the digital component. [Gerber et al., 2016]

For concrete implementation of biotic games, Gerber et al. recommend using Biotic Processing Unit (BPU)s. A BPU houses microbes or other biological material that is part of the biotic game as well as sensors to enable digital input and output signals for communication with other computers. [Gerber et al., 2016]

An example for a medium designed for biotic games, that uses a BPU is *Trap it!* by researchers of Stanford University. [Lee et al., 2015a, Gerber et al., 2016]

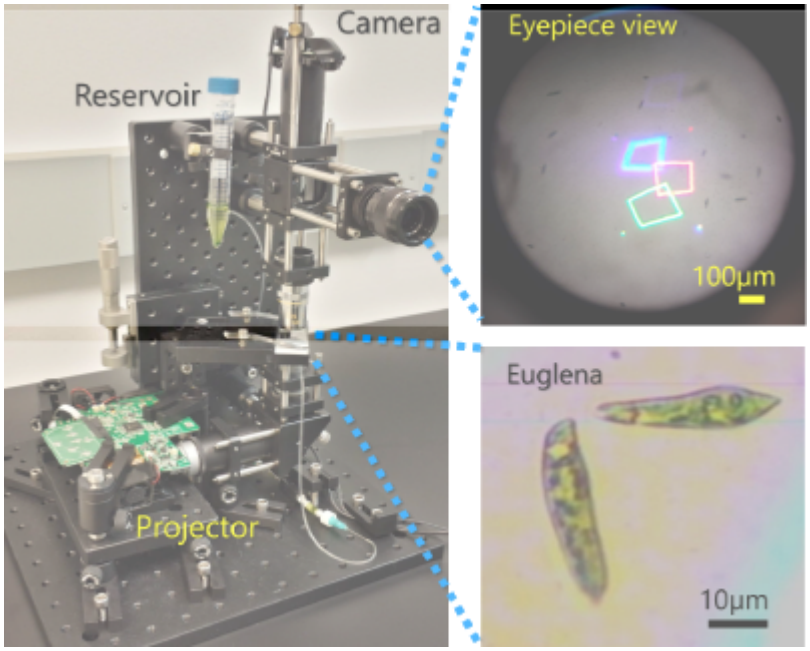

Figure 4.18: *Trap it!* hardware. [Lee et al., 2015b]

Trap it!'s BPU is shown in figure 4.18. It consists of Euglena cells as its biological material, a projector to create stimuli and a camera sensor captures the signal. This collection of hardware components can be treated as an abstract unit with programming interfaces

when creating biotic games. [Gerber et al., 2016] The Euglena cells are cultured in a reservoir that is controlled by a programmed Arduino board. The chamber is regularly automatically flushed to regulate the amount of cells. [Lee et al., 2015a]

When designing biotic games, designers have to take additional difficulties and problems into account. While traditional programming usually involves working with components that execute deterministic logic, with biological material non-deterministic behavior is a constant factor that has to be considered. The playing experience however still has to feel robust and consistent. Gerber et al. summarized best practice rules for biotic games: [Gerber et al., 2016]

- Usage of a robust BPU and biological material

  The advantages of using a BPU, i.e. hardware abstraction, have been already presented above. Small material, i.e. single cells or organic molecules, should be used not only for ethical reasons but also for their property of being low-maintenance and fairly cheap. By using Euglena cells, Lee et al. used biological material in *Trap it!* that offers these properties. [Lee et al., 2015a, Gerber et al., 2016]

- Match length and time scales of human and biological components

  Game designers are usually not able to alter the speed of their biological material afterward or even dynamically. Therefore, thorough considerations on what material to use have to be made before the game design process has started. Degrees of flexibility are usually provided by the level of zoom and optimized by using a combination of optical and digital zoom. The degree of zoom has to be chosen in a way that enables players to easily see the biological material, as well as interacting with it. Therefore size and speed of movement of microbes also have to be in a certain ratio, otherwise players will not be able to interact with them [Gerber et al., 2016]

- Design Hardware and Software to make up for non-deterministic behavior

  This rule has to be realized throughout different stages and components. Flexibility in the intensity of stimuli increases the robustness of the gaming experience. Applied to the example of the presented *Trap it!* system, this means that light impulses should be usable with a different amount of lux to compensate for non-deterministic and unpredictable differences in the response to these impulses. [Lee et al., 2015a, Gerber et al., 2016]

  Classical game design elements like a game narrative should be implemented in the digital game design space. This allows for much more flexible and deterministic control over game elements, which is especially important for elements that appear and disappear dynamically or have to change their shapes and size. [Gerber et al., 2016]

  The behavior of cells can also be different for every entity of biological material, therefore designers should offer the possibility to interact with specific cells only, so

that cells that don't behave in the desired way can be filtered out. [Gerber et al., 2016]

Scenarios that are difficult to recreate in the biological design space should be simulated in the digital design space. This is especially important in the prototyping and development phase. While biophysical models can be helpful, simple agent-based simulations of reactions to stimuli often suffice. [Gerber et al., 2016]

- Present biology and technology

  Players of biotic games should be aware that they are interacting with actual biological material in real-time. This can be established by providing tutorials that provide an extra layer of digital visualization of microbes or by providing an eyepiece in addition to the camera to clarify that a microscope is involved. [Gerber et al., 2016]

  Furthermore, it is advisable to visualize details on a subcellular level, e.g. by applying colors to certain features of the biological material. In addition, also features like speed of movement or growth can be visualized. [Gerber et al., 2016]

  Apart from the awareness of playing a biotic game, players should also be able to understand why a game is implemented as a biotic game instead of just programming a digital simulation. [Gerber et al., 2016]

- Design ethically and safe

  When it comes to ethics, biotic games raise several questions, especially when interacting with beings, other than non-sentient microscopic organisms, such as crickets. Furthermore, Gerber et al. suggest not modifying cells for ethical reasons, i.e. cell interaction instead of cell manipulation. A minimal ethical recommendations framework was presented in 2014. [Gerber et al., 2016]

  To ensure the safety of players, it is advisable to use cells that are already established in educational use, e.g. the Euglena cell, that was used for *Trap it!*. Locking biological material into closed spaces, e.g. inside a BPU, helps keep players safe. Another approach is actual remote interaction. [Gerber et al., 2016]

- Take audience and application into account

  The desired game experience has a great impact on the hardware architecture. Biotic games for entertainment purposes should be always readily available to play without lots of preparation whereas their use in schools for demonstration purposes may require some preparation. This decision has to be made beforehand. Furthermore, the design should consider richness in observable biological behavior. A large discovery space creates more interesting scenarios for players. [Gerber et al., 2016]

Paratextual Play

In several cases, digital games are published with additional, complementing material, similar to the special material that is often added to a film DVD. [Glas, 2016]

Glas refers to this content as paratextual material and considers it an integral part of the media ecology of a video game. The combination of text, i.e. the actual narration of the game, and paratextual shapes how games are perceived and understood. [Glas, 2016]

In comparison with its counterpart from the video industry, paratextual material in video games is often integrated much more deeply into the actual medium, whereas on video media they can usually be accessed within the menu and are usually completely separated. Glas names audio commentaries which are integrated as speech balloons in the game world and unlockable content as examples, which can either be enabled after finishing the game or by successfully completing specific tasks within a game. [Glas, 2016]

In addition, paratextual content can be linked to reward systems (see 4.1.12), which creates a playful interaction with making-of material making it a meta goal of the game itself. [Glas, 2016]

4.3.13 Non Player Characters

NPCs are game elements, that possess a similar intelligence within the game context and knowledge of the game world and rules as players.

The intelligence that NPCs are equipped with is often referred to as artificial intelligence and its implementation quality is considered crucial for a realistic and challenging gaming experience or as Dignum et al. put it "intelligent characters for games can make games better" [Dignum et al., 2009].

For programmers and designers, NPCs are very complex systems to define and implement, since they should behave autonomously and therefore only be loosely coupled with the game engine. On the other hand, NPCs should feel integrated into the game world. Therefore a translation system between properties of the game world and actions and will of NPCs has to be established for each game. [Dignum et al., 2009]

In many modern games NPCs are even more complex, since they should also cooperate with each other in an intelligent manner by an elaborate communication system. [Dignum et al., 2009] Examples for this requirement are shooters, where single NPCs split up or form groups to follow a certain strategy or sports games, where players of a squad have to coordinate passes and movement between each other.

4.3.14 Play as Performance

Within the last years, the importance of playing video games as a performative act has attracted large audiences, especially within online communities. A whole new ecological field evolved around play as performance, often referred to as Let's Plays.

Fernández-Vara developed a framework that puts video games in a performative perspective. Theatrical performance was chosen to serve as the basis for this framework, since it provides lots of similarities with Let's Plays sessions. Players of video games do however have a dual role, i.e. they are performer and audience at the same time. [Fernández-Vara, 2009]

A performance requires an audience that gives meaning to an action, as Fernández-Vara points out. Another characteristic for performances that is applicable to theaters as well as gaming is that the magic circle constitutes the boundaries of the actions. [Fernández-Vara, 2009]

Performances have five different properties, whether they are taking place on a sports pitch, in the theater or in front of the screen: [Fernández-Vara, 2009]

- Time

  Generally there are three different types of time. *Event time* represents the duration of the performance, *set time* is *event time* with a predetermined length and the *symbolic time* is the time represented in a performance, e.g. a historic period in a theater play. In performances there is a specific order of time-based events. [Fernández-Vara, 2009]

- Objects

  Objects have a specific value in performances, which may differ from the value they have in a non-performative context. [Fernández-Vara, 2009] Within the game world, in-game currencies are a prime example for different value systems in different contexts.

- Non-Productivity

  Performances do not create goods that are of value outside of the performance context. This property is however debated, since performances often produce money, e.g. considering gambling as a performance. [Fernández-Vara, 2009] In Let's Plays sessions that are streamed online this property is also questionable, since royalties for the streaming platform and the streamer are generated.

- Rules

  Performances take place in the confines of rules, which define the optimal actions to take in a situation within the performance. [Fernández-Vara, 2009]

- Performance Spaces

  The rules and regulations within a performance are only effective within the magic circle of the performance. [Fernández-Vara, 2009]

Fernández-Vara makes use of different concepts presented in this scoping review in the concept of her performance framework. The classical theater performance model that her

own is built upon consists of dramatic text, which corresponds to mechanics (see 4.3.1), performance, which corresponds to dynamics (see 4.3.2) and Mise-en-scène (see 4.3.3), which correseponds to aesthetics (see 4.3.3). [Fernández-Vara, 2009]

Games that simulate other performances, e.g. dance games or karaoke where players actually have to move or sing, are more likely to attract an audience of people who are not participating in the game itself. Playing a game with impressive skills or uncovering exploits or glitches within a game are other popular shapes of gameplay performances with high potential of an interested audience. [Fernández-Vara, 2009]

E-Sports

Regarding performative gameplay with a remarkable skill set, e-sports have manifested themselves as a potent industry, in which professional gamers compete against each other in teams or as solo performers.

It is often argued that there are vast differences between traditional sport performances and playing video games as performances. A popular opinion is that e-sports should be called *pro gaming*, since games are not necessarily sports by nature. [Ferrari, 2014]

According to Ferrari, e-sports differ from aesthetic sports (a category of sports by David Best [Ferrari, 2014,McFee, 2013]) due to their emphasis on the human body. Spectators of e-sports events, do not observe the gamers, who are often even hidden from the audience, but the projection of the game scene. Therefore, the aesthetic value of the performance is not created by a human body, but by the work of game designers. [Ferrari, 2014]

Ferrari spots several problems of the aesthetics of e-sports. Strategy games have very similar processes of build up for each player, which makes it boring for spectators to watch, fighting games suffer from phenomenons like zoning and games that are played in first-person perspective suffer from confusing switches of player perspectives, due to most views looking alike, which makes it hard for spectators to distinguish between players. [Ferrari, 2014]

4.3.15 Problem Solving in Video Games

Anderson et al. examined how problems are solved in video games by applying microgenetic methods [Anderson et al., 2009]. As pointed out by Koen Luwel, the usage of microgenetic methods to examine a process requires researchers to carefully observe state changes from before they take place until the state reaches a stable position. [Luwel, 2012] In this scenario this translates to examining closely how participants apply different rationales to overcome riddles in video games.

In their study Anderson et al. observed the strategic thinking process of students between nine and twelve years old (n=22) over four months when playing commercial video games. The focus of this study was to answer how feedback within games impacts game play strategies and whether children used systematic strategies in order to solve game riddles. [Anderson et al., 2009]

The used methodology is based on a research framework with seven steps, which are based on a model by Kuhn and Pease: [Anderson et al., 2009, Kuhn and Pease, 2008]

- Recognizing that a problem exists
- Designing investigations that will result in relevant findings for said problem
- Interpreting collected evidence
- Justifying conclusions drawn from the prior step
- Revising theories based on collected evidence
- Generating predictions
- Sharing results

The observed game sessions were split into different categories represented by codes: [Anderson et al., 2009]

- A player understood a concept and applied it
- A player is moving towards understanding a concept
- A player is applying previously gained knowledge
- A player does not understand a game concept

This coding served as the basis for further examination. Anderson et al. recommend to apply this coding to existing models of strategic competence in order to increase insights into the strategic thinking process in problem solving. [Anderson et al., 2009]

4.4 Forms of Representation

4.4.1 Spatial Representation

Social Space

Research on spatial representations in video games are often based on Lefebre's observations, declaring space as a produced artifact, that is built upon a society's spatial practice. Therefore, Lefebvre refers to the product of this process as *social space*. [Lefebvre and Nicholson-Smith, 1991, p. 291]

According to Lefebvre there are three aspects to the system of social space [Lefebvre and Nicholson-Smith, 1991, p. 38f]:

- Spatial Practice

  According to Lefebvre, social space is built slowly within the process of spatial practice, while being presupposed by and adapted to the needs of society. Deciphering a society's social space leads back to its spatial practice.

- Representations of Space

  Social space is represented by cultural concepts, such as those of scientists, planners and architects.

- Representational Space

  Social Space is primarily experienced through its semantic signs, e.g. symbols and images. Representational space is passively experienced and changed according to the recipient's expectations and imagination. In terms of video games and their perceptions, this concept is of major importance.

As Zhang points out, video games are representations of space, where game designers are what planners and architects are to non-virtual space. At the same time, however, they are also representational space, perceived by players via the game's characters [Zhang, 2014].

Perception of Spatial Representations

Schwartz claims, that through a high degree of realism, game worlds can be perceived as real and players engage with them as tourists [Schwartz, 2006]. Game Designers can provoke interesting effects in players, when creating a representation of a city in a game, that is then perceived through gameplay by locals. Zhang examined, how the virtual representation of Hong Kong in the game *Sleeping Dogs* is perceived by locals, who find themselves in the paradoxon of being visitors or tourists of their own town. [Zhang, 2014]

Zhang describes, what compromises game designers have to make, when creating a representation of a real location, especially if it has the aim of being authentic and still enjoyable within the boundaries of game mechanics. With *Sleeping Dogs* designers had to find a balance between an authentic and a cliche-prone representation of the city. Furthermore, some details had to be adjusted to adapt the city into an adequate representation for a game, for example the streets had to be wider then they actually are, to ensure smooth gameplay. [Zhang, 2014]

Furthermore, Zhang examined, that Hong Kong natives had special gameplay experiences and objectives when playing *Sleeping Dogs*. In an interview series, his finding were that a player's engagement could be compromised by negative feelings about a cliched hometown. Furthermore, Hong Kong-based players showed a lot of interest in minibusses, which are typical for the city and requested a greater number of interaction possibilities with these vehicles. Sine the spoken language within this game is Cantonese, several interviewed players created their own interaction method with and aim within the game,

provoking pedestrians on the street, so that those would respond with Cantonese swear words. [Zhang, 2014] This shows, that the spatial representation within a game can lead to subjective aims and perceptions of players or a group of players, which can be used as a tool by designers.

Ludic Space as Architecture

Adams considers ludic video games space as a form of architecture, since their design undergoes a similar process. Therefore, a comparison between the two spaces with regards to human perception has been presented: [Adams, 2003]

- Vision

  The visual angle with which ludic space is perceived is significantly smaller than human eyes are capable to perceive. The visual angle for computer monitors is between 40 and 60 degrees, compared to up to 200 degrees in real space. For consoles that are connected to TVs the difference is even bigger due to the increased distance. [Adams, 2003]

  Real space is perceived fully stereoscopic whereas video games need VR periphery to enable stereoscopic vision. Other restrictions include light intensity, darkness, image resolution and fixed focus. [Adams, 2003]

- Sound

  The perceivable sound in video games is strongly dependent on the provided software and hardware. Game sound is only three-dimensional if players have a surround sound system. The number of ambient sounds is limited by supported sound channels. Sound effects in games are often approximations and do not fully represent their real counterparts. However, in ludic spaces soundtracks can be added to contribute to the designed atmosphere. [Adams, 2003]

- Touch

  Haptic elements in ludic spaces are hardly ever implemented. Even though tactile feedback is incorporated into the game experience (see 4.3.10) this feedback usually correlates to in-game events rather than to the ludic space. [Adams, 2003]

- Smell

  The use of smell in video games is still in an academic state and not common for commercial game design. [Adams, 2003]

The architecture in ludic places is often similar to real places. Adams points out that the main purpose of architecture in ludic spaces is to support gameplay. Therefore, a house in a video game does not necessarily have to have the same functions as in real life. Objects in ludic space usually introduce constraints into a game, i.e. they limit the game world and predefine where avatars can move and what they can explore. [Adams, 2003]

Furthermore, architecture in games can convey familiarity as well as certain emotions, which can be triggered by styles, e.g. a cartoon shading or a surrealist setting. [Adams, 2003]

4.4.2 Level Design

Level Design Practices

Kayali and Schuh examined level design in what they refer to as contemporary retro games, i.e. games that contain "retro flair with modern, focused gameplay" [Kayali and Schuh, 2011]. Within the confines of this study the core game mechanic (see 4.3.1) is considered the base on which level design elements are built. [Kayali and Schuh, 2011]

A subset of definitions of good level design is given by Kayali and Schuh: [Kayali and Schuh, 2011]

- Balance Difficulty and Challenge

  The balance of difficulty and challenge enables players to find themselves in an optimal state of flow (see 4.3.7). [Kayali and Schuh, 2011]

- Balance Between Freedom and Constraints

  Players should experience the feeling of agency by being provided with the freedom of executing individual actions while constraints ensure that games are deterministic and somewhat predictable. [Kayali and Purgathofer, 2008, Kayali and Schuh, 2011]

- Recombine Game Elements

  Players should be able to reuse elements and actions and combine them in individual ways in order to evoke the feeling of mastery. [Kayali and Schuh, 2011]

- Drive Narrative

  Levels may be used to introduce new aspects or elements into the game and should be designed in a way so that they are aligned with the game narrative and progress. [Kayali and Schuh, 2011]

- Guidance

  Elements in game levels should include indicators that convey possibilities to interact with them. [Kayali and Schuh, 2011]

After the examination of seven contemporary retro games, Kayali and Schuh identified the following practices regarding level design: [Kayali and Schuh, 2011]

- Expand on Strong Game Mechanic

  This design practice is limited to games that heavily rely on a single game mechanic which is easy to apply. Players need to master the game mechanic and use it in a

certain way in order to progress. This game principle is supported by level design which includes small sections that can be replayed multiple times without losing a substantial quantity of game progress. Progressing in levels means encountering new challenges or increasing difficulty. This practice of level design is commonly used in physics games. [Kayali and Schuh, 2011]

- Iterative Level Design

  Levels that are designed iteratively contain several different game elements that are generated procedurally. This leads to randomness in the game experience, due to the procedurality levels usually being composed of randomly generated elements and no two game sessions are identical. This approach scales very well as the used methods only have to be designed once and can be used multiple times. Kayali and Schuh cite Saltsman, the creator of one of the examined games, who states that applying this technique is risky since even though the elements seem to be randomly generated the predictability needs to be neither too high so that players get bored nor too low so that players get frustrated. [Kayali and Schuh, 2011, Saltsman, 2010]

- Design Game Modes not Levels

  Instead of levels that represent that game progress and reveal game objects, designers can also present players with different game modes. The core mechanics are shared throughout all different game modes but game objectives, rules and preconditions vary. [Kayali and Schuh, 2011]

- Sandboxes and Emergent Gameplay

  Several games do not contain fixed-level designs or procedural algorithms that create game objects but leave the creative process of arranging game objects as a level to the players. Game designers include a set of game objects that can be arranged by tools that are provided to the player. The designer's objective in this case is the design of intuitive level creation tools as well as game objects that support a high degree of recombination. [Kayali and Schuh, 2011]

- Object-Oriented Level Design

  Object-oriented level design is based on the inheritance of patterns. Basic patterns are introduced in a level and when the game progresses these are extended with variations. This corresponds with object-oriented programming. Variations have to be creative in order to not create a game experience that feels repetitive. [Kayali and Schuh, 2011]

Mise-en-Scene in Level Design

Logas and Muller promote a holistic mise-en-scene approach for level design in computer games. This approach includes designing a game focusing on immersion to emotionally connect to a player. In effect, this means that a game designer can use every visible object in a game scene to encode information that is passed to players on a conscious or

on a subconscious level. Level design can be used as a means of communicating not only emotion, but also psychological meta-information about the in-game characters and as a part of the narrative. [Logas and Muller, 2005]

The classical mise-en-scene in film includes cinematography, lighting, blocking of actors, art direction, set dressing, costumes, props and use of color (see Use of Colors in Games). As the researchers point out, all the above-mentioned elements of the mise-en-scene lie within the responsibility of the level designer. [Logas and Muller, 2005]

The use of mise-en-scene in level design is mostly manifested in survival-horror games, as Logas and Muller point out. The researchers state, that similar techniques are applied all over different game genres, but a detail to the extent in which scene design is conducted in films is still uncommon. Their thorough analysis of the mise-en-scene elements in the scene design of two films is supposed to help game designers examine level design with the same detail. [Logas and Muller, 2005]

4.4.3 The Role of Light in Video Games

Niedenthal presents a terminology framework for lighting in video games. The lighting of ludic space is heavily influenced by the lighting in animation films. In order to analyze the role of lighting in video games, Niedenthal uses the five objectives of lighting by Calahan: [Calahan, 1996, Niedenthal, 2005]

- Directing the viewer's eye
- Creating depth
- Conveying time of day and season
- Enhancing mood and atmosphere
- Revealing character personality

Several techniques used in video games are directly derived from classical cinematic lighting, e.g. leaving the eyes of an avatar in the dark to not convey his mood or motivations. This is usually done via directed light which is situated on top of the avatar. These techniques are commonly used in cut scenes, where the perspective is fixed. However, the free exploration and the reduced control over the lighting within the scene due to the changing camera angle often make it impossible to anticipate exactly how players will perceive a designed scene. [Niedenthal, 2005]

The color of the lighting also affects how players perceive a game and consequently also their behavior (see 4.4.5). Belcher and Kluczny state that mood and vision are directly related and a change in vision has direct implications on players' mood which changes their decision-making strategy. Poorly lit surroundings may make avatars appear more dangerous and guide players' decision-making process towards eliminating them due to applied heuristics. [Niedenthal, 2005, Belcher and Kluczny, 1987]

4.4.4 Time Representation

Narrative Time in Video Games

The representation of time within a narration is a crucial concept in the video game narrative. The universal concept of narrative time is not bound to the context of the ludic and is therefore applicable to narrations within the boundaries of various media types. The Oxford Research Encyclopedia defines narrative time as follows:

"To consider the ways in which narratives involve the interrelationships of different temporalities is also to be reminded of the disjunction between so-called "real" or clock time and time as it is experienced. In contrast to the uniform directionality of clock time, time as it is experienced is constantly intertwined with memory and anticipation: that is, any experienced present is also interwoven with multiple pasts and futures. Narrative time captures this experience." [Nelson and Spence, 2020]

The concept of disjunction between two different timelines has been examined and adapted by several scholars. Eskelinen, for example, uses the terms *story time (the time of the events told)* and *discourse time (the time of the telling)* [Eskelinen, 2004] to explain the same time correlation in narratives.

Video games are often narratives, as Anyó pointed out, where the narrative time is directly affected by the player's actions. [Anyó, 2015] The concept of disjunction of two different times is also covered and put into a gaming context by Eskelinen, who states that within the confines of the video game context, the relevant times are *user time (the actions of the player)* and *event time (the happenings of the game)*. [Eskelinen, 2004] Juul uses the concepts of *play time (the time span taken to play a game)* and *fictional time (the time of events in a game world)* as measures to describe narrative time within computer games [Juul, 2011, p. 142]

As Anyó stated, Maietti extends this theory by replacing the concept of play time or user time with interaction time, since the actual time of playing a game and the time of game interaction can vary and according to Maietti, the latter is more appropriate to accurately understand narrative time relations in games. According to Anyó, the concept of interaction time is what stands out when comparing the narrative time of video games with other media types. Different factors like the player's skill influence interaction time and make it non-linear. [Anyó, 2015] While the time it takes to consume a film is usually predetermined by its length, this does not necessarily apply to games, where the interaction time can be either fixed or dependent on the player.

Anyó states that the narrative loop is a typical design element in video games (for example if the avatar dies within a game, the player has to restart the loop) to present a narration to the player and to move forward in the story. This pattern creates tension between the participation time and the story time and has become a key feature of video games. [Anyó, 2015]

Anachronisms

The representation of timelines cannot only be influenced by game designers by tweaking the fictional time and by parameterizing interaction time, but also by composing its chapters within a certain order. Gaudrenault and Jost defined the order within the cinematographic context as the comparison of the order determined by the diegesis and the order of its occurrence within the narrative. [Jost and Gaudreault, 1995, p.112] The observations of Gaudrenault and Jost are scientifically based on a publication of Gerard Genette, who identify three different orders, in which a narrative can take place: chronological narrative, analepsis and prolepsis[Anyó, 2015; Genette, 1989; Jost and Gaudreault, 1995, p.114].

While the chronological narrative respects the order of the diegesis within the narration, analepsis and prolepsis present two options of anachronisms[Genette, 1989; Jost and Gaudreault, 1995, p.114]. Within the scope of cinematography, the terms *flashback* and *flashforward* are commonly used terms for analepses and prolepses, but as Gaudrenault and Jost as well as Anyo pointed out, those t erms only refer to visual aspects. Analogous to the *flashback*, within an analepsis an occasion, for example, a memory, is recalled in a later point in the story line, whereas in a prolepsis, a sequence that happens later in the narration is presented earlier within the narration, analogously to the *flashforward*.[Anyó, 2015; Jost and Gaudreault, 1995, p.114]

Anyó furthermore explicates, that while being fairly common in movies, it is difficult to incorporate these narration principles within a video game. This is due to what he refers to as the temporal paradoxes or paradoxes of time travel: if the avatar dies during an analepsis, the character has to be dead also in the present, which does not coincide with the current state of the narration. After a prolepsis, the player who controls the avatar has information on the future state of the game which influences the avatar's behavior based on knowledge, that the avatar cannot possibly have. According to Anyó, anachronisms are practically non-existent in video games due to these paradoxes. [Anyó, 2015]

4.4.5 Use of Colors in Games

Geslin et al. state that "emotions are a key element in the success of video games". [Geslin et al., 2016] The researchers conducted quantitative research with n = 85 to examine whether emotions in players can be evoked or enhanced by the mere use of colors in the graphical representation of a game. Participants were presented with a semantic subjective questionnaire, based on IAPS surveys. [Geslin et al., 2016]

24 randomly selected still images from different game genres were rated according to the emotions they evoked in the participants. Those ratings were then analyzed with regards to a calculated color model to detect correlations. Geslin et al. tried to attenuate the impact of age, sex and cultural background on study results by not evaluating their analyses against certain emotions, but against the general emotional dimensions of valence and arousal. There was moderate diversity within the group of participants, 31 females

and 54 males with an average age of 32 were selected. For their IAPS based survey, they asked for emotions of Pleasure, Arousal, Domination (PAD). [Geslin et al., 2016]

The following properties based on color distribution were calculated for each image. The computed values were brightness, hue, value, chroma and lightness. Correlations were calculated using Pearson's correlation coefficient. [Geslin et al., 2016]

Geslin et al. found correlations for several emotions and color properties. The feeling of happiness (and unhappiness), as well as fear (and dominance) can be influenced by image brightness, value, chroma and lightness. For the hue value no significant correlation could be proven in both cases. [Geslin et al., 2016]

In correlation tests for arousal, i.e. calmness versus excitement, no statistically significant findings could be documented for either of the above-mentioned color properties. [Geslin et al., 2016]

Futhermore, for happiness and arousal, a correlation between chromatic diversity in the sample images and the tested emotional states could be found, whereas this could not significantly be proven for the emotions of fear or dominance. [Geslin et al., 2016]

As can be seen in figure 4.19, a higher color diversity leads to a higher level of arousal whereas valence is determined by the brightness and chroma of colors. [Geslin et al., 2016] These values form a 2D coordinate system with emotions and their intensities can be easily mapped to polar or Cartesian coordinates.

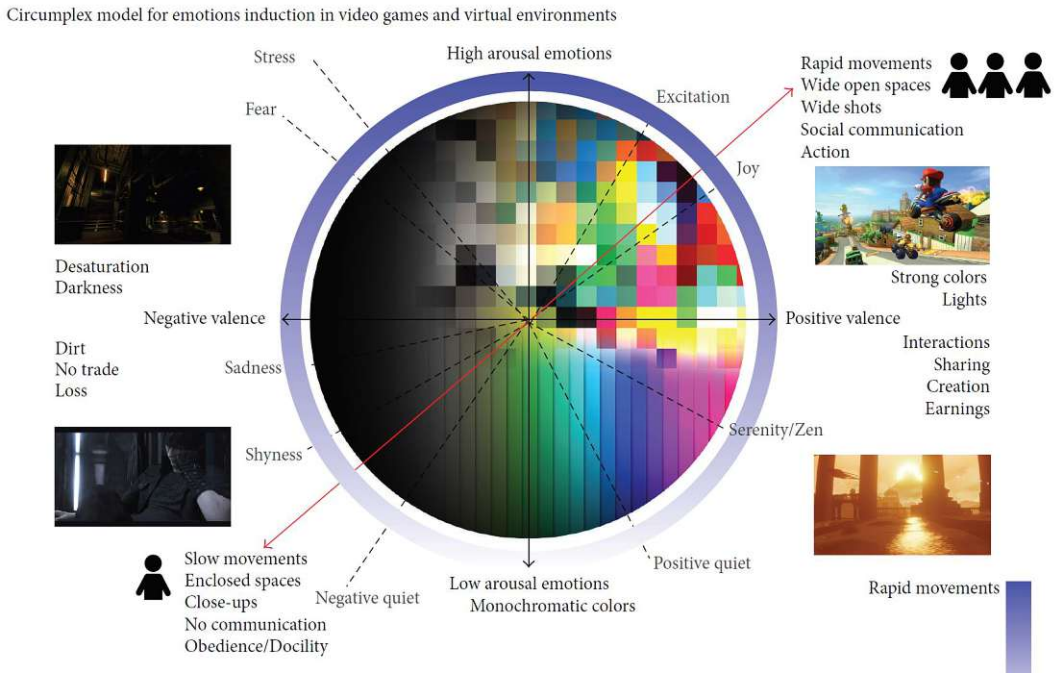

Figure 4.19: Circle of colors and emotions, ©Erik Geslin Ph.D. 2012 - 2015

4.5 Character Design

4.5.1 Non-Verbal Communication in Avatar Design

Thurlin and Manninen propose the incorporation of non-verbal communication (NVC) in avatar design in order to enhance their communicative functions. [Thurlin and Manninen, 2003]

Three types of NVC for avatars were examined by Thurlin and Manninen, due to their research scope of visual aspects of NVC: [Thurlin and Manninen, 2003]

- Physical Appearance

  An avatar's physical appearance is composed of the decoration that a player applies to it. It ranges from hair to physique. [Thurlin and Manninen, 2003]

- Kinesics

  An avatar's kinesics includes all its body movements and gestures. [Thurlin and Manninen, 2003]

- Facial Expressions

  Adding facial expressions to an avatar can enhance the natural communication between users. These are often designed by animators who study human facial expressions and try to create an authentic representation in a game world. [Thurlin and Manninen, 2003]

Thurlin and Manninen created a three-layered model for the integration of NVC based on observations of human interaction: [Thurlin and Manninen, 2003]

- Elements of NVC

  This layer represents the tools a designer incorporates into the avatar design. It is composed of the categories *physical appearance*, *kinesics* and *facial expressions*. Designers should consider carefully at this stage, which elements of which category enhances communication between players. [Thurlin and Manninen, 2003]

- Varying the Elements

  Within the second layer, the designer chooses in which way the elements can be expressed, e.g. how fast an avatar waves. [Thurlin and Manninen, 2003] This layer parameterizes the elements of the first layer.

- Personalization

  The personalization layer allows for alteration of combinations of elements and variations of NVC in character design. In order to achieve natural NVC, it is essential to the gestures of avatars do not look exactly the same. [Thurlin and Manninen, 2003]

4.5.2 Avatar Categorization

Kromand created a conceptional categorization of avatars by using a twin axes model (see figure 4.20). [Kromand, 2007]

The four resulting quadrants categorize the following types of avatars:

- The Central-Open Avatar

  The actions that this type of avatar executes are a central part of the video game. Players can choose lots of avatar properties and knowledge of the game helps to choose and use them effectively. [Kromand, 2007]

- The Central-Closed Avatar

  The central-closed avatar is the most common type of avatar. It cannot be personalized or changed but its actions are crucial to the game experience. Kromand states Pacman as a popular example. [Kromand, 2007]

- The Acentral-Open Avatar

  The actions that this type of avatar executes are not central to the game, at least when being examined as single actions. For acentral-open avatars combinations of actions are more important than single commands and often single commands cannot be executed through the player. Players can customize this type of avatar freely. [Kromand, 2007]

- The Acentral-Closed Avatar

  The acentral-closed avatar is the least flexible and the least important. Players have little to no control over the appearance or actions of the avatar. Kromand considers this type as "useless from a ludological perspective". [Kromand, 2007]

4.5.3 Character Identification

Shaw describes different types of relationships between a character and a player. Elements of game design provoke that this relationship shifts between self-identification and self-reflection. [Shaw, 2011]

Furthermore, as Shaw cites Kennedy and Schleiner [Kennedy, 2002, Schleiner, 2001], the type of relationship between a player and a character depends on the players themselves, e.g. a male player may experience playing as a female character as a form of cross-gender role-play whereas a female player may identify more with the character. [Shaw, 2011]

In a thinking aloud study (n=27), participants' remarks about their relationship to the character during game sessions were collected. [Shaw, 2011]

The results showed, that agency over a character enhances immersion (see 4.3.8) but does not increase character identification, meaning that higher power over a characters

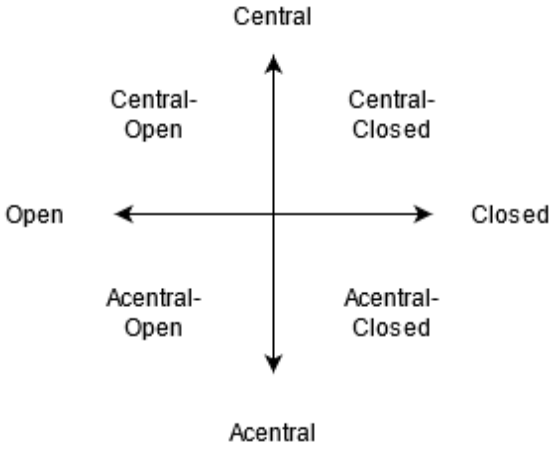

Figure 4.20: The Avatar Categorization Twin Axes Model by Kromand [Kromand, 2007]

movements and actions make players feel as if they are in the game themselves, but do not make them identify with the character on an emotional level. [Shaw, 2011]

This process also leads to self-reflection, i.e. when players have a high level of agency within a game, they reflect on the players' actions as if they were their own, due to the above-mentioned property of immersion. [Shaw, 2011]

Narrative structures in games generally lead to a higher level of identification with the character, given that the genre and game design allows for this process to happen, e.g. the player is willing to identify with a strong female character and plays as Lara Croft. [Shaw, 2011]

4.5.4 Personality in Character Design

According to Lankoski et al. designing the personality of a video game character is more sophisticated than that of a protagonist in films or books, since it partly depends on a players' actions. In order to approximate the character design of non-interactive media, game designers can limit the freedom of a character's actions and create an unchangeable setting. [Lankoski et al., 2003]

One important tool that designers can use to communicate character personality or properties is characterization. [Lankoski et al., 2003] When players observe Superman, they see a muscular body hinting that the character is able to lift heavy things has lots of strength, whereas when they observe Spiderman who is very slim, they will suspect that he has a flexible body which allows for different ways to defend and attack.

Lankoski et al. propose to design a game with the protagonist's needs in mind, since gameplay should reflect them and ultimately within a game session, the protagonist's needs equal the player's. One concrete approach to consider a character's personality in game design is the use of Egri's three-dimensional character design model, which

has been slightly adapted by Lankoski et al. in order to better fit the needs of game design. According to this model, character design can be approached through the layers of *physiology*, *sociology* and *psychology*. [Egri, 1972, Lankoski et al., 2003]

4.5.5 Cuteness in Character Design

Derived from Japanese comic culture, cuteness of video game characters is an established concept, that has also been largely successful in the western world. In a study by Tosca the game *Super Monkey Ball* was examined with regards to its character design and how players respond to this aspect of the game. Furthermore, the level of influence of the characters to the overall gaming experience was examined. [Pajares Tosca, 2003]

Figure 4.21: The Super Monkey Ball Characters [Nintendo-Online.de, 2019]

In *Super Monkey Ball*, players can choose from four different characters, see figure 4.21. At this point it is important to note that different characters do not offer different abilities or gameplay experiences in *Super Monkey Ball*, they merely change the visual and aural appearance of the game, which qualifies this game for an isolated visual character design analysis. Also, a sophisticated character story to promote character discovery and identification is missing, the game only gives a short description of the characters' personalities. [Pajares Tosca, 2003]

Tosca cites McCloud, who claims that simpler drawing, i.e. fewer details, in character design promote player identification. [McCloud, 1994, Pajares Tosca, 2003] Therefore, especially in Japanese comics, it is common that protagonists have simpler representations than villains. The two opposing principles, in this case, are *identification* and *objectifying*

or *otherness*. [McCloud, 1994] Tosca compares the monkeys from *Super Monkey Ball* to *Donkey Kong* as an exemplified version of this principle. [Pajares Tosca, 2003]

According to Tosca, integrating cuteness into character design is targeting the game market for children and parents. It creates empathy and overall a similar relation as players would have to their children or pets. Cuteness can be willingly created by following illustration techniques, e.g. an overly proportional head and eye size. As Tosca points out, a largely popular example of one of these techniques is *Hello Kitty*. Furthermore, *Hello Kitty* is comparable to the characters of *Super Monkey Ball*, due to their shared property of emptiness, i.e. they do not have a complicated story that is clearly visible by the consumer, but is provided merely with a short description by the manufacturer or designer, which is of little importance. [Pajares Tosca, 2003]

Figure 4.22: A drawing of *Hello Kitty* [Pixy.org, 2019]

In game character design there is a distinction between avatars and actors. Avatars are representations of the player in the game world, they can either be a customizable image or a photo of the actual player or a simple representation, e.g. a mouse cursor. Actors extend the concept of avatars by personality and other individual characteristics. The examined characters of *Super Monkey Ball* are somewhere between the two concepts as due to the aforementioned missing properties, e.g. character story or different gaming characteristics, they do not qualify as actors. [Pajares Tosca, 2003]

Qualitative questionnaires were handed to study participants of four different groups (n=18) before and after playing *Super Monkey Ball* to examine how players perceived the character design. The participants' age ranged from 10 to 29, their playing experience differed and male and female genders were considered. The results of the analysis revealed, that cuteness in characters is immediately appealing to younger players, while the older participants stated that even though one of them stated that he/she realized what the

designers were after when creating the characters, he/she does however not consider the characters cute. [Pajares Tosca, 2003]

After playing the game, participants considered the character *Baby* their favourite, by far. While younger female participants mostly used the term cute to describe the appearance of the characters, older participants enjoyed playing with the characters due to what one of them referred to as the kitch factor. The characters were mostly associated with positive attributes. The contrary of "cute" in this context seemed to be "cool". [Pajares Tosca, 2003]

Tosca states that cuteness that appeals to children is perceived positively also by adults because it comes with a kitch factor that is currently fashionable. Therefore, cuteness has a direct positive effect on children and an indirect positive effect on adults, i.e. it works in different ways, but it works. For some adults, it takes a certain level of interaction so that a positive impact is achieved. A prerequisite for the kitch factor to be effective is that there is a common understanding of it within society. [Pajares Tosca, 2003]

4.5.6 Uncanny Valley

The uncanny valley is a phenomenon that has been examined in robotics, especially in an HCI or assistive technology context but it also applies to the design of virtual characters. In 1970, Mori presented a model, according to which robots are more likely to be accepted by humans if their appearance is more similar to that of a human. There is however a region on the similarity scale, where devices or characters that look a lot like humans but are not entirely equal are not perceived as likable at all. This region is called the uncanny valley (see figure 4.23). [Mori, 2017]

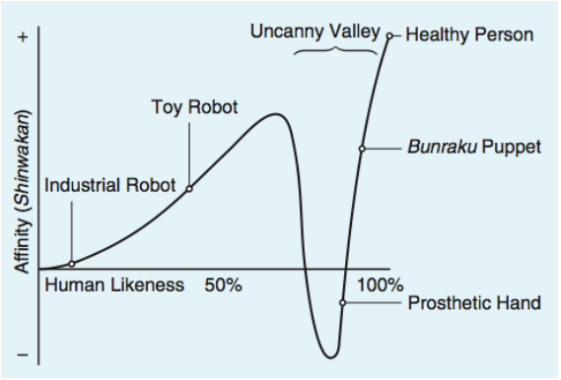

Figure 4.23: Mori's Uncanny Valley [Mori, 2017]

In a survey by Schneider et al. (n=60) in which participants were shown different characters with white backgrounds, scaled to approximately the same size, data were collected on how similar they appeared with regards to human appearance and how likable the characters were. In accordance with Mori's findings, more human-like characters are

considered more likable, but in the mid-range, i.e. between not human-like and very human-like, the character attractiveness decreases. [Schneider et al., 2007]

Schneider et al. state that these findings have implications on character design of video games and recommend using characters that emote like humans but differ significantly in appearance in order to avoid negative implications in attractiveness. [Schneider et al., 2007]

4.6 Social Interactions in Play

4.6.1 Achievements

Hamari and Eranti extracted a framework on how to design and evaluate achievements from scientific findings of popular achievement systems. Xbox Live and Steam are named as successful early adopters of achievement systems by awarding their players with digital recognition symbolized by digital badges and trophies and making this design element an industry standard. [Hamari and Eranti, 2011]

Achievements have often been considered as a non-essential part of games due to them not having an effect the progress within the core game. They can however represent a meta goal, i.e. an additional objective for a player and may therefore be considered as a game themselves according to Hamari and Eranti. Furthermore, in addition to the core game system, they open up the achievement and reward system in which achievements are goals. [Hamari and Eranti, 2011]

Considering data of nine games, the following properties that define achievements have been extracted by Hamari and Eranti: [Hamari and Eranti, 2011]

- Signifier

  Achievements contain visual information, typically including an icon, a title and a description referring to the challenge that has to be solved in order to obtain the achievement and the resulting reward. [Hamari and Eranti, 2011]

- Completion Logic

  Completion logic for obtaining an achievement consists of four components: a *trigger*, i.e. an action or an event, *pre-requirements*, i.e. general requirements of the game state, *requirements* that have to be met in order to activate the trigger and a *multiplier*, which defines how often the other three components have to apply in order to obtain the achievement. [Hamari and Eranti, 2011]

- Rewards

  When obtained, achievements are shown to the receiving player during a game session as well as to other players in joint game sessions. In addition to the reputation which is publicly shared, the reward is usually connected to an achievement score which allows for direct comparison with other players. [Hamari and Eranti, 2011]

- Levels in an Achievement

  Achievements just like core games often follow a hierarchical pattern, i.e. they increase in difficulty over time and like core games they are often divided into different levels which are supposed to be reached one after another. In several cases different levels share the same completion logic, except for the multiplier which can be altered in order to make an achievement more difficult to obtain. [Hamari and Eranti, 2011]

4.6.2 Communities

Micro, Meso and Macro Communities

Warmelink and Siitonen reviewed publications (n=17) with different scientific methodologies on the structure of communities in online multiplayer games that were released between the years 2000 and 2010. The main aim of this review was to tackle the problem of lacking definitions and imprecise terminology within this field of game design research. [Warmelink and Siitonen, 2011]

Three different categories emerged from the analyzed publications which should serve as a basic taxonomy of gamer communities, according to Warmelink and Siitonen: [Warmelink and Siitonen, 2011]

- Micro

  Micro-communities are often short-lived and mostly goal-motivated. Forms of micro-communities are groups, teams, raids or parties. [Warmelink and Siitonen, 2011]

- Meso

  Meso structures consist of larger entities than micro-communities. These formations last longer and are often institutionalized, e.g. clans. [Warmelink and Siitonen, 2011]

- Macro

  Macro communities are characterized by their identity which is created by its members who share a common value system. [Warmelink and Siitonen, 2011]

4.6.3 Design Patterns for Collaborative Play

While multiplayer options in video games are very common, their integration and importance within the design process differ. As Reuter et al. point out, several design considerations, e.g. trade-offs between collaboration and competition or interaction between players are characteristic for multiplayer games and are key elements in design processes for multiplayer games. [Reuter et al., 2014]

In collaborative games, players form alliances in order to solve riddles and progress. Reuter et al. used Bjork's bottom-up approach to extract game design patterns (see 4.3.1) and applied it to this type of game, specifically to collaborative player interaction. Previously presented patterns for multiplayer games have their origins in cooperative games, which are often used synonymously for collaborative games. Generally, player interactions in collaborative games are characterized by their synchronicity in which actions are executed in order to achieve joint objectives. [Reuter et al., 2014]

The quantity of analyzed games by Reuter et al. has not been explicitly disclosed, however 15 games have been named as examples for cooperative games that served as the basis for the extracted game design patterns. Interactions were categorized according to spatial (e.g. *where does interaction take place in the game world?*), temporal (*e.g. how synchronous do actions have to be*) and functional properties (e.g. *how many players can take part in collaborative actions*). [Reuter et al., 2014]

In addition to Bjork's properties of game design patterns (*name*, *description*, *consequences*, *using the pattern* and *relations*), Reuter et al. extended the classification with the following properties: [Reuter et al., 2014]

- Spatial Relation

  Does an interaction happen at a specific location in the game world or is it present throughout the whole game?

- Temporal Duration

  How long does player interaction take?

- Player Freedom

  May players chose whether to collaborate or not or is it mandatory?

- Functional Role Flexibility

  Do players have to fulfill static roles within the process of collaboration or can they freely decide which part of collaboration they would like to execute?

The resulting game design patterns for collaborative play are categorized in three different roles: [Reuter et al., 2014]

- General

  Design patterns of this category describe high-level objectives, e.g. *concurrency*, that can be achieved with different game mechanics.

- Gates

  Gates are collaboration interaction requirements that have to be met in order to progress in the game.

- Support

  Design patterns of this category describe actions where one player is benefiting another, e.g. by protecting them.

Analogously to Björk and other researchers who focused on game design patterns that were developed in a bottom-up manner, Reuter et al. claim that accompanied by a basic understanding of game design, the presented patterns can provide a general solution to common problems within this domain. [Reuter et al., 2014]

Love and Bozdog introduce the term semi-spectatorship, with the distinction of internal semi-spectatorship, i.e. active players that are temporarily inactive due to other players completing the main tasks at a given moment and external semi-spectatorship, i.e. spectators who watch a performative game session, while often taking part in the experience by commenting on strategies, etc. [Love and Bozdog, 2018] Four design approaches for the development of games with the primary goal to enhance social play by focusing on spectatorship and semi-spectatorship are presented. These approaches are divided into four categories: [Love and Bozdog, 2018]

- The Curation of Spectacle

  Games with novel concepts with emotional access attract spectatorship. [Love and Bozdog, 2018]

- Use of Physical Game Design

  Games that involve physical contact and contain rituals weaken social boundaries and have a positive effect on spectatorship. [Love and Bozdog, 2018]

- Use of Game Mechanics That Support Team Work

  Dependencies between players and volatile intensity of tasks for each player promotes team work and enhances internal semi-spectatorship. [Love and Bozdog, 2018]

- Widening of the Magic Circle

  The usage of gestures as an input means adds a performative dimension to game sessions. This enhances external semi-spectatorship. [Love and Bozdog, 2018]

4.6.4 Promoting and Predicting Team Cohesion

Based on Hogg's Social Identity Theory, which describes relations within groups and self-conception in group memberships [Hogg, 2020], Martin and Good examined how game rules can be analyzed in order to predict team cohesion within a game and subsequently whether game rules can be defined in a way that promotes the feeling of belonging to a group within gameplay. [Martin and Good, 2014]

According to Hogg's theory, for every individual, there are multiple characteristics that form group memberships (a person may belong to the group of females as well as to the

group of players of a certain game) and these characteristics are more or less salient over time. [Martin and Good, 2014]

Martin and Good analyzed two games, one of which contained rules that aided players if they cooperated and one where game rules were developed around individual performance. Both games did however offer multiplayer actions. Two groups of participants (n=36) played one of the games each and subsequently completed a questionnaire in order to analyze how associated they felt with their respective group.

By applying the Social Identity Theory, Martin and Good were able to predict which game would lead to a stronger group cohesion, which was backed by data collected in the questionnaires. Furthermore, it is stated that Hogg's factors for group relations can be applied in game design processes to promote team cohesion. [Martin and Good, 2014]

There are however several individual factors that alter how players behave in collaborative situations, e.g. role expectations and individualization within groups as presented by Boudreau which may have effects on team cohesion. These have not been considered by Martin and Good. [Boudreau, 2005]

4.7 Narratology

4.7.1 Interactive Digital Storytelling

According to Spierling interactive digital storytelling is often considered a discipline containing elements of game design and cinematic storytelling with four influential approach directions. *Animated Storytelling for Film Production*, HCI, *Computer Game Design* and *Artificial Intelligence*. [Spierling, 2005]

Based on practical examples of NPCs who are conversing with human players, Spierling introduces a layered model to classify interactive and linear storytelling which is not restricted to video games.

A linear animated story has four abstract design levels:

- Plot

  The plot is defined by the *plot outline* and the *dramatic structure*. It creates the *narrative function*. [Spierling, 2005]

- Scene

  The scene is defined by the *scene base* and creates the *scene script*. [Spierling, 2005]

- Dialogue

  The dialogue is defined by the *dialogue base* and *actions / conversations*. It creates *stage directions*. [Spierling, 2005]

- Animation

  The animation is defined by the *animation base* and its *presentation* inside the game. It creates an *animation system*. [Spierling, 2005]

These four levels are controllable by the author (to a certain extent) and perceived by the audience or in case of video games by players. When a story is interactive, players enter the controllable domain. For each layer elements of agency exist and alter the level of control that the author has over the storytelling process. In video games the code adds to the predefined elements that authors create. Spierling calls this state of player involvement *semi-autonomy*. [Spierling, 2005]

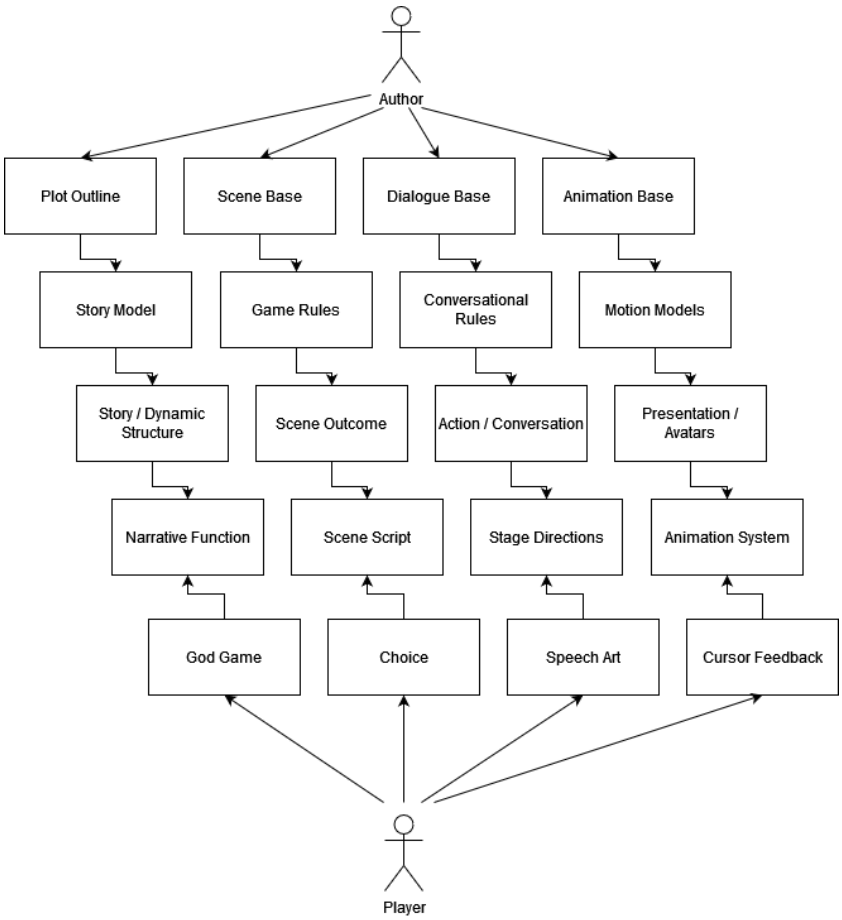

Figure 4.24: Narratology Model as Described by Spierling [Spierling, 2005]

Authors have a greater level of control over the columns on the left than over columns on the right as visualized in figure 4.24, i.e. authors can anticipate narrative functions more easily than the animation system, since it is mostly unforeseeable how a player will move their avatar. [Spierling, 2005]

Players do not always have agency over narrative functions. Spierling refers to simulators in which players can plot the story as God game [Spierling, 2005]

4.7.2 Indexical Storytelling

As Fernández-Vara points out, the spatial dimension, i.e. the game world, is a common element of the story and game elements, functioning as a bridge. Environmental storytelling is a fundamental concept of game design that has its origins in theme park design where the spatial environment is designed so that it supports the story in a certain way or creates its own narrative. [Fernández-Vara, 2011]

Indexical storytelling is a concept for generating a story through traces of different kinds within a video game. [Fernández-Vara, 2011] It is based on Peirce's perception of logic and its division of signs: [Peirce, 1998, Fernández-Vara, 2011]

- Icons / Likenesses

  Signs that resemble or imitate ideas or objects [Fernández-Vara, 2011], e.g. a drawing or a gesture.

- Indices / Indications

  Signs that have a real connection with what they represent [Fernández-Vara, 2011], e.g. visible breathing in a cold environment.

- Symbols / General Signs

  Signs that convey a certain meaning through how an object is used [Fernández-Vara, 2011], e.g. abstract warning signs.

Indexical storytelling uses signs of the categories mentioned in this list to create a story. This means that the perspective of indexical storytelling uses a much more complex construction of stories, i.e. lots of small narrative elements form an aggregate which is the game story. Fernández-Vara considers indexical storytelling a "refinement on environmental storytelling" [Fernández-Vara, 2011], since it determines how the traces of the story are integrated into the game world. The main story themes that are covered in video games are the stories of avatars and the story of the game world. As Fernández-Vara points out, indexical storytelling is a technique used in game design practice but has not been considered and defined as such. [Fernández-Vara, 2011]

4.7.3 Character-driven Storytelling

Mariani and Ciancia point out that narratives and games are in the process of increasingly intertwining and hybrid experiences are more often to be found, e.g. in interactive films or series on Netflix, where watchers can choose how the story continues. Likewise, the importance of the narrative character in video games is increasing as they are used to

organize and frame experiences as a means to enhance their comprehensibility. [Mariani and Ciancia, 2019]

Three different experiments (n1 = 59,n2 = 45,n3 = 63) with different aims served as a base for a character-driven storytelling framework. The first experiment focused on the development of a character which is derived from an archetype. Students used tarot cards and statues to invent a story, which served as a base for interactive narrative prototypes that were captured on a storyworld canvas, which structures the story into environment, background story, value system, life goals and objectives, language and system of relations. [Mariani and Ciancia, 2019]

The second experiment had the objective to build an actual story from a storyworld canvas. Students had to develop a character from the given information (the storyworld canvas). Two tools were to be used in order to achieve this task, the character wheel and Vogler's archetypes. The character wheel is a list of different character properties: [Mariani and Ciancia, 2019]

- age
- gender
- ethnicity
- nationality
- physical and mental skills
- personality
- environment
- social class
- civil status
- religion and other beliefs
- education
- work experience
- habits
- physical appearance
- hobbies

Vogler's archetypes are the following [Vogler, 1998]:

- Hero
- Mentor
- Threshold Guardian
- Herald
- Shapeshifter
- Trickster
- Shadow

The story map tool is then used to create a narrative structure by incorporating the following situations into a story: [Mariani and Ciancia, 2019]

- The character is in a state of equilibrium.
- The character faces a conflict which disturbs the equilibrium.
- The character overcomes this conflict.
- The character established a new equilibrium.

In the third experiment the story was used as a base to create a game world. Based on a *storyworld canvas* students applied the *character wheel*, Vogler's archetypes and the story map tool to achieve the status from the last experiment. The next task was to create an interactive narrative concept. Complex narratives are difficult to document, therefore, the intertwining elements of the elaborated narrative were visualized in a tree-like structure, referred to as the *interactive narrative architecture* by Mariani and Ciancia. [Mariani and Ciancia, 2019]

The three experiments with all the used tools are presented as a framework for the creation of stories with a great emphasis on the characters within the game world. [Mariani and Ciancia, 2019]

4.7.4 Micronarrative

Bizzocchi et al. present the micronarrative as a storytelling tool with the ability to create narratives of flexible structure. Micronarratives are elementary parts that can be arranged together and put into hierarchical relations. [Bizzocchi et al., 2014]

Narrative arcs serve as a presentation template of narratives in video games. A game possesses a overall narrative arc which is composed of different arcs of smaller scale with micronarratives being the smallest units of arcs. Even though micronarratives have small granularity they are still coherent when observed in isolation. [Bizzocchi et al., 2014]

Micronarratives have three properties: [Bizzocchi et al., 2014]

- Hierarchical

  Narrative arcs occur in different granularity and can be nested in order to combine multiple smaller narrative structures into bigger ones. [Bizzocchi et al., 2014]

- Modular

  The interactive game environment impacts how narrative structures are perceived. In order to be able to arrange and rearrange micronarratives in different orders they have to be designed with modularity as a design principle. [Bizzocchi et al., 2014]

- Accumulative

  Micronarratives have to support accumulation, i.e. they are not perceived individually but as part of a narrative flow. In an attempt to make sense of the narrative elements and the events in-between players use their own interpretation of micronarratives. Therefore, it is essential that micronarratives can be put into accumulative sequences and still present a comprehensive story. [Bizzocchi et al., 2014]

An alternative approach to micronarratives are protonarratives as advocated by Pinchbeck in which narratives consist of a network of predetermined objects. Their relationship is predefined to a certain extent as well as the range of different interpretations. [Pinchbeck, 2008]

4.7.5 AI Generated Drama

In the process of developing games with complex narrative structures, e.g. Role Playing Game (RPG), drama managers can be used as tools to author a narrative based on rules, algorithms or user input. The desire to offer personalized narrative experience quests for designs that support parameterization.

As Drachen et al. point out, individual user experiences in storytelling is gaining in popularity. Traditionally, due to technical limitations video games rely heavily on predetermined stories which is a contrary approach to personalized narratives. [Drachen et al., 2009]

A novel bottom-up approach for developing interactive stories is presented by Drachen et al. that uses collected data from game sessions of pen-and-paper RPG games. These data are later used as training data for an AI system that dynamically creates strategies for drama manager data. [Drachen et al., 2009]

The quality of collected data is specifically centered around the role of the game master whose task includes the managing of the game story plot which corresponds with the tasks of a drama manager. The process of plot creation follows a simple sequence: *processing* of information, *decision making* based on the processing, *actions* within the game world

as a result of decisions and *reactions* to the actions which initiate a new cycle of the sequence. [Drachen et al., 2009]

In their study Drachen et al. used transcribed dialogues between players as input data. The single statements were categorized by manual annotation, e.g. *request information, give information, give assistance*. [Drachen et al., 2009]

The D3M architecture is proposed by Drachen et al. as an artificial intelligence-based approach to convert these data into meaningful decisions regarding the narrative of a video game. Annotated data are stored in a case library where the entire pool of decisions are saved. During game execution cases are matched with the game state and a suitable case from the library is applied. The newly created scenario is then revised and saved as a new entry in the case library. [Drachen et al., 2009]

4.7.6 Dialogue Systems

Ryan et al. present a procedural approach to creating dialogues betweeen NPCs. [Ryan et al., 2016b] Traditionally, the modeling of these dialogues has been modeled as a tree with several branches which is still a frequently used technique, e.g. in the video game *Minecraft*. [Stufft and von Gillern, 2021]

Instead of putting single lines of dialogue text in a unidirectional data structure, e.g. a tree or a directed graph, authors do not model any relation between text but annotate text with a characteristic of concern which will be used as a criterion to select a specific text element. Due to the selection being made at runtime game state can be incorporated into the decision process. [Ryan et al., 2016b]

The presented dialogue system is based on the Talk of The Town framework, which was also presented by Ryan et al. Talk of The Town is a framework which allows NPCs to learn about their environment by propagation, i.e. NPCs observe their surroundings and develop belief systems based on the observed evidence. [Ryan et al., 2016a]

The dialogue system of Ryan et al. supports turn-based dyadic conversation, based on a model of different conversational roles: [Ryan et al., 2016b]

- Conversant

  Either participant in a conversation

- Initiator

  A character who starts a conversation

- Recipient

  a character with which the Initiator started a conversation

- Speaker

  A character who is currently speaking

- Interlocutor

  A character who currently listens

Text elements and their corresponding annotations are referred to as dialogue moves. Ryan et al. used annotations with high granularity, e.g. *agree about the weather* [Ryan et al., 2016b]. This allows for usage in very specific scenarios. A text element may have multiple annotations with different granularity depending on how versatile it is. [Ryan et al., 2016b]

Furthermore, the dialogue system includes the concept of conversational obligations, i.e. a question in a conversation requests the interlocutor to answer accordingly in the next turn. In order to assimilate in-game conversations to their real-life counterparts, they are guided by a system of conversational goals. These goals include a goal plan, which is a pre-authored sequence of either a subgoal with its own goal plan or a dialogue move. [Ryan et al., 2016b]

A conversation may only be activated if certain conditions are met, which is defined (at design/development time) in conversational frames. The conversational frame *phone call* has the existence of a phone conversation as a precondition and the recipient's goal to find out the caller's identity and what they want. The recipient's obligation is to pick up and convey their identity. Additionally, conversation violation constraints can be defined. [Ryan et al., 2016b]

The process of the conversation is determined by open obligations of one conversant, i.e. turns are not equally distributed among characters but characters with open obligations get precedence. If both characters have open obligations a probability function is used to resolve the deadlock. [Ryan et al., 2016b]

After each dialogue move the conversation state is updated (interlocutors have a knowledge gain that they can use to adjust their reaction) and if applicable the global game state is also adjusted. Evidence that changes the state can be either a statement, a declaration a lie or eavesdropping. They have an effect on the interlocutor's belief system who progresses to further propagate the shared ideas and views. [Ryan et al., 2016b]

In an evaluation, the procedural generation of conversations as presented by Ryan et al. was rated four out of five in terms of naturalness whereas arbitrary line selection was rated one out of five. [Ryan et al., 2016b]

4.8 Game Analysis

4.8.1 Player Experience Analysis

Similarity Matrix

Marczak et al. present a technique that can be used to compare gameplay and analyze as well as visualize player behavior within a game session. They propose the recording

of audio streams with normalization and comparison of their frequencies in order to gain insights into gameplay and observe parallels and differences between sessions. The calculated similarity value is represented in a two-dimensional matrix. [Marczak et al., 2015]

As pointed out by Marczak et al., the two dimensional representation is advantageous since it can be displayed as an image. The more the audio signals differ at a fixed point in time the higher the intensity of the corresponding pixel, i.e. similar signals are displayed as black pixels while different signals are displayed as white pixels. Therefore similar signals result in lines within the similarity matrix image.

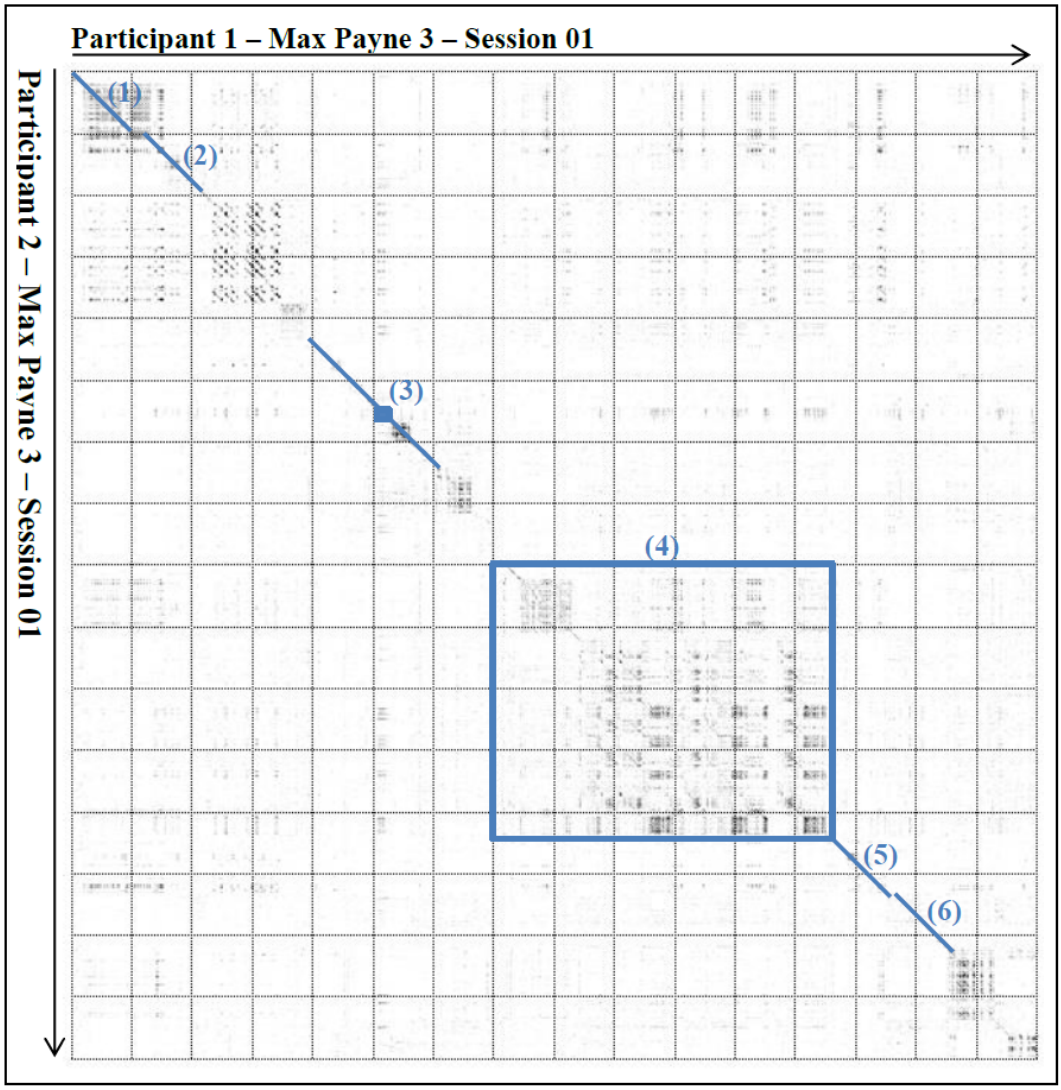

Figure 4.25: Example of a Similarity Matrix by Marczak et al. [Marczak et al., 2015]

Table 4.1: Behavior state codes as created by Soppitt and McAllister [Soppitt and McAllister, 2011]

BEHAVIOUR STATE	CLASSIFICATION	PLAYER EXPERIENCE	PLAYER REACTIONS
Engrossment	Positive	Emotional investment and empathy	Positive remarks and nodding
Engagement	Positive	Focused and engaged in the game task	Expressionless face, reduced blinking frequency
Curiosity	Neutral	Exploring game interactions without being engaged	Relaxed behavior with understanding verbal expressions, e.g. "I see!
Frustration	Negative	Player is agitated or frustrated, doesn't understand interaction	Head shaking and sighs
Boredom	Negative	Player is not engaged in gameplay	Relaxed seating position, increased frequency of eye movement due to higher level of distraction

As can be seen in figure 4.25, the similarity matrix conveys different patterns that disclose player behavior. The first section marked by Marczak et al. shows that the audio signals have been exactly the same for participant one and participant two. When analyzing the results, Marczak et al. found out, that this is due to a cut scene in the beginning, which cannot be skipped. The diagonal in section two also shows a cut scene, which is slightly shifted to the right shows that participant one passed more time in the main menu than participant two. Section four shows a difficult section within the game, where both participant's avatars died multiple times. Since the soundtrack starts again after an avatar died, the numerous diagonals represent the different retries of this game section. [Marczak et al., 2015]

It becomes evident, that even though the image visualization makes use of human pattern recognition skills, experience in reading similarity matrices as well as knowledge of the played game helps to explain similarities and correctly interpret the patterns.

Sequential Analysis

Soppitt and McAllister present a methodology to measure the quality of a video game by analyzing player experience. The used method combined behavioral and sequential analysis of player interaction.

The player interaction of examined game sessions are split into different state codes. A pilot study with two gamers and three games was conducted in order to create a code language. Recorded player movements and reactions were observed and classified in consultation with findings in scientific literature.

The players were encouraged to verbalize their gaming experience which helped understand their bodily reactions. Soppitt and McAllister analyzed the audiovisual material of the player as well as the recording of the game in order to map in game actions to player behavior and to better understand player experience states. The state codes which were created as a result of this analysis can be seen in Table 4.1. [Soppitt and McAllister, 2011]

For the actual study, participants (n=10) were recorded playing games on the iPhone

platform. Sequences of the game sessions were later coded and documented in an excel sheet. The results from the two games with the lowest and highest ratings on game platforms were compared in order to draw parallels between behavior states and these ratings. [Soppitt and McAllister, 2011]

Examined characteristics were *mean state frequency*, *mean state duration* as well as *behavioral transitions*, frequency of transitions between two state codes and *positive minus negative behavior over time*. [Soppitt and McAllister, 2011]

The analysis results of Soppett and McAllister show that games of high quality provoke and sustain the engagement of their players. In sessions of low quality games players experience curiosity and frustration for longer periods of time. Transitions from frustration have been proven to be a key indicator that distinguishes high and low quality games. [Soppitt and McAllister, 2011]

4.8.2 Analyzing Potentially Harmful Game Content

According to van Vught et al. current age-restrictions classifications fail to take interaction between players and the game into account which differs from linear media. Nonetheless, the same frameworks are applied to determine age-restrictions for video games. [van Vught et al., 2012]

In order to better understand gameplay, van Vught et al. present a feedback loop model, which positions interpretative activity (matching stimuli with known problems and creating hypotheses) and configurative activity (reacting by pressing buttons and executing strategies) as two opposing extremes on an axis. In gameplay sessions players constantly loop through both of these activity stages. The second axis of this model divides fictional and game elements. When players experience game contents they either belong to the fictional domain, i.e. they are part of the game story or to the game domain, i.e. they are part of the game rule system. According to van Vught et al., player experiences are situated somewhere within this twin axis model. [van Vught et al., 2012]

After analyzing different game sessions of multiple players (n=10) van Vugth et al. conclude that gameplay is always a subjective experience with triggers that guide a player's behavior and perception in a certain way. [van Vught et al., 2012]

By defining age restrictions by the same rules which apply for film, not only the configurative aspect from this model is completely unaccounted for but games are also framed as a mere fictional artifact without taking into account that certain actions are seen by a player as game elements and are therefore interpreted in a different manner. According to van Vugth et al. their model could serve as a basis for more accurate age-restriction classification. Players should be asked how they experience content in order to be able to map it to a point in the two axes model to better understand how game content affects players and how potentially harmful it is. [van Vught et al., 2012]

4.8.3 Social Architecture in Online Social Games

Based on the work of Social Architecture by Wright, which defines structures and systems within a capitalistic society [Wright, 2005], Kirman et al. apply similar analytic measures to online games with a social focus. Prior scientific work on social architecture in games focused on a mapping between game mechanics and player behavior without taking into account the context in which these game mechanics are presented to the players. Kirman et al. state that social architectures in multiplayer games follow more complex patterns than for example social media since actions are less likely to be predefined, e.g. players can trade or attack each other as well as build alliances and these constructs can change over time. The social architecture of these games is the aggregation of all the aspects that support social behavior, regardless of whether they were meant to have an effect on social aspects. [Kirman et al., 2011]

Regarding social architectures in games, the analysis results of server logs of six online multiplayer games revealed that the quantity of social contacts in games follows a power law with a negative scaling exponent. This means that very few players create a disproportionately large amount of social interaction in online games. These findings are similar to what similar studies in the field of social media networks conclude. [Kirman et al., 2011]

In order to compare social architectures based on player contacts or interactions and map it to social behavior, one must assume that the same game mechanics experienced in the same context by different players will evoke the same responses and is therefore completely predictable. Kirkman et al. state that this assumption is acceptable in their analysis since games with similar mechanics provided similar results with different players, hinting that the results are primarily based on the game mechanics. [Kirman et al., 2011]

One metric that Kirman et al. propose as a suitable parameter to mathematically compare social architectures is the scaling exponent α. [Kirman et al., 2011]

$$P(k) = k^{-\alpha}$$

Games with higher exponents have fewer players with lots of player interactions whereas in games with lower exponents more players are involved in community activities. When using scaling exponent analysis it is important to take the objectives of the game into account. If a game is promoted as a multiplayer game with social mechanics and it has a high αvalue, it is likely to have a flawed design or implementation. [Kirman et al., 2011]

4.8.4 Player Typology

Trait Theory Based Player Typology

The categorization of player into different types is a recurring objective in game design research. Exploring player groups supposedly helps when designing for a target audience.

According to Bateman et al. player typology theories are however hardly robust or adequate. [Bateman et al., 2011]

As stated by Bateman et al. typologies are however highly relevant in design as multiple popular techniques (e.g. *personas*) are based on them. psychometric type theories have been declared problematic with trait theories emerging as an alternative. In a questionnaire based study (n=1040), Bateman et al. collected evidence in order to build a foundation for a robust trait theory based player categorization. Five different traits that may be part of this categorization are: [Bateman et al., 2011]

- Openness to Imagination

  Players who enjoy gaming and engage with games of different genres were found to generally be more willing to use their imagination during play. [Bateman et al., 2011]

- Tolerance to Frustration

  Another characteristic that sets players apart is the tolerance to experience frustration. Some players like to play aggressively with the risk of losing while others generally avoid games that evoke feelings of anger or aggression. [Bateman et al., 2011]

- Tolerance to Real Time Play

  Some players have been found to prefer real-time control within games. This trait is likely connected to player skills and the ability to control elements in the game world in real-time. [Bateman et al., 2011]

- Preference for Group Play

  Social aspects are a key element of some players whereas others prefer to interact solely with a game system. [Bateman et al., 2011]

- Degree of Persistence

  Bateman et al. discovered that players who rate their own skills higher are more likely to show obsessive tendencies, i.e. a high degree of persistence. [Bateman et al., 2011]

Typology of Player Relationships

Smith presents a typology model to examine player relationships in multiplayer games. In order to analyze possible player relationships, different possible strategies for a sample multiplayer game (*Joust*) were identified and outlined. In this game, each player has NPC enemies and real player enemies that they have to destroy. The destruction of the other player enemy is more rewarding but attacking a fellow player includes a higher risk as players have to cope with two different types of enemies at the same time. An alternate strategy would be to cooperate with the other player to defeat the joint NPC

Table 4.2: Multiplayer Strategies with outcomes for Player 1 (P1) in *Joust* [Smith, 2005]

-	**P2: COOPERATE**	**P2: DEFECT**
P1: COOPERATE	Great	Bad
P1: DEFECT	Good	Mediocre

enemy. The outcome of the chosen strategy is however directly dependent on the chosen strategy of the other player, as can be seen in Table 4.2, where combinations of strategies with corresponding outcomes for one player (P1) are shown. [Smith, 2005]

As can be seen, cooperative behavior in this case is the riskier choice with a greater potential outcome. Attacking the other player is more secure, since the worst outcome may not occur but is less advantageous to each player. Based on these observations, Smith distinguished between three types of relationships between players: [Smith, 2005]

- Cooperative

  In cooperative relationships players' interests are fully overlapping and in many scenarios the challenge is to overcome an element within the game world or to compete against another team. This relationship type is applied in zero-sum, i.e. one player wins fully and the other players lose fully, as well as non-zero sum games. [Smith, 2005]

- Semi-Cooperative

  Players have a common objective but diverse individual goals. Challenges to overcome by using this relationship type are related to the game environment or another team in non-zero-sum scenarios. [Smith, 2005]

- Competitive

  In a zero-sum scenario players' objectives are directly opposed. Since one player wins fully and the other player loses fully there is no motive for a player to seek collaboration. [Smith, 2005]

4.9 Serious Games

4.9.1 Serious Exergames

According to Pachoulakis et al. predictability and repeatability of exercises are a major reason for patients dropping out of physiotherapy. Games enable a non-linear way of presentation of exercises, making them more attractive. [Pachoulakis et al., 2018]

Pachoulakis et al. designed and thoroughly analyzed two 3D video games, that were designed specifically with the target group of players with moderate stages of Parkinson's disease in mind. [Pachoulakis et al., 2018] These games and their thoroughly described

design process can serve as design guideline for serious exergames. Parkinson's disease is irreversible and without cure [Pachoulakis et al., 2018] but the important role of exercise has been proven multiple times. [Morris, 2000, Hackney and Earhart, 2008, Mestriner, 2016] Four specific symptoms of Parkinson's disease are tremor, rigidity, akinesia and postural instability. [Frank et al., 2006, Pachoulakis et al., 2018]

For the exergames' implementation, Pachoulakis et al. used the popular Kinect sensor by Microsoft [Pachoulakis et al., 2018], which is often used as a camera for similar applications, due to its additional depth sensor, that enables thorough motion tracking. One notable design paradigm of the exergames developed by Pachoulakis et al. is that accessibility must be provided throughout the whole game. Consequently, the exergames' menus were not only controllable by the player's body movement but also designed in a way that minimized fatigue while navigating through them. The variety of different movement gestures was purposefully held small for easy memorization. Players have to twist their torso to navigate through the menus, emulating the function of a right and left key and strech their arms over their head to select an option or to pause the game. As mentioned earlier, user friendliness and avoiding fatigue was an important issue, therefore very few menu elements were offered to the players, so that they do not have to twist their torsos for a long time to arrive at the desired menu item. [Pachoulakis et al., 2018]

Gestures were generally chosen not only to be medically helpful but also to be clearly detected. Therefore, small movements were not suitable to incorporate into these games, especially when tremor could be an issue while trying to execute them precisely. The player's aim in the game Balloon Goon is to pop balloons that move along four strings. Each of these strings are reachable with one extremity, resulting both arms and legs to be in movement. Balloons have to be either punched, where an arm extension classifies as a punch, the actual hardness and speed of punches do not matter within the confines of this game. Multiple levels with increasing difficulties have been implemented to create challenging game aesthetics. [Pachoulakis et al., 2018]

The second analyzed game was a downhill skiing game, where players had to collect colorful bonus elements while preventing collisions with obstacles. A gesture in which both ski poles had to be pushed requires synchronized and coordinated body movement and made the skier move through the snowy landscape. A torso moving gesture was used to make the skier go left and right. [Pachoulakis et al., 2018]

To detect movements and ensure that they are executed in a proper manner, the position of the joints is measured through the Kinect sensors and calculation models that include positional deviations and derived angles were applied in real-time. Pachoulakis et al. included further accessories for accessibility into their games, e.g. for movements that have to be executed in a coordinated way. Players with different levels of impairment on both body sides are recommended to use a stick between both hands to enhance the level of synchronization between them. Furthermore, players get direct feedback and the ability to observe their own movements, due to the recorded camera footage being displayed in real-time on the screen, as seen in figure 4.26. This feature also facilitate assistance by an attending psychotherapist, who could be giving hints for the proper execution of required

movements to avoid frustration among players who are having difficulties playing the games. [Pachoulakis et al., 2018] Another use case for this feature would be recording game sessions, so that therapists do not have to be physically attending at the time of play.

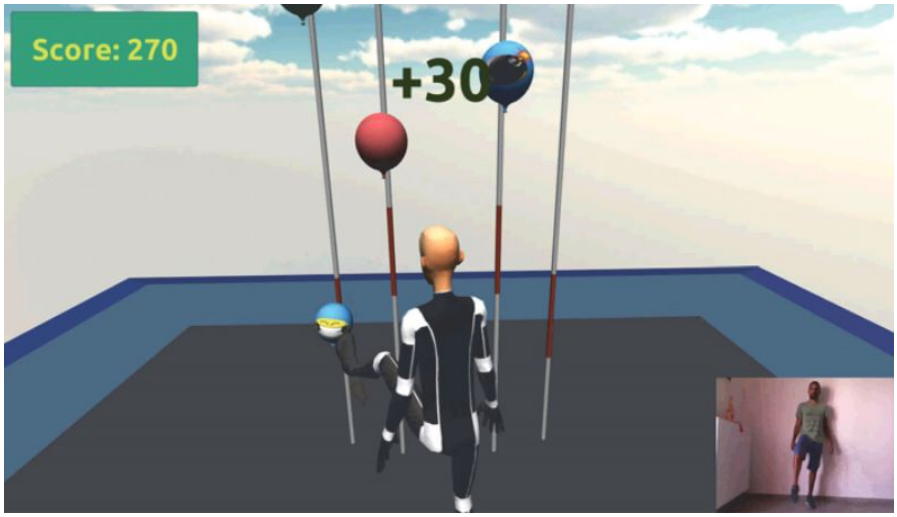

Figure 4.26: Game Scene of Balloon Goon, a game for Parkinson's disease patients [Pachoulakis et al., 2018]

Finally, Pachoulakes et al. expect improvements in the game experience by providing individual difficulty levels, preferably even with dynamic adjustments. Researchers are encouraged to close that remaining research gap. [Pachoulakis et al., 2018]

Immersion Through Audiovisual Environments in Exergames

Keating presents several design scenarios based on the use of an illuminated floor with programmed lighting and sound sequences as seen in figure 4.27, called *the Lambent Reactive*.

The game design for this platform is mostly inspired by dancing in clubs and the hardware design is based on the puzzle game *Simon*. The multisensory platform has proven to create highly immersive states in players and brings together concepts of audiovisual and kinesthetic interaction design. Keating aims to provide a comprehensive methodology for the different components of what make exergame platforms successful and enjoyable. [Keating, 2007]

4.9.2 Game Based Learning

Authentic Learning Experiences

Galarneau examined in which way learning experiences in serious games can be designed in order for them to be *authentic*. In order to establish a definition for authenticity in

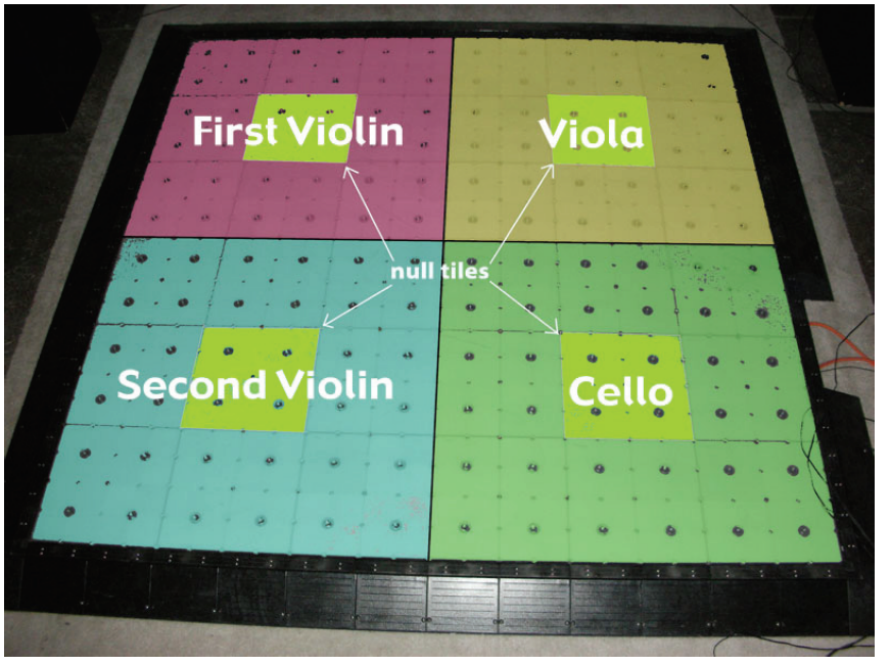

Figure 4.27: The Lambent Reactive Game Platform [Keating, 2007]

learning experiences she borrows from Ann Carlson, who states that authentic learning experience are based on learner-centeredness and challenging tasks in real-world situations. [Galarneau, 2005, Carlson, 2002]

Video games offer a wide variety of possibilities to try different solutions for different problems, without real consequences. Therefore, many different scenarios and failure states can be mapped within a computer game. Comparing these property to the above-mentioned affordance of authentic learning by Ann Carlson, game based learning is essential for scenarios in which experiences in the real world are either unrealistic or very difficult to achieve. [Galarneau, 2005]

Galraneau participated in designing two serious learning games, that are supposed to offer authentic learning experiences. In one game, players had to work on a construction site, with lots of possible action but without real world consequences when choosing the wrong tools or skipping a step. The second game helped mental health professionals to deal with difficult patients, by selecting different actions that are supposed to calm the patient. These technical artifacts are examples of situations that would be difficult or expensive to learn in a real world scenario but after gaining experience from the simulation game can be managed with a greater amount of confidence and skill. [Galarneau, 2005]

4.10 Gamification

Gamification as a term is not primarily related to game design research, as Robertson pointed out, its implementations hardly involve game designers. [Robertson, 2010] It is, however, obvious that gamification has its roots in insights and ideas that game designers came up with and knowledge as well as awareness about the overlappings on ludic and non-ludic contexts can be a crucial high level toolset for game designers. Mosca cites three different scientific definitions for gamification [Mosca, 2012]:

- A Process of Market Expansion

  This narrow definition limits gamification solely to the a penetration of non-ludic economic sectors into game technologies by incorporating game technologies (e.g. new media like CD-ROMs in the mid-eighties) or principles. [Mosca, 2012]

- Pointsification in Non-Ludic Contexts

  Being a subset of gamification pointsification as a concept is sometimes used synonymously with its superset term as it is a recurring key concept and widely adapted within several gamificated contexts. Kitefew et al. identified pointsification as a trend in design for gamification [Kifetew et al., 2017], while De Croon et al. classified it as a subdomain of gamification. [De Croon et al., 2018].

  Robertson introduced the term pointsification, stating that gamification is the wrong word for introducing quantifiable parameters into non-ludic contexts. [Robertson, 2010] She sees the missing participation of game designers in gamification as a motive for unprecise language and terminology in this field. [Robertson, 2010]

  Mosca identifies badge-points in supermarkets, credit structures of universities or car stickers for gas control as examples were pointsification is already well established. [Mosca, 2012]

- Ludification and Seriousization

  This definition takes into account the connection between the lufidication of the serious and the seriousization of the ludic [Mosca, 2012]. As examples of this perspective, he names serious games (see 4.9), adware and adgames [Mosca, 2012].

Deterding et al. define gamification as "the use of game design elements in non-game contexts", stressing, that the term refers rather to the use of design elements, than to the extension of design of non-game artifacts [Deterding et al., 2011]. Furthermore, they state, that the distinction of entertainment or serious games and gamificated artifacts is given by the intention of developing such systems [Deterding et al., 2011]. Developers of gamification artifacts intend to build a system with elements associated to games, game developers want to implement an actual game [Deterding et al., 2011].

Such elements are defined as characteristic to games, i.e. found in most, but not necessarily all games and associated with games, due to having a significant role in gameplay [Deterding et al., 2011].

4.10.1 Degrees of Gamification

Mosca identifies levels of granularity in the analysis of video games and claims that most, but not all of them play a role in the process of gamification. [Mosca, 2012] His observation requests a broad understanding of the term gamification, since it provides a holistic overview of how game design and game development influenced artifacts within the realms of serious contexts.

There is an increase of usages of software tools and routines that were originally used for video game development in non-ludic software development, as Mosca claims. [Mosca, 2012] These are applied in game-like simulations as well as introductions to software, that contain game design elements [Mosca, 2012].

The occurrence of design elements from computer games in serious software is a consequence of how computer literacy is developed and that most average computer users are familiar with these elements, due to their consumption of video games. [Mosca, 2012] Among others, Mosca named avatars, splitscreen and isometric representations as examples for common elements in serious software with origins in computer games [Mosca, 2012].

Collaboration in software or through software contains several collaboration practices, that have were developed for a joined gaming experience before shifting into serious contexts. [Mosca, 2012] The messaging and communication service Discord serves as an example for this observation. Originally founded as a means for in game communication [Discord Inc., 2021], alternative usages of this platform are already manifested and scientifically examined, e.g. by Lacher and Biehl [Lacher and Biehl, 2019].

Mosca states that in contrast to the above-mentioned factors, research on games, specifically game studies as its main discipline, has never had a significant impact in other research fields. [Mosca, 2012] He furthermore identifies input modalities as a level within the analysis of video games that did never have a notable impact within serious contexts, while devices like touchscreens or mouse, formally exclusively used in serious applications, were included in the ludic context [Mosca, 2012].

4.10.2 Reasons for Effectiveness of Gamification

Mosca states that, based on the insights of philosophers and other scientists, seeing culture as a fiction that is perceived as real, our society is built on ludic principles [Mosca, 2012]. This, as he explicates further, means, that gamification is a mere metarepresentation of our culture, i.e. if our culture is build on game principles, applying these on our culture reveals its structure. [Mosca, 2012] From a more practical perspective, this implies, that game based learning is not the gamification of learning, but since learning is part of our culture and our culture is ludic, it reveals the ludic property of learning [Mosca, 2012], which is, what makes gamification appealing and in many cases effective.

The same principle can be applied to pointsification, where the ludic principle is competition, where the scope is to perform better than other players or users of serious

applications. The gratification within this competition is what motivates and increases user engagement. [Mosca, 2012] Pointsification can furthermore assist or amplify other gaming principles. As Mosca hints, pointsification assists hierarchical play, where players can either identify with an avatar and its points, or build an identity, based on these properties. [Mosca, 2012]. Therefore pointsification can be used in immersion contexts, as well as in contexts, where alter egos are built.

4.10.3 Game Design Elements used for Gamification

Deterding et al. identify several game design elements, that can be used when gamifying artifacts. According to the researchers, they can be divided into five groups with regards to their abstraction [Deterding et al., 2011]:

- Badges, leaderboards and levels as game interface design patterns, consequently pointsification makes use exclusively of game design principles within this group
- Time constraints, limited resources or turns as examples for game design patterns and mechanics
- Clear goals and a variety of game styles as examples for game design principles
- The MDA framework or game design atoms as examples for game models
- Playtesting and playcentric design as examples for game design methods

4.10.4 Degamification

Bringing the ludic and non-ludic context together by applying specific elements taken from game studies in a serious application, not only gives it a ludic character but also takes the ludic character from the applied element away, since it becomes more and more associated with the serious context. Mosca calls this process degamification [Mosca, 2012]. He equals the gamification of an element or artifact to the degamification of another element and states that this applies even if the gamification only consists in a pointsification of an application [Mosca, 2012].

Sticking to pointsification as an example, brushing teeth with a smart toothbrush that shows points according to its users brushing performance makes brushing teeth more of a game, and simultaneously getting points as a measure for performance less of an element associated to games.

4.10.5 Motivational Elements Within Games and Gamification Artifacts

As stated earlier, the definition of gamification is rather vague and as the boundaries between ludic and non-ludic realms become blurrier the question of what defines a computer game is increasingly difficult to answer. Does the usage of pointsification in a

non-ludic context make a serious application a game? As mentioned above, game designers seldomly design gamification properties in non-ludic applications and characteristics that are widely associated with the ludic context and gamification can be of marginal significance to what defines games from the perspective of a game designer.

Robertson states that the public perception of gamification and how it is currently applied is far from the high level definition of applying game principles to serious contexts. [Robertson, 2010] Gamification, as understood in non-scientific contexts, equals pointsification. Several applications for pointsification can be easily identified, for instance fitness trackers, that display their user's achievements in numbers or social networks that quantify popularity and by making the numbers public allow direct comparison with other users. This is problematic, as Robertson explicates, as quantifiable measures are marginal features of computer games, they are just used as they are used when giving grades in school or other context to visualize progress [Robertson, 2010] or other concepts, that would otherwise be more abstract and difficult to grasp. Evaluating this statement against the aforementioned definition of Deterding et al. regarding elements associated with games, pointsification would not be sufficient to classify as gamification. The public perception of gamification could cause an incomplete understanding of game studies, game design elements and game design.

According to Robertson it is crucial to distinguish between motivational elements that make users do more of the same and those, that make users solve problems in a creative manner. [Robertson, 2010] A pointsificated application gives its users an objective, which as well as a quest or problem within game can be hard to reach or solve. What sets these two applications apart however, is that games make it hard but interesting to reach an objective, while pointsificated applications just make it hard. [Robertson, 2010]

4.11 Prisma Flow Diagram

The final PRISMA flow diagram for all conferences as mentioned before (see reflab:method) can be seen in figure 4.28.

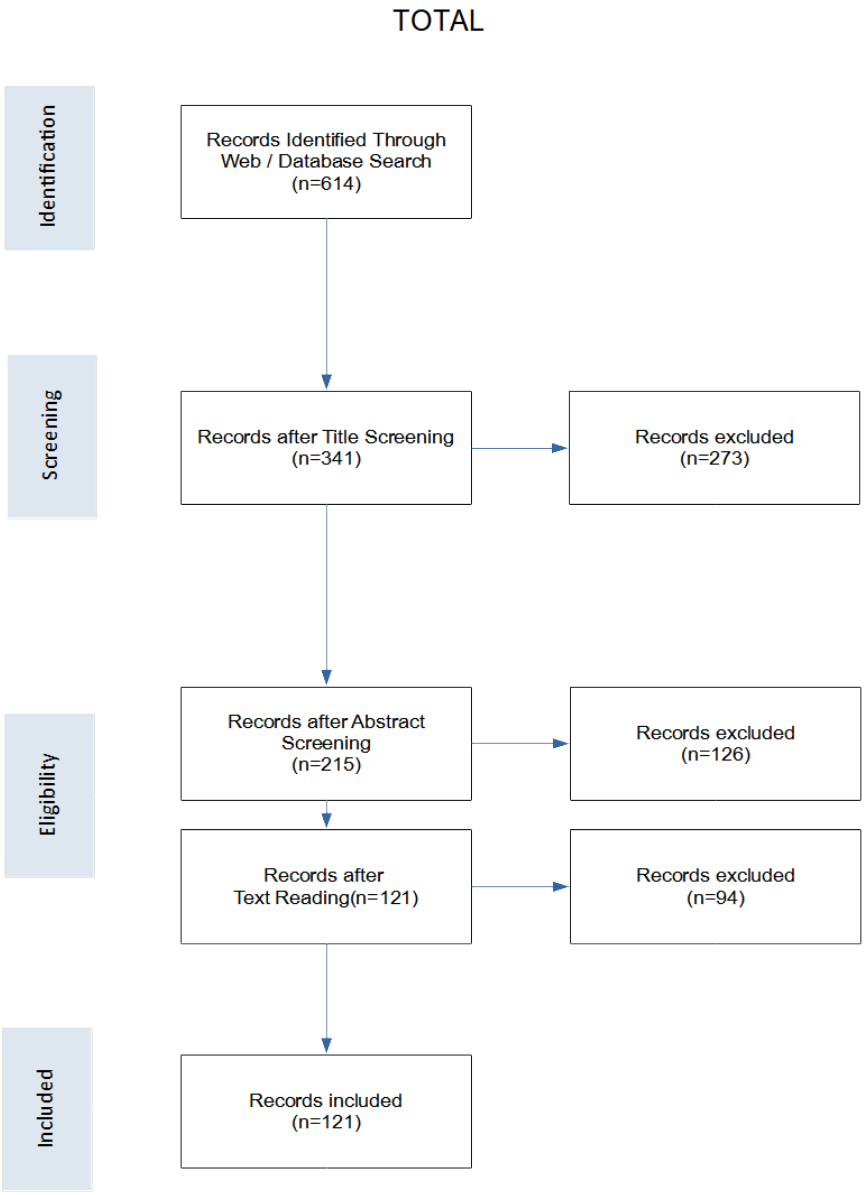

Figure 4.28: PRISMA flow diagram for all analyzed conferences

CHAPTER 5

Research Gaps - Discussion

As mentioned previously, the academic field of game design research is evolving rapidly and therefore, one of the objectives of this thesis was to collect and evaluate research gaps identified by scholars.

This chapter lists quests for research in the game design field that were expressed in publications and an evaluation whether these gaps are still actual and relevant.

5.1 Player Behavior

5.1.1 Pervasive Cheating in Practice

Glas points out that gamified social media systems like Foursquare are relatively new forms of participatory media and the effects and potential of cheating within these systems is yet to be researched. In particular, according to Glas it should be examined whether pervasive cheating can be used to convey meaningless rewards in gamified systems to other players (see 4.3.11). [Glas, 2011]

5.1.2 Biometric Feedback

The implementation of biometric interface technologies that are less intrusive than existing ones as well as the possibilities of using bio feedback for multiplayer experiences in which biometric information is used as a gameplay element are still subject to research and recommended future work for this research field. [Dekker and Champion, 2007]

Since Dekker and Champion expressed the need of further research in 2007, thorough research has been conducted on how biometric data can be collected in a less obtrusive manner, which data can be collected with which methods and how it can be analyzed. In the book *Games User Research*, Nacke describes all of the above-mentioned subjects in great detail and with respect to their application in the game design domain. [Drachen

et al., 2018] Therefore, the gaps identified by Dekker and Champion are now covered and cannot be considered up-to-date anymore.

5.1.3 Online Gaming Friendships

Eklund and Ask researched the maintenance and creation of relationships in social online gaming. As pointed out, online multiplayer games commonly reward good play performance and rarely social behavior. [Eklund and Ask, 2014]

The equilibrium of sociable behavior and successful game performance as well as real life constraints that shape who connects with whom in online games impose fields of conflict. Eklund and Ask state that too much research focus has been put on the social potential of multiplayer games whereas conflicts in this field are still mostly subject to future research. [Eklund and Ask, 2014]

These observations are in line with what Nguyen and Zagal propose, i.e. there is a necessity for more research to understand how individual players perceive challenge and the effects that competitive multiplayer gameplay has on its players. This would allow for an enhancement in match making systems, since it allows to ensure that opponents have a similar understanding of challenge. [Nguyen and Zagal, 2016] This may help to resolve the conflicts described by Eklund and Ask.

While there are publications regarding conflict resolving in online games, no research on the potential problems described by Nguyen and Zagal or Eklund and Ask were found within this literature research. One notable publication by Slovak et al. that approaches the same domain examined moderation in online game systems and how *save spaces* can be created has been presented ad the CHI conference in 2018. [Slovak et al., 2018]

5.2 Character Design

5.2.1 Non Verbal Communication in Character Design

The three layered model of NVC in character design by Thurlin and Manninen (see 4.5.1) contains the personalization of NVC. As stated by Thurlin and Manninen, personalization is what makes avatars "more distinguishable" [Thurlin and Manninen, 2003]. The researchers state that further research is required to determine what elements should be personalizable to which degree. [Thurlin and Manninen, 2003]

Furthermore, the incorporation of NVC of avatars in video games is non trivial and needs to be further explored according to Thurlin and Manninen. Real time control of NVC elements is not possible due to interference with with the main game controls. Thurlin and Manninen advocate for research on methods to enable a concurrent combination of gameplay and avatar NVC controls. [Thurlin and Manninen, 2003]

Since the presented research of Thurlinnen and Manninen in 2003 several publications have been dedicated to NVC. Especially VR technology put an emphasis on different commiunication means of avatars, among which NVC is an integral element.

Maurer et al. presented extensive research on gaze and hand gestures in video games. Visual tracking has been used as an input mechanism and the examined video game was specifically developed to be played with this type of input. In this case NVC was used as the only communication means in order to solve in-game problems as a team. [Maurer et al., 2017] The above-mentioned problem that NVC controls interfere with the main game controls in this case was solved by making NVC the main game controls.

Maloney et al. present different types of NVC that are used for avatars in VR environments. [Maloney et al., 2020] The perception of these types was evaluated in an interview study [Maloney et al., 2020] in order to answer the question of Thurlin and Manninen which was mentioned the first paragraph. The research gaps identified by Thurlin and Manninen are therefore at least partly resolved.

5.2.2 Uncanny Valley

Schneider et al. state that studies examining the uncanny valley in video games with regard to moving characters are missing. [Schneider et al., 2007] The afore-mentioned study by Schneider et al. (see 4.5.6) has been based on the evaluation of still images. [Schneider et al., 2007] As pointed out by Mori, movement "steepens the slope of the uncanny valley" [Mori, 2017], i.e. the actual effects of human-like avatar designs on players are supposed to have a greater impact than shown by Schneider et. al. Scientific proof is however still to be gathered in order to verify this claim. [Schneider et al., 2007]

In 2014 Piwek et al. conducted a study in which a zombie, which is one of the example characters in Mori's original publication [Mori, 2017] has been animated in order to examine whether movement amplifies the effects of the uncanny valley. This hypothesis was not supported by the results of Piwek et al., in fact the moving zombie showed higher acceptability rates than the still image. [Lukasz et al., 2014]

5.3 Gameplay

5.3.1 Dynamic Game Rules

In the aforementioned work on dynamic game rules (see 4.3.2), Togelius states that applying supervised learning algorithms in order to dynamically create and employ game rules on a training set of events always comes with the issue of underdetermination of induced rules. Therefore, it is suggested that a rule construction system that uses Popper's critial rationalism would be a better fit for this problem. Game rules should be treated as hypotheses and players or designers should be able to falsify, i.e. cancel out unwanted rules. [Togelius, 2011] Research on the applicability and effect of this solution approach is still completely missing.

5.4 Design Aims

5.4.1 In-Game Ads

As mentioned before (see 4.1.24), Herrewijn and Poels showed that by shaping the player experience, the difficulty of a video game has direct implications on the effectiveness of advertisements in video games. One of the limitations of these insights is that they do not contain direct implications for designers on a detailed level, i.e. which in-game parameters apart from difficulty can be adjusted in order to promote advertisement content. Specifically, further research on the effects of changing PAD parameters on the effectiveness of in-game advertisement are suggeested. [Herrewijn and Poels, 2011]

Furthermore, in the cited paper by Herrewijn and Poels self-evaluation via a likert scale was used as the assessment method. As stated by the authors, further research is required in order to capture how players feel about advertisements while playing the game as the used methodology only captures the post game session state. Apart from the effectiveness of advertisements, also player focus on the game environment is recommended to be taken into account and put into perspective in future research. [Herrewijn and Poels, 2011]

Ghosh introduces the perspective of regulatory focus into the effectiveness of in-game advertisement. In a similar study to the one by Herrewijn and Poels (evaluation via a Likert scale after game sessions), regulatory focus was one of the main metrics that were considered. [Ghosh, 2016]

No publications that directly cover the research gaps identified by Herrewijn and Poels were found in this literature research.

5.4.2 Casual Game Design

As shortly stated before (see 4.1.1), definitions of what casual games are still vary to a substantial degree within the domain of game design and existing definitions do not match casual game development practice. [Chiapello, 2013]

Implicit knowledge of professionals who develop casual games is still not researched enough to make it explicit according to Chiapello. This process requires practices to be examined thoroughly and applied to well researched game concepts which may have to be adapted to fit into the casual game domain. This would allow for crucial contributions to the theory of the design of casual games. [Chiapello, 2013]

5.4.3 Target Design

When examining why certain demographic groups seem to be excluded from the digital game market, the elderly often come to mind. Nap et al. state that when digital games had their first peak in the 1980, people who would now be classified as seniors often were outside of the game industry's target group. This perception of digital games being made for younger generations generally did not change. [Nap et al., 2009]

According to Nap et al., in order to be able to actively searching for interesting games to buy a substantial level of knowledge on the required hardware and game genres as well as current game developments is needed. Seniors often lack access to this domain knowledge. Nap et al. recommend to focus on the communication of trends and new developments in digital game design when conducting target design research for the elderly. [Nap et al., 2009]

Furthermore, board games are considered a suitable domain to study what potential players of different age enjoy while playing a game. Nap et al. state that knowing what seniors enjoy when playing board games can help tailor digital game experience to this demographic group and in consequence, develop guidelines or genres for game development with seniors as the target group. [Nap et al., 2009]

While several publications exploring the game market for elderly gamers with an explicit research emphasis on the preferences of older players have been published (e.g. Salmon et al. [Salmon et al., 2017] or Costa et al. [Costa and Veloso, 2016]), no publication was found in this literature research that explicitly cover the aforementioned gaps identified by Nap et al.

5.5 Design Process

5.5.1 Modelling Standards for Game Development

As in other domains of software development, good modeling and communicating techniques are crucial for an accurate translation from the game idea into a software artifact. Approaches to this problem have already been presented in this thesis (see 4.2.7). The aforementioned techniques however focus solely on the definition, documentation and communication of gameplay, whereas other crucial aspects of digital game design are not covered.

Montero Reyno and Carsí Cubel identify five domains for which their proposed multi-model approach (see 4.2.7) does not apply. Since a more concise and compact means of communication than natural language would be beneficial in the development stage in multiple domains, they suggest further research to develop precise modeling methods for the following areas: [Montero-Reyno and Carsí-Cubel, 2009]

- Graphic Interface Design

  Graphic interface design is an important aspect of video game development and one that leaves lots of room for interpretation, therefore it would be beneficial to have a robust modeling technique. As pointed out by Montero Reyno and Carsí Cubel, not only how game scenes are represented but also how they interact with each other and how players can interact with the game world as well as how the player progresses needs to be addressed when developing a video game. [Montero-Reyno and Carsí-Cubel, 2009]

- Audio Design

  For audio design it is important to define how sound is presented to a player, i.e. which events trigger which sound effect, which background music is played in each level or game state. [Montero-Reyno and Carsí-Cubel, 2009]

- Artificial Intelligence

  For several games it is important how NPCs act and react within the game world. Their motions and motives are among the things to be defined. [Montero-Reyno and Carsí-Cubel, 2009]

- Game Storytelling

  When designing a video game it is crucial that the structure and elements of storytelling are well defined. [Montero-Reyno and Carsí-Cubel, 2009] The model of micronarratives which is presented in this thesis (see 4.7.4) might be a good starting point to be extended to storytelling modeling techniques.

- Level Design

  A concise definition method for level design conveys how the game is structured. A well defined level design specification could be imported into a level editor in order to generate levels automatically. [Montero-Reyno and Carsí-Cubel, 2009]

While there are several publications on Model-Driven Game Development (MDGD), none seem to completely match one of the five above-mentioned domains of Montero Reyno and Carsí Cubel. A literature Review by Zhu and Wang provides an extensive overview of current research of modeling techniques. [Zhu and Wang, 2019] The presented approaches however are either domain specific (e.g. Sanchez et al. [Sánchez et al., 2015] or Thillainathan et al. [Thillainathan et al., 2013]) or highly technical (e.g. xml based approaches by do Prado and Lucredio [do Prado and Lucredio, 2015] or by Minovic et al [Minovic et al., 2009]).

There are however some approaches, e.g. by Hernandez and Ortega that include renderings or sprites of game objects in the graphic model and include hooks defined by ActionScript, e.g. onEnter, onUpdate and onExit [Hernandez and Ortega, 2010]. Even though this publication does not cover the needs expressed by Montero Reyno and Carsí Cubel, several properties, e.g. triggers are provided to make this model extendable for different use cases, which might probably suit the aforementioned modeling demands in game development. After a thorough literature research, the gap from domain driven or technical approaches to generalized modeling languages and techniques of all development related aspects seemingly still has to be closed. No clear standard in modeling techniques has yet been established in video game design and development.

5.6 Game Analysis

5.6.1 Player Typology

According to Bateman, the application of models of psychology, be it the trait theory (see 4.8.4) or psychometric methods in order to identify player types has limited outcomes. The claim is that the applied models were developed with motives that are far from the game domain and therefore the induced results lack robustness. [Bateman et al., 2011]

The typology developed by Smith (see 4.8.4) is an example for a model which is specific to the game studies domain but it applies only to a certain gameplay context, i.e. strategic multiplayer games. [Smith, 2005] According to Bateman a robust player typology needs to be general enough to serve game developers, researchers and players and needs to rely on theoretical principles that yet need to reach the required level of maturity before being applicable for a new player typology. [Bateman et al., 2011] A qualitative list of these principle is however not conveyed by Bateman.

In 2013, Ferro et al. conducted a literature study where different player types from game design research publications were collected and compared with personality types and traits from psychological research. Relationships between player types and game elements and objects have been examined in order to enable the design of games for a certain player type. Analogously to the findings of Bateman, Ferro et al. state that the trait theory conveys player preferences in a more accurate manner. Game elements and objects help to make the findings more generalizable since these artifacts are found not only in games of different genres but also in gamification contexts (see 4.10). However, Ferro et al. point out that relationships between player types and game elements still need to be examined more thoroughly. [Ferro et al., 2013]

5.7 Social Interaction in Play

5.7.1 Achievements

As pointed out by Hamari and Eranti, there are aspects of the effects of achievements on gameplay that are still to be discovered. One interesting topic of research that the is named is the comparison of gameplay with regards to achievements in situation where the list of badges and prizes are known with situations in which they are unknown to the players. [Hamari and Eranti, 2011]

Furthermore, aspects of game design are increasingly penetrating other contexts (see 4.9) and achievements are a commonly used technique to incorporate game elements into serious fields. Future research on achievements should therefore be abstract enough to include contexts other than traditional video games to convey more generalizable and useful results. [Hamari and Eranti, 2011] The analysis of pervasive cheating by Glas (see 4.3.11) can be seen as an approach towards this direction.

5.7.2 Player Communities

The term semi-spectatorship (see 4.6.3) describes that players who are not directly involved in a certain game scene may participate in the act of gaming in multiple ways. The aforementioned types of semi-spectatorship may serve as a base for the creation of communities. The required research on interplay between these two concepts is however still missing according to Love and Bozdog. [Love and Bozdog, 2018]

This literature research yielded that Love or Bozdog have been authos or coauthors of every publication with the coined term semi-spectatorship. The requested research has not been published yet and similar concepts (e.g. research on Let's Plays) are presumably too far from the concept of semi-spectatorship to infer the collected knowledge.

5.7.3 Fandom

Mavridou claims that fandom and gaming have strong ties and should be considered as two largely intertwining disciplines. While it has been acknowledged in the academic field that there are playful aspects in fan activities and gaming can be seen as a "fannish" [Mavridou, 2016] activity, there is not enough research that does not treat these two fields in an isolated manner but as interwoven areas of research. This would allow to fall back on research from the respectively other area to be applied in order to introduce new academic perspectives on fandom and gaming. [Mavridou, 2016]

In this single source literature research no publications were found that would combine the terms "fan" or "fandom" with gaming or playing, presumably this gap is still valid. As pointed out by Mavridou [Mavridou, 2016], several relatively recent publications can be found on playful fandom (e.g. by Newbury [Newbury, 2017]). The hybrid approach described by Mavridou however could not be found.

5.8 Forms of Representation

5.8.1 Cultural Heritage in Games

In Lelièvre's study on cultural heritage in video games, the design process of two video games was examined and compared in order to gain insights on how cultural heritage was communicated to players by the design of historical monuments in game worlds.

As pointed out by Lelièvre, systematic rules of cultural heritage within game design processes cannot be inferred by this study due to the small number of examined games. [Lelièvre, 2016] Therefore, the incorporation of cultural heritage in video games and its role in design processes is still a blind spot in the domain of game design research.

Since Lelievre's publication in 2016, research from different areas regarding cultural heritage in games have been published. The advent of AR in museum and tourism contexts has put an elevated degree of focus on this topic. One of the notable contributions in this field is by Lehto et al [Lehto et al., 2020]. The incorporation of cultural heritage

in a more traditional technological setting in serious games (see 4.9) by Vocaturo et al. [Vocaturo et al., 2019] has been published in 2019. The identified gaps by Lelievre have been covered since.

5.9 Serious Games

5.9.1 Domain Experts in Serious Games Design

Serious games are almost exclusively applied games and therefore the main objective for designing video games in this sector changes. As pointed out by van Roessel and van Mastrigt-Ide, usability and functionality are less important than the content that a domain experts introduces into the design process. Gameplay is mostly adjusted to the content and therefore the relationship between domain experts and designers when designing this type of game is assumed to be unique in the field of game design. [van Roessel and van Mastrigt-Ide, 2011]

Engström and Backlund review their work as designers and developers of serious games for more than a decade and describe the role of the domain expert, who has to provide information so that developers can delve into the field of interest and developers have to create and discuss the possible solutions. [Engström and Backlund, 2021] While this publication provides insight into practical work as a developer of serious games, a clear methodological approach on the cooperation of domain expert and designer is missing and has not been found in other publications within the scope of this literature research.

5.9.2 Game Testing in Serious Games

Serious Games are commonly very domain specific which decreases the game designers' knowledge of the target audience's demands. Therefore, game testing is of higher importance and early game testing can prevent that domain driven objectives or player acceptance are not met. As van Roessel and van Mastrigt-Ide state, time and cost constraints prevent extensive game testing for serious games in practice and recommend further investigation into how a balance between this important aspect of game development and practical constraints can be achieved. [van Roessel and van Mastrigt-Ide, 2011]

Solinska-Nowak et al. examined the methods of evaluation of serious games in Disaster Risk Management (DRM). From 49 examined DRM games, only eight games have been tested using structured methods, mostly consisting of questionnaires before and after the game sessions with questions regarding the effectiveness of the particular serious game. The biggest part of the examined games used content analysis by experts or observation and unstructured feedback as an evaluation method. Nine of the examined games were not tested at all. Therefore, most games were not tested in a structured manner against their actual objectives. [Aleksandra et al., 2018]

Even though the above-mentioned publication of Solinka-Nowak is domain specific, it categorizes means of testing serious games and backs up what van Roessel and van Mastrigt-Ide stated in 2011. [van Roessel and van Mastrigt-Ide, 2011] An overarching review on testing in serious games and on how testing should be conducted cost effectively in practice was not found in this literature review.

5.9.3 Learning Game Contexts

Marklund states that the academic field of learning games is currently focused almost exclusively on the game artifact, i.e. designs of learning games as well as their potential effect on players. The claim is that this kind of research excludes the importance of the context in which these games are deployed. [Marklund, 2014]

As stated by Marklund, serious games come with requirements that have to be met by the context in which they are applied in order to properly work. Furthermore, practical constraints may impose changes in the effects of a learning game but also enable new possibilities in the context of use. [Marklund, 2014]

In an extensive literature review Marklund finds that even though the demand of examining the real-world context of learning games has been known and explicitly expressed, e.g. in 2008, less than 8% of 104 examined papers have taken the application context of serious games into account. A more thorough examination of how learning games fail has been notable over time, mostly referring to failures in development processes. [Marklund, 2014]

5.10 Biotic Games

Gerber et al. examined the developments of computer technology and biotechnology and came across several parallels between these two fields. Drawn from those parallels, they estimate a gap of approximately 50 years between the two research fields, i.e. a lag of 50 years in the field of biotechnology. Based on this assumption they assume that research towards consumer products will develop soon, enabling the market to distribute them in 2022. They believe that research on cloud laboratories or biotechnology edutainment might lead to that development. [Gerber et al., 2016]

Furthermore, Gerber et al. see the following gaps and expect them to be academically covered within the upcoming years [Gerber et al., 2016]:

- Porting of Game Genres

  Existing game genres from digital as well as analog games will be translated to the biotic games design spaces. Basic research regarding this task is already done and implementations exist, e.g. a football game with paramecium cells. [Gerber et al., 2016] Parallels to existing video games can be drawn easily, e.g. with the digital game *NASL Soccer* from 1979, as seen in figure 5.1.

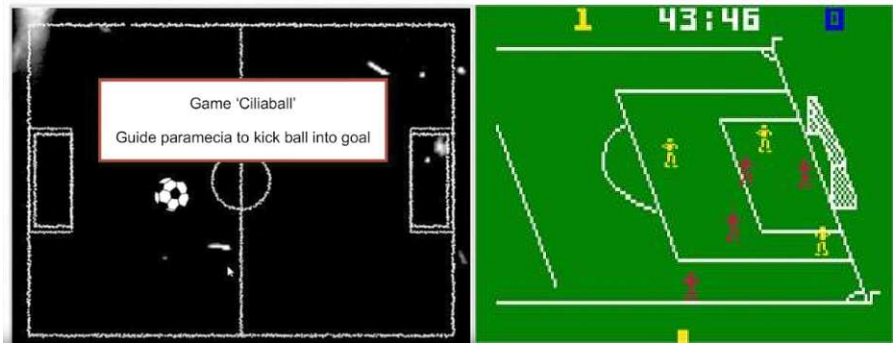

Figure 5.1: Comparison of biotic game *Ciliaball* and digital game *NASL Soccer*. Left image: ©labonachipVideos, right image: ©gamesdatabase.org

Newer publications suggest however, that it is likely that gameplay is adapted to fit the properties of biotic games than adapting biotic games to existing game genres. Kim et al. present design recommendations for games that make use of the biological "lag" [Kim et al., 2020] and to develop "slow biotic games" [Kim et al., 2020] in which the focus lies on aesthetics instead of spontaneous game behavior. [Kim et al., 2020]

- Flexibility in the Biological Space

  Gerber et al. assume that digitally augmented graphics, e.g. text will be displayable in the biological space. Considering *Ciliaball*, this would mean that the score will not be a digital overlay, but will be created by microbes that are forced into the shape of text by providing stimuli. The researchers expect, that this will be valid for all game functions that are now implemented in the digital space. [Gerber et al., 2016]

  The aforementioned slowness of biotic games as described by Kim [Kim et al., 2020] is still an unresolved issue and therefore the flexibility as described by Gerber et al. does not yet exist. Research regarding this type of application could not be found.

- Genetically Modified Organisms

  As mentioned above, designers of biotic games currently have to deal with cell properties that vary over time and with non-deterministic game behavior in the biological space. Gerber et al. assume that organisms will be genetically modified so that these behavior inconsistencies will not occur anymore. They predict that microbes will be programmed, i.e. modified for specific games, just like software is programmed currently. [Gerber et al., 2016]

  No applied case of genetically modified organisms in biotic games or approach towards this direction was found in the literature research.

- Directed Evolution

Games will incorporate directed evolution which will give players the ability to evolve microbes with player-specific properties. Cloud lab technology can help achieve this research milestone, by containing and separating certain organisms while allowing interactions. [Gerber et al., 2016]

This however is still a vision as no matching public research project or publication could be found in thorough literature research.

CHAPTER 6

Reflection

The identified key aspects which are based on scientific literature from relevant conferences of game design research should be considered an approach to gain insights about how focuses are placed within the scope of this research area. The vastly growing knowledge base as well as the multidisciplinary nature of game design research augment the need for a profound understanding of meta structures and an analytical confrontation with connections between different aspects.

The chosen methodological framework, which consists of standardized research methods that are highly compatible ensured transparency and clarity in an explorative research setting. The chosen scope has presented itself as highly challenging to be covered by a thorough scoping study given the limited resources. The University of Texas Libraries estimates one year of research for a team of three members to complete a standard scoping review. [Reviews, 2022] Due to the wide scope and the varying involvement of the research team, limiting the pool of includable sources has been a necessary measure in order to keep the workload at a highly extensive but feasible level.

The decision to include the conferences Digital Games Research Association (DIGRA), International Journal of Computer Games Technology (ICG), and The Italan Journal of Game Studies (G|A|M|E) has been backed by a domain expert, Martin Pichlmair, head of the ITU Copenhagen's "Games" study program and has led to diverse results with interesting intersections. Furthermore, both of the chosen conferences are featured in the aforementioned meta work by Martin [Martin, 2018] and Melcer et al. [Melcer et al., 2015]. The DIGRA conference notably yielded the highest quantity of included articles which cannot exclusively be traced back to the higher amount of publications but also to a focus that proved to match to the scope of this review to a high extent. It can be assumed that publications from the CHI PLAY conference would be a valuable extension to the findings of this thesis due to its recognition within the research community and its broad scope. Furthermore, the incorporation of a conference with narrow scope (e.g. on game narratology (see 4.7) or game-based learning (see 4.9.2) would be an interesting

addition. A full incorporation of a conference with a narrow focus would however likely lead to a strong result bias given the width of the scope. Furthermore, it should be stated that the identified gaps might be covered in more specialized venues which are not publicly accessible and therefore completeness regarding the evaluation of mentioned research gaps cannot be guaranteed.

It can be assumed that the presented results contain bias, which becomes specifically evident regarding two dimensions, i.e. academic bias and geolocational bias. A scoping review's aim is to capture research that has been conducted in a certain scientific area. As previously discussed in the context of non-euclidean geometry (see 4.3.3), practical solutions may overtake academic research by applying a different perspective and set of tools on a specific problem. The presented aspects presumably contain a lack of implicit and explicit knowledge which only consists in the practical domain but has no academic coverage. As can be seen in figure 6.1, the distribution of continents evaluated by the authors' workplaces for included publications has a very strong bias on contributions from Europe and North America. Research from Africa and South America is hardly represented in these results due to the small number of contributions for the covered conferences from these areas. Furthermore, the interpretation of inclusion criteria has been extensively discussed and inclusion decisions have not been made by a single researcher, nevertheless, it is inevitable that existing biases are part of decisions.

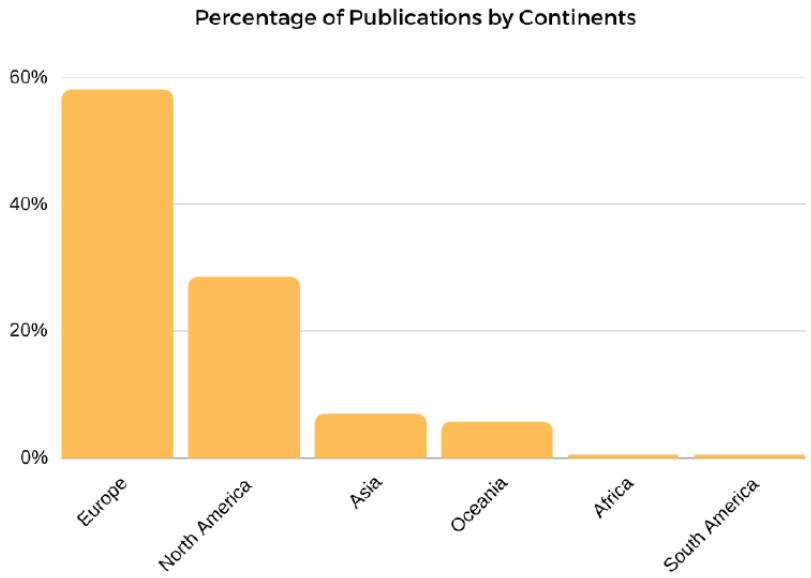

Figure 6.1: Distribution of Included Publications by Continent

The identified key aspects may be structured in different ways and different structures may seem more or less comprehensible for different recipients. Therefore, the different sections and assigned aspects should be considered a recommendation for a taxonomy that is largely subjective and not as the single correct categorization.

This thesis provides an extensive overview of the structures of game design research with a vast scope. The findings are addressed specifically but not exclusively to researchers who work in the field of game design and want to compare their research or knowledge to the aspects presented in this thesis. It is anticipated that the presentation of the research results as a taxonomy makes connections between different aspects of game design more evident. Furthermore, the gaps section provides a pool of topics for experienced researchers as well as students who want to contribute by publishing research which is meaningful to the state of game design knowledge. One objective during the process of composition of this review was to provide an entry point for game design research, regardless of existing knowledge. Therefore, complex domain-specific language has been avoided wherever possible. The broad scope of research aspects may be especially beneficial for practitioners who profit from the holistic perspective on game design which can directly or indirectly be applied when creating technological artifacts, i.e. digital games or playful applications.

Future research should be conducted to extend this review by adding research aspects from various conferences, e.g. CHI PLAY to account for contributions of different research communities and to identify additional research gaps. Narrowing down the scope and exclusively researching single aspects in meta-reviews is recommended for small research teams or single researchers with limited resources.

CHAPTER 7

Conclusion

This scoping review presents a holistic perspective on game design research. Publications of three relevant conferences on game design and associated topics have been thoroughly examined and evaluated in an iterative manner against predefined criteria. A constantly refined protocol with a priori definitions was used to provide transparent guidelines and to ensure a common understanding of criteria for publications of interest.

A taxonomy of ten categories with a total of 78 either independent or interdependent aspects of game design research is lined out. Links to other sections of this review are referenced in the text so that connections become clearer. The taxonomy results in the following sections:

- Design Aims
- Design Process
- Gameplay
- Forms of Representation
- Character Design
- Social Interactions in Play
- Narratology
- Game Analysis
- Serious Games
- Gamification

The presented publications cover either novel approaches in game design or valuable enhancements to existing perspectives and techniques. Publications are identified and listed and the contribution to the knowledge state for game design research has been explicitly covered for each of the identified aspects. The emphasis of the selection of key aspects is clearly on the design of video games, therefore, implementation details and technical specifications are out of scope.

The following articles have been considered especially valuable for the state of video game research regarding the defined scope:

Table 7.1: Valuable Publications Featured in this Thesis

Chapter	Title	Authors
Design Aims	Putting Brands into Play: How Player Experiences Influence the Effectiveness of In-Game Advertising	Laura Herrewijn, Karolien Poels
Design Aims	Winning versus not losing: exploring the effects of in-game advertising outcome on its effectiveness	Tathagata Ghosh
Design Aims	Formalizing casual games: A study based on game designers' professional knowledge	Laureline Chiapello
Design Aims	Age Differences in Associations with Digital Gaming	Henk Herman Nap, Wijnand A. IJsselsteijn, Yvonne A.W. de Kort
Design Aims	A survey of video game preferences in adults: Building better games for older adults	Joshua P Salmon, Sarah M Dolan, Richard S Drake, Graham C Wilson, Raymond M Klein, Gail A Eskes
Design Aims	Factors influencing the adoption of video games in late adulthood: a survey of older adult gamers	Liliana Vale Costa, Ana Isabel Veloso
Design Process	A Platform-Independent Model for Videogame Gameplay Specification	Emanuel Montero-Reyno, José Carsí-Cubel
Design Process	Model-Driven Game Development: A Literature Review	Meng Zhu, Alf Inge Wang
Design Process	A DSL for rapid prototyping of cross-platform tower defense games	Kevin Sánchez, Kelly Garcés, Rubby Casallas
Design Process	Enabling Educators to Design Serious Games – A Serious Game Logic and Structure Modeling Language	Niroshanand Hoffmann Thillainathan
Design Process	A Flexible Model-Driven Game Development Approach	Ely Fernando do Prado, Daniel Lucredio
Design Process	Model driven development of user interfaces for educational games	Miroslav Minovic, Milos Milovanovic, Mladjan Jovanovic, Dusan Starcevic

Design Process	Eberos GML2D: A Graphical Domain-Specific Language for Modeling 2D Video Games	Frank Hernandez, Francisco Ortega
Forms of Representation	OFabulis and Versailles 1685: a comparative study of the creation process behind video games on historical monuments	Edwige Lelièvre
Forms of Representation	Augmented Reality Gaming as a Tool for Subjectivizing Visitor Experience at Cultural Heritage Locations—Case Lights On!	Anttoni Lehto, Nina Luostarinen, Paula Kostia
Forms of Representation	Educational Games for Cultural Heritage.	Eugenio Vocaturo, Ester Zumpano, Luciano Caroprese, Saverio Mario Pagliuso, Divina Lappano
Character Design	Supporting visual elements of non-verbal communication in computer game avatars.	Tomi Thurlin, Tony Manninen
Character Design	Exploring Gaze and Hand Gestures for Non-Verbal In-Game Communication	Bernhard Maurer, Alina Krischkowsky, Manfred Tscheligi
Character Design	"Talking without a Voice": Understanding Non-Verbal Communication in Social Virtual Reality	Divine Maloney, Guo Freeman, Donghee Yvette Wohn
Character Design	Exploring the Uncanny Valley with Japanese Video Game Characters	Edward Schneider, Yifan Wang, Shanshan Yang
Character Design	The uncanny valley: The original essay by masahiro mori	Masahiro Mori
Character Design	Empirical evaluation of the uncanny valley hypothesis fails to confirm the predicted effect of motion	Piwek Lukasz, S. McKay Lawrie, E. Pollick Frank
Social Interactions in Play	Framework for Designing and Evaluating Game Achievements	Juho Hamari, Veikko Eranti
Social Interactions in Play	Player Communities in Multiplayer Online Games: A Systematic Review of Empirical Research	Harald Warmelink, Marko Siitonen

Social Interactions in Play	Game Design Patterns for Collaborative Player Interactions	Christian Reuter, Viktor Wendel, Stefan Göbel, Ralf Steinmetz
Social Interactions in Play	A Three Person Poncho and a Set of Maracas: Designing Ola De La Vida, A Co-Located Social Play Computer Game	Lynn H.C. Love, Mona Bozdog
Social Interactions in Play	A Study of Team Cohesion and Player Satisfaction in two Face-to-Face Games	Eleanor Martin, Judith Good
Social Interactions in Play	Role Theory: The Line Between Roles as Design and Socialization in EverQuest	Kelly Boudreau
Narratology	Interactive Digital Storytelling: Towards a Hybrid Conceptual Approach	Ulrike Spierling
Narratology	Game Spaces Speak Volumes: Indexical Storytelling	Clara Fernández-Vara
Narratology	Character-driven Narrative Engine. Storytelling System for building interactive narrative experiences	Ilaria Mariani, Mariana Ciancia
Narratology	The Role of Micronarrative in the Design and Experience of Digital Games	Jim Bizzocchi, Michael Nixon, Steve DiPaola, Natalie Funk
Narratology	Story and Recall in First-Person Shooters	Daniel Pinchbeck
Narratology	Towards Data-Driven Drama Management: Issues in Data Collection and Annotation	Anders Drachen, Michael Hitchens, Arnav Jhala, Georgios Yannakakis
Narratology	A Lightweight Videogame Dialogue Manager	James Ryan, Michael Mateas, Noah Wardrip-Fruin
Game Analysis	Player Typology in Theory and Practice	Chris Bateman, Rebecca Lowenhaupt, Lennart Nacke
Game Analysis	The Problem of Other Players: In-game Cooperation as Collective Action	Jonas Heide Smith

Game Analysis	Towards Personalised, Gamified Systems: An Investigation into Game Design, Personality and Player Typologies	tiLauren S. Ferro, Steffen P. Walz, Stefan Greuter
Serious Games	Collaboration and Team Composition in Applied Game Creation Processes	Lies van Roessel, Jeroen van Mastrigt-Ideti
Serious Games	Serious games design knowledge: Experiences from a decade (+) of serious games development	Henrik Engström, Per Backlund
Serious Games	An overview of serious games for disaster risk management – Prospects and limitations for informing actions to arrest increasing risk	Solinska-Nowak Aleksandra, Magnuszewski Piotr, Curl Margot, French Adam, Keating Adriana, Mochizuki Junko, Liu Wei, Mechler Reinhard, Kulakowska Michalina, Jarzabek Lukasz
Serious Games	Out of Context - Understanding the Practicalities of Learning Games	Björn Marklund
Gamification	Can't play, won't play	Margaret Robertson
Gamification	Gamifying collaborative prioritization: Does pointsification work?	Fitsum Meshesha Kifetew, Denisse Munante, Anna Perini, Angelo Susi, Alberto Siena, Paolo Busetta, Danilo Valerio
Gamification	Gamification and serious games in a healthcare informatics context	Robin De Croon, Davina Wildemeersch, Joris Wille, Katrien Verbert, Vero Vanden Abeele
Gamification	From game design elements to gamefulness: defining" gamification"	Sebastian Deterding, Dan Dixon, Rilla Khaled, Lennart Nacke
Gamification	Investigating Team Effectiveness Using Discord: A Case Study Using a Gaming Collaboration Tool for the CS Classroom	Lisa L Lacher, Cydnee Biehl
Player Behavior	Breaking Reality: Exploring Pervasive Cheating in Foursquare	René Glas
Player Behavior	Please Biofeed the Zombies: Enhancing the Gameplay and Display of a Horror Game Using Biofeedback	Andrew Dekker, Erik Champion
Player Behavior	Games user research	Anders Drachen, Pejman Mirza-Babaei, Lennart E Nacke

Player Behavior	The strenuous task of maintaining and making friends: Tensions between play and friendship in MMOs	Lina Eklund, Kristine Ask
Player Behavior	Good Violence, Bad Violence: The Ethics of Competition in Multiplayer Games	C. Thi Nguyen, José P. Zagal
Player Behavior	Mediating Conflicts in Minecraft: Empowering Learning in Online Multiplayer Games	Petr Slovak, Katie Salen, Stephanie Ta, Geraldine Fitzpatrick
Social Interaction in Play	Framework for Designing and Evaluating Game Achievements	Juho Hamari, Veikko Eranti
Social Interaction in Play	A Three Person Poncho and a Set of Maracas: Designing Ola De La Vida, A Co-Located Social Play Computer Game	Lynn H.C. Love, Mona Bozdog
Social Interaction in Play	Playful Fandom: Gaming, Media and the Ludic Dimensions of Textual Poaching	Orion Mavridou
Social Interaction in Play	The Case of Competitive Video Gaming and Its Fandom: Media Objects, Fan Practices, and Fan Identities	Elizabeth Marie Howell Newbury
Biotic Games	Interactive Biotechnology: Design Rules for Integrating Biological Matter into Digital Games	Lukas C. Gerber, Honesty Kim, Ingmar H. Riedel-Kruse
Biotic Games	Working with Nature's Lag: Initial Design Lessons for Slow Biotic Games	Raphael Kim, Siobhan Thomas, Roland van Dierendonck, Nick Bryan-Kinns, Stefan Poslad

Furthermore, research gaps as identified by scholars who published at the conferences within scope were presented and falsified wherever scientific work could be found that cover the mentioned gaps.

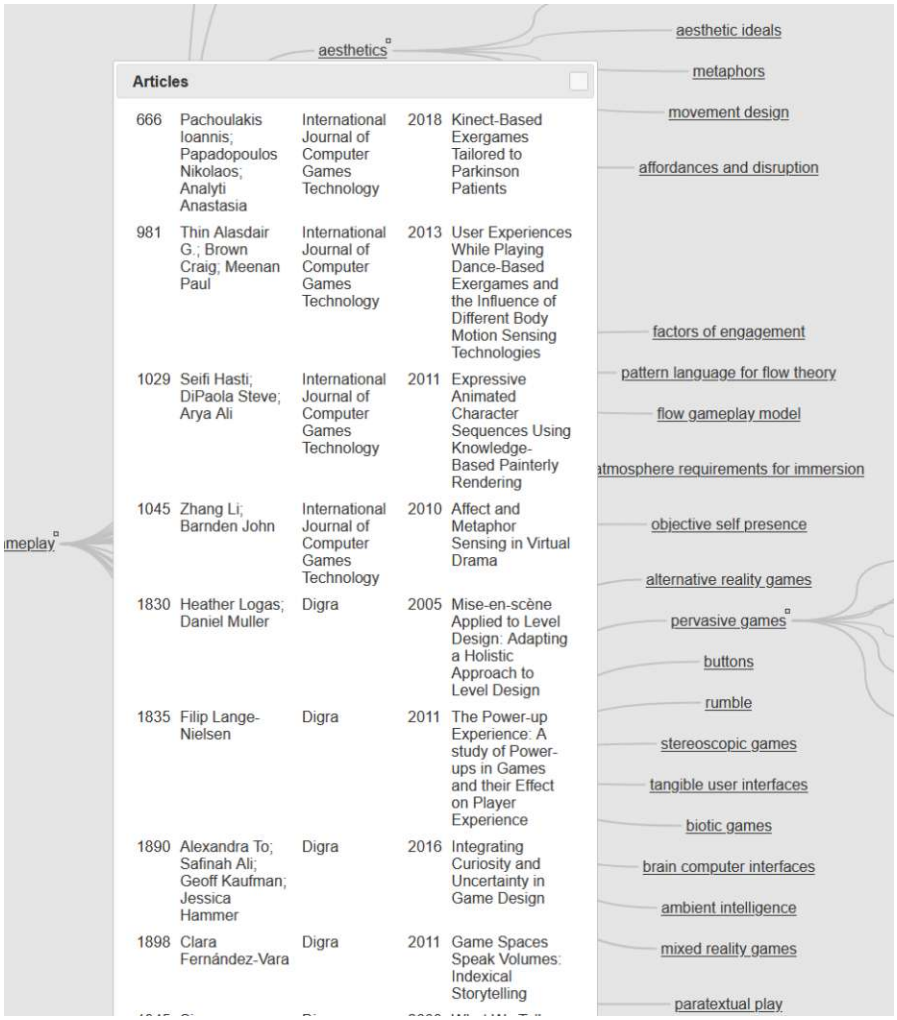

Figure 7.1: Interactive Visualization of Aspects and Publications

The literature database that was created and maintained for the entire duration of the research process has been made available in an interactive form. The findings of this thesis are visualized as a tree with clickable nodes which represent sections. Each click on a node opens an overlay with all relevant publications for the selected section as can be seen in figure 7.1. The interactive visualization can be accessed via `https://litrev.abendstille.at/concepts`.

List of Figures

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Listings

Acronyms

ACE Assist me, Challenge me, Emote me. 27, *Glossary:* Assist me, Challenge me, Emote me

API Application Programming Interface. 9, 11, *Glossary:* Application Programming Interface

AR Augmented Reality. 40, 79, 138, *Glossary:* Augmented Reality

BCI Brain Computer Interface. 78, *Glossary:* Brain Computer Interface

BPU Biotic Processing Unit. 84–86, *Glossary:* Biotic Processing Unit

CSV Comma Separated Values. 10, 11, *Glossary:* Comma Separated Values

DIGRA Digital Games Research Association. 143, *Glossary:* Digital Games Research Association

DRM Disaster Risk Management. 139, *Glossary:* Disaster Risk Management

FCF Four Channels of Flow. 69, *Glossary:* Four Channels of Flow

FOV Field of View. 73, 74, *Glossary:* Field of View

G|A|M|E The Italian Journal of Game Studies. 143, *Glossary:* The Italan Journal of Game Studies

HCI Human Computer Interaction. 48, 74, 104, 109, *Glossary:* Human Computer Interaction

HUD Heads Up Display. 77, *Glossary:* Heads Up Display

ICG International Journal of Computer Games Technology. 143, *Glossary:* International Journal of Computer Games Technology

iGEQ in-game Game Experience Questionnaire. 45, *Glossary:* in-game Game Experience Questionnaire

JSON Javascript Object notation. 11, *Glossary:* Javascript Object Notation

MDGD Model-Driven Game Development. 136, *Glossary:* Model-Driven Game Development

MMORPG Massively Multiplayer Online Role-Playing Game. 45, 46, *Glossary:* Massively Multiplayer Online Role-Playing Games

NPC Non Player Character. 23, 34, 57, 64, 65, 87, 109, 115, 121, 136, 169, *Glossary:* Non Player Character

NVC Non Verbal Communication. 99, 132, 133, *Glossary:* non-verbal communication

PAD Non Verbal Communication. 98, 134, *Glossary:* Pleasure, Arousal, Domination

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses. 6, 7, 129, 130, 155, *Glossary:* Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RPG Role Playing Game. 114, *Glossary:* Role Playing Game

SAM Self-Assessment Manikin. 45, *Glossary:* Self-Assessment Manikin

SQL Structured Query Language. 9, 10, *Glossary:* Structured Query Language

TUI Non Player Character. 82, *Glossary:* Tangible User Interface

VR Virtual Reality. 79, 92, 132, 133, *Glossary:* Virtual Reality

Glossary

Achievement are goals defined by the game that are gained by completing a task and is connected to the player profile [Hamari and Eranti, 2011]. 32, 46, 82, 105, 106, 129, 137

ActionScript is a programming language by Adobe. 136

Adgames are computer games that are adware. 126

Adware is the umbrella term for software that has the purpose of showing its users advertisements (e.g. for gaining revenue). 126, 163

Aesthetics are anticipated emotional responses that occur when interacting with a computer game [Hunicke et al., 2004]. 19, 26, 27, 59, 60, 67, 68, 78, 89, 123, 141

Affective Design is a design method with the aim to support emotional and mental communication [Ng et al., 2012]. 48

Agency is the state of being in control to fulfil an objective. 19, 43, 45, 50, 80, 93, 100, 101, 110, 111

Application Programming Interface is an interface provided by a software programm to invoke functions or retrieve data. 9, 11

Applied Game is a game that is deployed for a purpose like training or education. 79, 139

Assist me, Challenge me, Emote me is a heuristic based design approach for affective gaming by Gilleade et al. [Gilleade et al., 2005]. 27

Assistive Technology is technology that is built for people with special needs. 104

Augmented Reality is human perception enhanced by digital overlays. 40, 79, 138

Avatar is a game object representing the player. 25, 28, 32, 46, 77, 92, 95–97, 99, 100, 103, 110, 111, 118, 127, 128, 132, 133

Biotic Processing Unit is a system that houses biologic material and sensors to incorporate it into games. 84–86

Brain Computer Interface is an interface that lets humans control a computer via mere brain function. 78

Character Wheel is a list of character properties [Mariani and Ciancia, 2019] (see 4.7.3). 112

Characterization is the process of designing observable aspects of a character [Lankoski et al., 2003]. 101

CHI PLAY is a conference on game design research. 143, 145

Clan is a group of players who player multiplayer games together. Sometimes clans are also referred to as guilds. 106

Comma Separated Values is a data format that represents table data in text where columns are separated by a split character, usually a colon or semicolon. 10, 11

Critical Rationalism is a paradigm according to which hypotheses must be defined so that they are falsifyable so that they can be tested [Rowbottom, 2010]. 133

Design Box is an ideation technique in which designers are presented with random design constraints and they have to pitch a game idea sticking to these constraints. [Altizer and Zagal, 2014]. 47

Digital Existentialism is a concept according to which the value system of the creator is reflected within digital artifacts. 20

Digital Games Research Association is a conference on game design research. 143

Disaster Risk Management are strategies and measures that are taken to avert disaster risk. 139

Discord is an online communication platform. 127

Drama Manager is a tool that creates stories based on rules [Drachen et al., 2009]. 114

Dynamics describe the actions and behavior of game elements in response to player input [Hunicke et al., 2004]. 28, 38, 57, 60, 67, 68, 78, 89

E-Sports is an umbrella term for competitive video gaming. 89

Embedded Design Model is an approach to embed a message into game design [Kaufman et al., 2015]. 30

Environmental Storytelling is when a spatial environment is designed so that it conveys or supports a story [Fernández-Vara, 2011]. 111

Field of View is the pane of content that can be seen, e.g. what the monitor shows. 73, 74

Flow is the state of "complete absorption of what one does" [Csikszentmihalyi, 1997]. 45, 69–71, 93, 114

Four Channels of Flow extends flow by three other channels, i.e. boredom, frustration and apathy [Csikszentmihalyi and Csikszentmihalyi, 1992]. 69

Foursquare is a social media network based on location data. 82, 83, 131

Game Essay is a game that provides questions about its own nature or cultural surroundings [de Smale, 2016]. 27

Gameplay Loops design structures consisting of an objective, a challenge and a reward [Guardiola, 2016]. 18

Ganking is when a player is killing another player who is significantly weaker [Achterbosch et al., 2013]. 24

Geocaching is a playful activity with the aim to find objects based on location information. 80

God Game is a term defined by Spierling for simulators in which players plot the story [Spierling, 2005]. 111

Golden Ratio is the perfect balance of challenges between boredom and anxiety [Csikszentmihalyi, 1991]. 18

Hardcore Games are the opposite of casual games, i.e. games that are supposed to capture the entire attention of a player [Salter et al., 2019]. 18

Heads Up Display is a section on the game screen where the state, e.g. points, life points, etc. are shown. 77

Heuristic is an umbrella term for problem solving methods that are not optimal but sufficient [Martí and Reinelt, 2011]. 30, 95, 163

Hook is an interface through which a developer can insert code into a programm. 136

Human Computer Interaction is a discipline that revolves around the design, implementation and evaluation of computer systems for human use [Sinha et al., 2010]. 48, 74, 104, 109

in-game Game Experience Questionnaire is a questionnaire of 14 items to collect player experience data [Boletsis and McCallum, 2016]. 45

Interaction Paradigm is a counter model to the stimulus response paradigm, which see games as a medium to initiate an ongoing dialogue on emotions by player interaction [Harrer and Schoenau-Fog, 2015]. 26

International Journal of Computer Games Technology is a conference on game design research. 143

Java is a programming language. 10

JavaScript is a programming language, primarily used in web browsers, but sometimes also used as a scripting language for other client software. 9, 12, 169

Javascript Object Notation is a data format that can be used to serve data for usage in web applications. 11

Key-Lock is a type of quest that requires a player to find or unlock a key in order to unlock something within the game world [Ashmore and Nitsche, 2007]. 58

Kitch Factor a term coined by Tosca that refers to characters who reflect positive attributes due to being considered cool [Pajares Tosca, 2003]. 104

Lara Croft is a popular female protagonist of action games. 101

Lense is a term coined by Schell which describes a perspective with a small scope and a concrete question according to which game design can be analyzed [Schell, 2008c]. 23, 67, 79

Let's Play is a recorded game performance that is available on streaming platforms. 87, 88, 138

Location Based Game is a game that reacts to a player's location information [Jacob and Coelho, 2011]. 80

Ludus is controlled play with an objective [Denk, 2011]. 56

Massively Multiplayer Online Role-Playing Games are online role playing games that are played by a large number of players. 45, 46

Mechanics in the game context are in-game objects and the framework of rules [Hunicke et al., 2004]. 26, 55–57, 60, 67, 68, 89, 91, 94, 107, 120, 128, 168

Micronarrative is a technique to structure a story in small robust parts that can be accumulated to a story. 113, 114, 136

Mixed Reality Games is an umbrella term for different genres of games, e.g. pervasive games, location-based games, and augmented reality games [Wetzel et al., 2016]. 47

Modding are mostly unofficial alterations to a digital game. 19, 167

Model-Driven Game Development is a method of game development where in-game behavior is documented using modeling techniques. 136

Mods are deployable entities that are created as a result of modding. 20, 43

Netflix is a streaming service for films and series. 111

Non Player Character is a character in a video game which is controlled by artificial intelligence. 23, 34, 57, 64, 65, 87, 109, 115, 121, 136, 169

Non-Verbal Communication is every aspect of communication which is not word based. 99, 132, 133

Paidia is free, uncontrolled play [Denk, 2011]. 43, 56

Paratextual refers to additional material that is offered with a digital game [Glas, 2016]. 87

Participatory Design is a design method that engages all stakeholders in a project. 48, 49

Party is a group of players that completes adventure tasks in multiplayer games. 106

Pervasive Games is a game genre that extends the gameplay experience by temporal, spatial and social factors [Montola, 2005]. 39, 79, 166

Phidget are cheap usb powered input device electronics, e.g. knobs. 82

PL/pgSQL is a procedural programming language for the PostgreSQL database (see `https://www.postgresql.org/docs/9.2/plpgsql.html`). 11

Platform Games also-called platformers are games with the main aim to control a character to run or jump to beat enemies [Kaufman et al., 2015]. 38

Player Centered Design is a design method that revolved around the player and the game design counterpart to user centered design. 48

Pleasure, Arousal, Domination is a model to analyze environmental perception by the dimenesions of pleasure, arousal and domination presented in 1974 [Bakker et al., 2014]. 98, 134

PLEX is a framework by Arrasvuori et al. that assists in understanding and designing playful technology [Arrasvuori et al., 2011]. 81

Pointsification is the usage of quantifiable parameters (e.g. points) within serious contexts. 126–129

PostgreSQL is a relational database management system. 9, 11, 167

Postgrest is a webserver to expose relational data as a web service (see `https://github.com/PostgREST/postgrest`). 11

Power-Ups are either enhancements or modifications for existing mechanics or introduce new mechanics into a game [Lange-Nielsen, 2011]. 55, 56

Preferred Reporting Items for Systematic Reviews and Meta-Analyses is an item reporting recommendation by a collaboration of the Ottawa Hospital Research Institute and the University of Oxford (http://prisma-statement.org). 6, 7, 129, 130, 155

Protonarrative is a technique to structure a story as a network of predefined objects [Pinchbeck, 2008]. 114

Psychometric Type Theory are scientific approaches to categorize types of humans, e.g. the well-known Myers-Briggs type indicator [Boyle, 1995]. 121

Quest are in-game tasks that are given to the player. 58, 114, 166

Raid is a multiplayer strategy where multiple players synchronously try to defeat a joint enemy. 106

Rendering is a computer generated 3D representation. 63, 136

restful is an architectural modal for web services. 11

RFID is a technology that wirelessly transmits data. 40, 41, 82

Rhetorices Partes are different levels of developing a speech [Ueding and Steinbrink, 1986]. 47

Role Playing Game is a genre of analog and digital games. 114

Sandbox is a game mode without losing conditions and often with unlimited in-game resources. 39, 69

Sandbox Creation Environment is an umbrella term for game modes in which players can experiment with game objects and behavior without the restriction of rules, e.g. money constraints. 20

Self-Assessment Manikin is a nonverbal method of measuring key dimensions of emotional responding [Bynion and Feldner, 2020]. 45

Semi-Spectatorship describes that players who are not directly involved in a certain game scene may nonetheless participate in the act of gaming [Love and Bozdog, 2018]. 108, 138

Seriousization is the application of serious elements in ludic contexts. 126

Social Identity Theory is a theory by Hogg that describes self-conception in groups [Hogg, 2020]. 108, 109

Spawn Camping is when a player is repeatedly killing another player by waiting where this player will spawn again after their death [Achterbosch et al., 2013]. 24

Sprite are images or collections of images that are shown within a game [Tyers, 2016]. 136

SQLite is a small and file based relational database (https://www.sqlite.org). 9

Stimulus Response Paradigm is a perspective in which messages are transferred from the game to the player with the game as a conveying medium [Harrer and Schoenau-Fog, 2015]. 26, 166

Story Map Tool is a technique to create narrative structure [Mariani and Ciancia, 2019]. 113

Storyworld Canvas is a visualization tool that can be used to structure a story [Mariani and Ciancia, 2019]. 112

String is the datatype for text in several type based programming languages. 10

Structured Query Language is a language standard for data definition and manipluation in relational database management systems. 9, 10

Talk of The Town is a framework that allows NPCs to learn about their environment [Ryan et al., 2016a]. 115

Tangible User Interface is a type of user face which is controlled by touch. 82

The Italan Journal of Game Studies is a conference on game design research. 143

The Magic Circle is a (usually virtual) world in which the rules of a game apply [Brown, 2015]. 18, 45, 88

Thinking Aloud is a research method for usability testing in which study participants articulate their thoughts during usage of the to be tested artifact. 100

Trash Talking is when a player is verbally attacked by another player [Dixon, 2007]. 24

Treant JS is a JavaScript library for rendering tree diagrams (see `https://fperucic.github.io/treant-js/`). 12

Unreal Tournament is an ego-shooter video game. 58

Urban Play is an umbrella term for playful interaction with a player's surroundings [Ferri et al., 2016]. 43

Values at Play is a project founded in 2005, that "investigates how designers can be more intentional about the ways in which they integrate human values into their game-based systems" [Values at Play, 2021].. 22

Virtual Reality is a depiction of reality which is produced by computers. 79, 92, 132, 133

VNA is an ideation technique based on cards with verbs, nouns and adjectives [Kultima and Alha, 2011]. 47

Vogler's archetypes are categories of characters (see 4.7.3). 112, 113

Volksmusik is traditional German folk music. 67

Wicked Problems are problems that are difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize. [DeFries and Nagendra, 2017]. 21, 50

Zoning is when a player forces their opponent to play in a specific way [Wilson, 2011]. 89

Zotero is an open source software for collecting and organizing scientific work. 9, 10

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