

**TRANSFORMING HACIVAT-KARAGÖZ SHADOW PLAY  
TO AN INTERACTIVE-EDUCATIONAL COMPUTER GAME**

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TO AN INTERACTIVE-EDUCATIONAL COMPUTER GAME

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## **Abstract**

It is a known fact that computer games are influential on cognitive performance and that they have a huge potential if used as learning tools. In this study, the aim is to design an educational computer game based on Hacivat-Karagöz play, i.e. a Turkish shadow theater play. Instead of a classic shadow theater play, the current design lets children direct the characters and tell their improvised story. The game is designed to be helpful for improving the social abilities of children and as a side benefit it can help for keeping this valuable tradition alive. In this study, the outline of this game is provided and the classic Hacivat-Karagöz characters are re-designed in 3D. The chosen interaction medium is Leap Motion. HCI of leap motion is tested and the results indicate that the designed UI is successful enough to let children simulate the basic shadow theater tools. The redesign of these 2D-shadow theater characters in 3D was one of the most challenging steps. In order to tackle the task at hand, artistic skills were found to be equally important as technical skills. Although the current design is sufficiently capable of what was initially required, the current game concept needs to be revised with people from different backgrounds in order to create a more elaborate educational tool and to take the developed concept a step further.

# HACİVAT-KARAGÖZ GÖLGE OYUNUNUN ETKİLEŞİMLİ EĞİTİCİ BİLGİSAYAR OYUNU OLARAK UYGULANMASI

## Özet

Günümüzde bilgisayar oyunlarının, oyuncuların kavrama yeteneğine etkisi ve öğrenim aracı olarak kullanım potansiyeli bilinen bir gerçektir. Bu çalışmada geleneksel Türk Gölge Oyunu olan ve tarihte de eğlence ve eğitim amaçlı kullanılan Hacivat-Karagöz Oyunu'nu eğitsel bir bilgisayar oyunu olarak hazırlamayı amaçladık. Geleneksel Hacivat-Karagöz Oyunu'ndan farklı olarak; oyunu yöneten, karakterleri canlandıran "hayali" lerin oyuncular, dolayısıyla çocuklar olmasını hedefledik. Bu sayede edilgen bir izleyici yerine, etken bir oyuncu olarak, çocukların sosyal yeteneklerini geliştirmeyi ve yok olmaya yüz tutmuş önemli bir kültür mirasını gelecek nesillere aktarmayı amaçladık. Bu çalışmada; iki boyutlu, minyatür sanatı ile bağları olan Hacivat-Karagöz figürleri ve oyun elemanlarını üç boyutlu olarak yeniden tasarladık. Bilgisayar kullanıcı etkileşimi için günümüz popüler arayüzleri yerine, alternatif ve yenilikçi bir arayüz olan Leap Motion cihazı kullanmayı hedefledik. Yapılan uyarlamalar, arayüz olarak geleneksel Hacivat-Karagöz tiyatrosunun bilgisayar ortamında simulasyonunu gerçekleştirmeyi hedeflemektedir. Geleneksel figürlerin üç boyutlu bilgisayar ortamına aktarılması ve insan bilgisayar etkileşimi, bu çalışmadaki en zor adımların başında yer almaktadır. Teknik beceri ve bilgilerin yanında, sanatsal becerilerin de aynı oranda önem kazandığı bu çalışmanın gerçekleştirilebilirliğini ve zorluklarını belirlemiş olduk.

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## **Chapter 1 Introduction**

Today, with the rapid development of technology, our daily lives have changed dramatically with new ways of communication and entertainment forms. All these changes caused a huge intellectual gap between generations. Marc Prensky calls new generation as "Digital Natives" and their parents as "Digital Immigrants". By definition, "Digital Natives" pertain to the new generation who was raised with computers and internet along with the criticism on the lack of concentration [1].

Studies show that computer games are influential on cognitive performance and that they have a huge potential as learning tools. Researchers believe that educational computer games will be more effective than the conventional education tools because of the following reasons [2]:

- They can affect many more users
- They can be used anytime, anywhere
- They are designed according to effective learning paradigms
- They can stimulate chemical changes in the brain that promote learning

In history of Turkey, a traditional shadow theater play, called Hacivat-Karagöz, has been used as an educational tool to introduce the republic and rights. Hacivat-Karagöz has also been used for entertainment and educational purposes for children and is packed with interactivity in it's roots. Later on, Hacivat-Karagöz is replaced in our daily lives with other entertainment forms such as cinema, TV and games.

## **1.1. Problem And Question Of Research**

The main question of this research can be worded as: "Is it possible to create a new educational game tool by combining this traditional play's assets with the latest technology?"

With the improvements in technology and broadband internet access, reaching information was never as easy as it is today. In daily and professional life, we can complete most of the tasks thru computer and internet. On the other side in education systems students mostly have to use pencil-notebook and printed books instead of computers.

As a side effect, students are not interested with material covered in classes as before [1]. Their motivation and energy is being focused to their personal interests and computer games which have vast graphics and entertainment features. Considering this problem, digitizing the learning environment is an important milestone, for example the Fatih project [3] in Turkey is a project with this aim. However, as Clark and Kozma revealed decades ago, using only tablet computers with the same methods used in traditional mediums, such as digital e-books, will not solve the problem. As stated by Clark's definition; "new media do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition [2].

Based on this theory, problem is not just about using computers or digital materials; it is about creating new methods and tools for education based on the new trends in technology.

## **1.2. Aim of the Research**

The aim of this research is to create a new educational video game based on the traditional shadow theater play which can be used as a tool in Fatih Project [3]. A side goal is to keep the tradition Hacivat-Karagöz play alive and help for transferring the culture to next generations.

### **1.3. Objectives of the Research**

The objective of this study is to design a game model and create a game documentation for an educational video game which can be a digital environment for classes with the concept of Turkish traditional shadow theatre Hacivat-Karagöz play.

### **1.4. Motivation – Why Are We Using Games?**

Today to motivate the students and keep their interests in classwork is a problem.

While there are many new video games with interesting subjects and fascinating graphics, studying on a subject with books is not interesting enough.

If we assume that video games are rival to school classes for catching interest of students. we cannot say that classes are strong enough in these areas;

- the use of technology
- interestingness
- graphics
- surprises
- competition
- socialization

Video games have proven techniques for increasing motivation and getting attention of users. What if we use techniques as in game design for classes to make subjects more interesting? In this thesis, we are trying to design an educational game with this motivation.

### **1.5. Why Important? For Who?**

Migration to digital environment at school for education is an up-to-date topic. Turkish government's biggest project is Fatih project in this area is in a pilot period for now.

This study is focused on primary school students (aged 7 to 12), who use smart classes within the Fatih Project.

Fatih project has many advantages for students and classes however only scanning or rewriting books in digital format with small animations is not enough for cognitive performance. To make the project more successful, we need better tools. Making an interactive educational game that gets interests of students would be important for students and to the future of this migration.

If cognitive performance is not be targeted, first generation of students in this digital environment will face bigger problems in future.

Also Hacivat-Karagöz Shadow Play is an important cultural theatre play from Ottoman time and with the cartoon movies and interactive video games, it started vanish from our culture. This project is also important for transferring this tradition to next generations.

## **1.6. Is Hacivat-Karagöz based Role Playing Game Applicable as a Solution?**

Hacivat-Karagöz Shadow Play has been used as an educational theatre throughout the Ottoman history and in the first years of Turkish Republic. It has always been interesting for children and has a cultural value. Even today, this traditional shadow theater play gets attention of children.

Role Playing and Drama are accepted as important and modern educational methods. Thus, Role Playing Video Games are popular today and have high motivational advantages compared to other types of games while having very similar dynamics to the daily and educational life. We can say that these games are successful in making players focus on the game. Especially MMORPGs (Massively Multiplayer Online Role Play Games) have very detailed and successful game designs and are suitable for being used as educational tools or as environments for educational tools.

Due to the fact that both Hacivat-Karagöz play and Role Playing are interactive plays and are used for education, they are expected to be applicable for accomplishing our objectives.

## Chapter 2 Background

### 2.1. Introducing Shadow Play and Hacivat-Karagöz

#### 2.1.1. Origin of the Shadow Theater



*Photograph 2.1 Egyptian Mameluke shadow figures [6]*

Shadow play exists since very early times of human history [4]. There are a few theories on the origin of the shadow play, common one states that shadow theater originated from Asia.

A claim proposes that shadow play first arose thousand years B.C. in Java known as "Wayang Kulit". Wayang Kulit is used for worshipping and showing respect to spirits which is a tradition on Bali island [5].

Other theories states that shadow play first emerged in India then taken to Java or first occurred in China then with Mongols tribe spread to Turks of Central Asia then Iran, Ottoman Lands etc. Various research results stress the link between shadow theater and nomadic tribes of Central Asia.

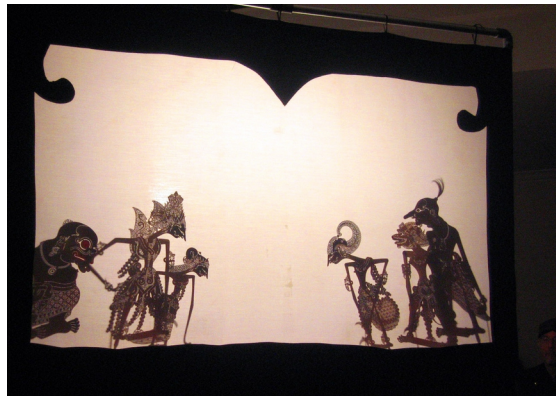


"For nomads have animals and, therefore, leather. They have tents and fire and therefore, a lighted screen. A shadow show of fifty actors packs into a small saddlebag. It is known that Scythians of the third and fourth centuries BC made handsome silhouettes of leather. And in burial grounds along the Altai Mountains near Outer Mongolia, along the old trade route between China and Russia, there have been found cutout leather animals, one a moose that could well have been a shadow figure."  
(as quoted in [6])

The usage and forms of the figures are parallel to Shamanic culture. Chinese sources argue that, Turkish and Mongolian tribes were keeping the figures that represent gods, sacred figures or ancestors. Without a doubt, shadow play is a very important element of the shaman religion [7].



*Photograph 2.2  
Wayang Kulit Show [23]*



*Photograph 2.3 Wayang Kulit Show[23]*

Nurettin Sevin writes that "In Chinese shadow plays represent the two opposite qualities of, good and evil. This shows that the Chinese plays preserve the Hindu element of duality..."

...The shadow play is a means of Buddhist and Shamanist worship. Just as the polytheist had amphitheaters and altars, the Christian churches have bells and mosques have minarets, all religious which believe in ancestor worship – i.e. Shamanism and Buddhism – have a shadow screen which reflects the dualism of good and evil. This play does not exist among non-Buddhists; it could not. The Arabs and Greeks learned this play from Turks who, though Muslim, continued the

tradition, which was a remnant of their Shamanist and Buddhist period." [8]

We can safely say that ever since their pre-Islamic Shamanist days, the Turks had a close relationship with shadow play. While adopting certain fundamental features of Asian shadow play, they have used and preserved these elements.

Metin And, in his book "Dünyada ve Bizde Gölge Oyunu" (Shadow Play at Home and the World) [4], suggests that the Hacivat-Karagöz play is associated with the rituals for contacting and worshiping ancestors such as "Wayang Kulit". It contains the basic elements of dualism and animism. With the advent of Islam, some of these features were whittled away or repeated but never completely abandoned.

"Metin And, who made the most extended research on the history of shadow play, summarizes that in Ottoman Empire Yavuz Sultan Selim met with the shadow play in Cizre and transferred the Egyptian player to İstanbul right after he invaded Egypt in 1517. Metin And thinks that, the mentioned words, kavurcak – kaburcak – kolkorçak, has been showed as the proof of the relation between Turkish language was about puppet show play instead of shadow play." [9]



*Photograph 2.4 Cambodian Khmer shadow theatre [24]*

Shadow play was spread in Ottoman Empire after 17th century and was regularly exercised during Ottoman sultans' birthdays, son's circumcision celebrations and wedding ceremonies. The public enjoyed the shows in local cafes and houses in

Ramadan month.

Since nomadic tribes did not produce many written records, their involvement with shadow play was never fully understood [6].



*Photograph 2.5 "Göstermelik" made for 23 Nisan celebrations [21]*

Furthermore, there are similarities between Turkish and Asian shadow theater cultures. Some researchers believe that Indonesian master shadow puppeteers, the "dalang", is similar to the Turkish puppeteers; "hayali". Both of them start the show with a kind of invocation, which has references from animism and sufism. There are also some similarities between Indonesian "kayon" (tree of life) and Turkish "göstermelik" which are a static figures shown before the shows.

The Guardian figure in Luanzhou (Northeast China) known as "Big Hand", has a big hand similar to Karagöz figure in Turkish shadow play. Also, both wore nomadic cloths.

"Big Hand is a peculiar figure found only in the Northeastern and Luanzhou Shadows of China. Reverently referred as "Big Brother" by the performers, it is placed on top of all the other figures when stored in order to guard them; and unlike all the other figures, the head of Big Hand is never separated from its body, even when it is put away." [6]

Despite these similarities, Turkish shadow play also has differences from the Asian shadow theater. Turkish shadow play is generally performed in small places such as local cafes with 50-60 people watching. This is why, the figures are smaller than the Asian ones. For example, in Bali shadow play, figures are 125 cm high in contrast Turkish Shadow play figures are 30-40 cm high. Also there is a special Turkish shadow play version called as, "Huzur Karagöz'ü" which is performed for sultans behind a silk screen with 18cm tall figures. In Indonesian shadow play, Wajan Koulit,

show can be watched from both sides of the screen. The Wayang Lamah, another version of Indonesian-Bali shadow play is performed during day, without scree [7].



*Photograph 2.6 "Big Hand" of Luanzhou/Northeastern Shadow Theatre Figure of China [4]*

Turkish Hacivat-Karagöz figures are always colorful, painted with over-saturated colors, while the Far East figures are generally black and white. Chinese shadow play figures are mostly colorless and motionless. In Japanese shadow play, four puppeteers are needed for each figure. Turkish shadow play is performed with one master puppeteer and one apprentice, one puppeteer is enough to direct two figures.

### 2.1.2. Hacivat Karagöz Play

Shadow play in Turkey is mostly known as "Hacivat-Karagöz". Hacivat-Karagöz is a 17th century thematic show. The topics are regularly updated with daily events and news by "hayali"s (master of Hacivat-Karagöz game). The game played a vital role during the first years of the Turkish Republic, where the aim was to describe the fundamentals of the republic and reforms to the public [9].

Name of the play comes from one of the main characters and also known as Karagöz-Hacivat.

During history, the stories and the characters are blended to the zeitgeist. The play is performed with 30-40 cm high figures made from the animal hide or leather cut in the form of the characters and painted using vegetable dyes. Each character is attached to 2 or more sticks in order to give motion ability.

Puppeteers called "Hayali", "Hayalci" and "Karagözcü" used these sticks to move the characters. Puppeteer is behind a screen which is usually a sheet of cloth and the audience is on the other side of the screen. Figures are projected onto the screen with

the light of a candle (today, any light source) behind the screen.

With "Hayali", two more people are behind the screen. One of them is the helper of "Hayali" and the other is responsible with the sound effects and music. Nareke and Def are the only instruments used in Karagöz play. Tambourine is used for the songs and most of the sound effects.



*Photograph 2.7 Karagöz-Hacivat [21]*

Hacivat-Karagöz play begins with a figure of an item such as a flower, a bowl of fruit or graphics about the importance of the day (such as 23th April, National Sovereignty and Children's Day). This item, called "göstermelik", distracts the audience before the play. With the whistle of "nareke" (a short cane), "göstermelik" is removed from the screen and the play starts [11].

First, Hacivat enters the screen singing a song, called "semai". After the song, he sings a prologue or "perde gazeli" which has a mystic quality. After this prologue, Hacivat shouts for his friend and Karagöz comes with anger and with a will to fight. Then Hacivat flees and re-enters the scene after Karagöz calms down [7].

After this introduction, the dialogue section, which is a dynamic section, starts. Most of the dialogues and satire begin during this part.

Then the setting up of the scenes with decors and materials begins. Hacivat-Karagöz scripts are usually named with the happenings in this section where the other characters also enter the play.

The epilogue consists of only the dialogues between Hacivat and Karagöz. Karagöz asks audience to forgive any shortcomings or faults during the performance. Then the

show end [9].

### 2.1.2.A. Characters

Karagöz is a less educated, unskilled but brilliant man. He is also frank, brave and short tempered. In some sources, he is stated as a gypsy or a nomad. He represents the voice of the common man and expresses their problems. Mostly, he is unemployed and needs money. In some plays, Hacivat finds him various jobs such as Ramadan drummer, fruit seller etc. In most of the plays, the humor inside the play is based on his short-temper and his misunderstanding of foreign words (arabic, english or french). Since he speaks his mind, he always gets in trouble. He easily gets angry and shows a tendency to resort to violence (e.g. slapping Hacivat). Thus, mostly one of his arms is extended and is in motion.

He has a rounded face with a beard and a mustache representing a common man in Ottoman Empire. He always wears a hat, named "ışkırak", which often falls down before his bald head appears. His clothes are mostly red and have a waistband on. He always has a tobacco pouch hanged on this waistband. He wears a type of shoe called "yemeni".

Hacivat is totally the opposite of Karagöz. He is well educated, cultured, easygoing and a respected man. He always works to maintain the status-quo. He is a self seeker. He finds jobs for Karagöz and encourages him to to develop his intellectual skills. He knows one or more foreign languages. Mostly mocked up by Karagöz for the words he uses from foreign languages. When trouble arises, he flees. He is the pacifier of the fights.

His clothes are mostly green and he wears a hat. He has a thin face with a sharp beard and a mustache. He wears "yemeni" as well.

## 2.2. Role Playing Game

### 2.2.1. What Is Role Play?

The term "role" comes from ancient Greece theaters about two thousand years ago. A young physician, Jacob L. Moreno (1889-1974), who developed fundamentals of psychodrama and sociodrama, added actual methodology which enabled people to reflect on the way they were playing the various roles in their lives, called role

playing [12].

A role-playing game is a game in which the participants play the roles of characters and collaboratively create stories. Participants determine the actions of their characters based on their characterization, and the actions succeed or fail according to a formal system of rules and guidelines. Within the rules, they may improvise freely; their choices shape the direction and outcome of the games.

Role playing is kind of less technical but more social simulation. It is included in the training program of astronauts and in flight simulators perform even rare situations during flight. Exercising salespersons to deal with customers, doctors to interview patients, teachers to deal with difficult situations require some measure of actual practice and feedback where role playing helps.

Role playing is also known as acting, dramatic play, socio-drama. For a child role playing is the instinctive way to learn and understand the outer world, social values and emotions of others. It can be used as a teaching strategy, to teach various topics in literature, social studies, history etc. Power of the role play comes from the social nature of learning with stimulating and experiencing in socially and intellectually.

Role playing activities can be divided into four stages (as cited in [11] Cherif & Somervill, 1998):

1. Preparation and explanation of the activity by the teacher
2. Student preparation of the activity
3. The role-playing
4. The discussion or debriefing after the role-play activity

Role playing is a good way to develop the skills of initiative, communication, problem-solving, self-awareness, ability to use initiative, and working cooperatively in teams [12].

### 2.2.2. Role Play Game in Education

"Role Playing and Role Playing Games are instrumental in various areas of education and in development of higher level thinking. This is case for history, geography, science and engineering." [13]

Psychologists describe two modes of learning as; assimilation and accommodation [12]. Assimilation is filling in the mental map of individuals' world. In accommodation, individuals change the mental map, expand or alter it based on the new information. These two modes are complementary.

Memorization without critical thinking counts as assimilation which we know as remarkably easy to forget. Swimming and climbing to tree are examples of accommodation which help individuals to gain experience and mastering in that field.

Role Playing offers several advantages to instructors and students. First of all, it gives opportunity to use motivation facts of Role Playing to instructor, thus student interest can be increased. To move from assimilation learning mode to accommodation, instructors need to activate students and role playing is a good choice. As side effects, role playing teaches empathy and understanding of different perspective [14].

### 2.2.3. Previous Academic Study on Role Playing Games and Virtual Worlds in Education

In physiology education, using biography writing in a personality theories course, Mouller (1985) posited that student interest, critical thinking and class discussion increased. Chrisler (1990) noted that a biography assignment, on role playing provided a diagnosis promoted critical thinking and empathy for people with mental illness. Nesmith Roy and Kleisinger's (1997) students reported that they learned more about their subject, felt more comfortable, had greater capacity to put themselves into their subject's point of view and gained greater appreciation of other perspectives and cultures [15].

Virtual Worlds can count as a branch of Role Play in video games. In reality, the relationship between Virtual Worlds and Role Play is complicated. Virtual Worlds present practicable environment for Role Play in digital world. Today, it is already popular among video gamers with Massive Multiplayer Online Games (MMOGs) which generally combine with Role Play Games such as World of Warcraft. It is likely that technologies and tools developed for video games will be used in other application fields. There are various Virtual World projects for education and also can be related to Role Playing.



In a project called Travel in Europe' (TiE) (<http://www.tieproject.eu/>), researchers aim to build an interactive multimedia platform for European cultural and artistic heritage. Project includes online serious games, which let players to move in the virtual environment with educational and entertainment features [15].

"In the TiE project, Serious Games exploit the concept of travel, which is an engaging invitation to knowledge acquisition, and which also exploits geographic contextualization. The 3D reconstructions are of contemporary European cities, in which users are challenged to explore and discover local history, art and customs." [15]

Serious Virtual Worlds – a specialization of Virtual Worlds (VWs) that are used in training/learning settings are gaining popularity in the education research and practice community, as they offer a unique opportunity for immersive learning.

In this area, one of the first and biggest role playing and virtual world game, second life hosts the widest and most quantitative research for education. Second life provides one of the most important requirement for role playing, an imaginary-virtual world. Researches indicated that 3D virtual environments could potentially provide safe environments whereby students could learn by doing and experimenting. 3D virtual worlds do support constructivist learning because users interact with each other and the environment. In applying experiential learning theory, some researchers successfully used Second Life, to create a project-based multidisciplinary programs [16].

Earlier studies mostly focused on the motivational supports in game designs with searching on popular games. Bowman (1982), Malone (1981), Provenzo (1991), Rieber (1996). In some of these studies, they contemplated on developing new education techniques with the integration of game design elements. Rieber's research is on the psychological and sociological benefits of playing game [14].

These studies have common outcome states that; game designs with clear goals and tasks increase challenge and feedback.

There is also research which is inspired by and focused on the Role Play games and Massive Multiple Online Role-Play Games (MMORPGs). Basically, these studies investigated how role play video games affect personal and social reflexivity. As an

example Turkle's research was based on Multi-User Dungeons which is an early time MMORPG. In addition to this, in Stone (1995), Turkle (1995), Curtis (1992), Reid (1994), Jakobson (2002) assumes that, MMORPGs present a virtual environment for player to experiment in a safe, non-threatening, expand, explore and reflect on different aspects. Rieber's study (1996) also reveals that narrative/fantasy story and designs increase motivation and have an important potential for learning tools.

Riner's (1996) and Riner ad Clodius' (1995) studies reveals that role-playing games support collaborations across time & space with classrooms and across classrooms [14].

### **2.3. Hacivat-Karagöz Based Role Playing Game as a Solution**

There are several facts for solving the problem with Hacivat-Karagöz based role playing. Some of these are directly related to role playing attribute while some of them are indirectly related.

As mentioned in 2.2.3, critical thinking, student interest and class discussion participation would increase with this game. Hacivat-Karagöz based role playing will give a chance to students to act as Karagöz, a non-educated person but brave and honest and as Hacivat, a well educated person, respected but self-seeker. We believe that using these traditional characters as avatar can would make students interested in the topics and also introduce them to this traditional shadow play while enjoying the game.

These two opposite characters will give a chance to empathize and criticize the situations. Also they will have a chance to think like a teacher while explaining the subjects in debate.

As opposed to the education with drama techniques, in form of role playing, will give chance to students to be creative and participate more if they have lack of confidence.

With higher motivation of role playing and being active for a role play will enforce students to work and understand deeply and trigger accommodation learning. The dialogue games can help them to improve their linguistic skills and also a chance to exercise speaking in foreign languages. Role playing in a virtual world instead of a

real world in real time is important for students to feel comfortable and would provide a good start to earn confidence.

## **2.4. Fatih Project**

Fatih Project announced by Turkish Government as integrating state-of-the-art computer technology into Turkey's public schools. Project covers smart boards, tablet computers, printers and networking in school building [3].

All state schools spanning from preschools all the way to high school level will receive a total of 620,000 smart boards, while tablet computers will be distributed to 17 million students and approximately one million teachers and administrators. This project, which is being conducted by the Ministry of National Education and supported by the Ministry of Transportation [17].

Fatih project aims to enable teachers and students to use latest technology effectively and to transform society into an information society [3].

## **Chapter 3 Methodology**

### **3.1. Game Concept**

Turkish Shadow play, Hacivat-Karagöz is inherently interactive. This is why transforming Hacivat-Karagöz to a video game is destined to have easy integration based on interactivity.

"Like interactive media design, the shadow play also has an interaction between the performance and the spectators. For example, in the art of "ombromanie," which is based on the formation of the shadows of different figures formed by hands and fingers, the artist and the spectators are in the same place. The spectators also can join the show by creating their own figures. In this way, the spectators' involvement in the play is at a maximum. In the traditional shadow play, which is performed behind a screen, there is a classical theater tradition that is based on the shape of humans, animals, and objects. The artist can direct the performance with improvisations according to the spectators' response-demonstrating the essential features of an interactive performance." [7]

Traditional shadow play, Hacivat Karagöz can be a key solution to get children's attention and to teach traditional historical culture to Turkish students. This solution can transform the traditional game and its characters to another dimension while rescuing it from utter desertion.

Hacivat-Karagöz traditional play, provides the basics of the story, environment, design aspects of the video game as given in Game Documentation part, Chapter 3.2.

Hence, instead of watching a cartoon or listening stories/fables, children are allowed to create their own stories. For motivation, game doesn't exist only with the missions or plays inside. Since this is a Free-Roaming Role Play Game, players are expected to add their own tastes and interpretation. Thus, game will be a living virtual world which reflects the players inside. To provide this, design of elements and characters must be flexible.

In the game, players are responsible with the style, the act and the talk (in dialogue missions) of the characters. (for more details see chapter 3.2.11) Since each character need one player for direction, two or more players should play interactively. Each players' voices are recorded by the system. All plays are also recorded by the system. This gives the ability to review recorded performances. Players will get missions to play and they are allowed to share the records with friends or their teacher. After each mission is complete, player will earn rewards-points. With them players can also create new characters representing themselves, their friends or teacher.

Players do not have to be only children, they can be teachers or parents as well. During class, the teacher can use the game for motivation purposes. Teacher can also use this game to punish the negative behavior of a child by transforming him/her to a game character.

### 3.1.1. Aim

The primary aim of this game is creating a new tool for students to work on digital mediums such as tablet computers and getting their attention into the lessons with using video games' techniques. We aim to design this game to be used in or out of the class as class-works, team-works and home-works.

This game can be a way to improve child's self-confidence and imagination. The Hacivat-Karagöz concept would help to introduce the traditional culture. The virtual world in game will motivate players and will be a suitable environment to introduce Turkish/Ottoman culture. Dialogues, players create would socialize them, develop their creativity and imagination as well as help in improving their linguistic ability. This can teach children how to behave in public and ethos as in the original play. With the help of stories, we predict that this game can be helpful to teach history or geography.

One of the benefits of this game is to enable children, who has a lack of self-confidence, express themselves and participate more in classes. This latter feature would make classes more interactive than conventional methods.

Secondary aim of the game is keeping Hacivat-Karagöz Play alive and promoting it to young people.

### 3.1.2. Dialogue Missions

Similar to original concept, the dialogue missions start with a prologue, then resume with the dialogue (the interactive part) and end with an epilogue. In some episodes or modes, players would complete missions instead of free dialogues and with these missions a story can be built instead of a long prologue.

#### 3.1.2.A. Prologue

In prologue, players are introduced to the story and the problem. It is mostly the non-interactive part of the game. In prologue, the dialogues between characters may continue with the player or players can start a dialogue from the beginning.

Prologues will be created before. The game producers or teachers will be allowed to create new dialogue missions for their students/players. For teacher players, there will be a similar UI with student players. Teacher players will record their own dialogue for prologue and after done, they will be allowed to edit, add sound and visual effects on it before submission.

Also, for custom dialogue missions, with prologue, teachers will be allowed to add new grading systems which can also be used in class gradings. (See 3.2.8 and 3.2.9)

#### 3.1.2.B. Dialogue

Players should continue the given subject or dialogues given in the prologue, but can merge it with or add new subjects. Players are almost free in terms of acting, the way for solving the problem and the time they can use. They can also use different objects and scene setups. If we compare with the original game; players are amateur "hayali"s (Turkish term for the director of the Karagöz-Hacivat play).

#### 3.1.2.C. Epilogue

In the epilogue part, story ends with a conclusion and music. This part is may be pre-recorded like the prologue part or can be asked players to record.

#### 3.1.2.D. Critics

After epilogue part the audiences and the players are asked for the critics of the game. The performed dialogues can be replayed, so players can watch their own performance later. Audiences can vote or grade the performance thru social media and teachers give gradings for assigned grading parts.

#### 3.1.3. Recording the Play

With proper recording of the play, the game can be used outside of the class as a homework or can be a part of an exam. Also videos created with this game can be shared online and on social platforms or can be performed in theaters as a show.

#### 3.1.4. Similar Games

##### **Freak n Genius**

Freak n Genius is a Microsoft Xbox platform game in development. It uses Xbox Kinect cameras to recognize the pose of the player and transforms it to the game characters. It also records the sounds and syncs the lips with the sound. The player can save this 2D comic video and share it thru web. The game lets players to create their own characters with kinect camera or thru computer.

This game idea is similar to Karagöz project. One difference is characters in Freak n Genius are in 2D and it basically uses the kinect cameras to direct the characters.

##### **Grafighters**

Grafighters is another startup aimed to produce a fight game with characters designed by players. Players draw their own characters on a paper, take the photo of the drawings, and add them to Grafighters as interactive characters. Grafighters tries to recognize all kinds of character anatomies which is a challenge in this game. Drawing characters on paper and transferring them smoothly is a useful idea to support creativity.

### **3.2. Game Documentation**

#### 3.2.1. Game Play

In this game, players will control the human characters which are based on

traditional shadow play. Each character has different personalities and skills.

In the beginning of the game, each player will own two characters, Karagöz and Hacivat. Players are free to swap between characters before plays and missions in the game. Similar to the traditional shadow theatre play, there will be hundreds of different characters, players will meet or will be used during the play and missions. With higher experience and levels, players will be able to unlock new characters and specialize and collect.

As we mentioned in chapter 2.1.2.A, main characters, Hacivat and Karagöz are totally different in personality also other characters have significant personalities. In missions and in dialogue missions, players have to act like the character they choose to play. With their score and improvements, they will earn new characters or new clothes or features to improve owned characters.

### 3.2.2. Genre

The game will be developed as a Free-Roaming-Action-Online Multiplayer-Role Play-Educational Game Environment

### 3.2.3. Objectives of the Game

Objective of the game is to complete missions and develop characters with better social skills. Players can play in the world of the game without mission or they can choose some missions to improve their characters.

Beyond the missions in the game, there are also dialogue missions which is a unique parts of the game. In dialogue missions players would be acting like their avatar in multiplayer mode thru network. Players have to get into the dialogue and debate on a given subject with the perspective of their avatar. During the chat, game will be recorded, and they will allow to edit the record and share with their friends thru social media.

Since the game is a free-roaming game, players do not have to follow missions. They are allowed to play without any missions.

### 3.2.4. Platform

Game will work on mobile devices mostly on Android tablets: especially designed



for usage in on FATİH project.

### 3.2.5. Intended Audience

The intended audience of this game is primary school students who will use the game as an educational tool.

### 3.2.6. Language

Original/Default Language of the game is Turkish. Also it will have English version as foreign language support for English studying players

### 3.2.7. Features

- 3D Free-Roaming game
- 3rd person view
- Multiplayer
- Based on Traditional Shadow Play, Hacivat-Karagöz Play
- Customizable Dialogue Missions
- Recording and Sharing mode
- Sound Effects and Voice Editing
- Customizable character
- School Integration

### 3.2.8. Missions

One of the key component of Role Play Games is missions in the game. Players are free to select missions to complete and each completed mission improve the character in one or more dimensions. Players can get these missions individually and after accomplished, they will earn credit or experience. These mission games are classified as: exploring, learning/training and duty missions.

In explore missions, players are asked to find a new shortcut or new places in the virtual world. These missions can be completed without accepting before.

Learning-training missions are important to train players and sets hierarchy between missions. Characters can train on specific duty jobs to complete another missions successfully.

Some of these missions are based on daily duties such as building assets, helping to an old lady, working in a job, matching pairs, classifying or finding a lost object. Some duty missions can be personal missions or have to be completed in multiplayer mode thru internet/network

With these missions players will earn awards as kuruş (money), experience and heart. Kuruş is the materialistic path while others are more spiritual. With these different types of awards, we aimed players to experience voluntarily missions and to discover the emotions and spirituality.

Completing dialogue missions will also give similar awards where the quantity is adjusted for completion. When they share their dialogues online, players will earn more experience and audience will be able to vote on both players' creativity, timing, subject, etc.

As we mentioned earlier in chapter 3.1.1 these Dialogues missions can be based on class workouts which can be used by teachers at school. Thus these subjects of dialogues can follow a syllabus of national education. To be more flexible and useful, teachers are allowed to create new dialogue subject in the game and can add new grading criteria.

Since these dialogue missions can be homeworks or class works for school, given by teachers. Players are allowed to and can be asked to send them to the teacher.

#### 3.2.8.A. Mission Examples

Mission 1: Player's initial character affected with black-magic. Player is asked to create his/her character's variation with an animal body (See Appendix A). Since the original character is locked, player has to play with his/her character variation, and return his/her character back to original body. These character variations will be published and voted thru social networks. For detailed illustrations see Appendix B.1.

Mission 2: Player unlock a new character, named as "Beberuhi" (See Appendix A). Player is asked to create a new character based on the given/specified concept and

given/specified characteristics. After design, player will have one more extra character to play. For detailed illustrations see Appendix B.2.

Mission 3: Work in a market or a grocery store (as an example). Tasks would be similar to separating the products (apple & oranges) or calculating the total price and getting the payment and return the change. After mission completed, player will earn money and skill. For detailed illustrations see Appendix B.3.

Mission 4: Help the old lady standing in the middle of the street. After mission completed, player will earn heart and health. For detailed illustrations see Appendix B.4.

### 3.2.9. Dialogue Missions

Dialogue missions have a few dimensions. First of all, they will reflect the traditional/original Hacivat-Karagöz play. Dialogue games will have three parts as the traditional play; Epilogue, Dialogue and Prologue.

Epilogue will introduce the subject to play and also these parts are important to transfer the soul of traditional play. Players will learn more about characters (also there will be some training parts for the starters) or meet new characters mostly in this part.

In dialogue play, players will be free to continue the play with the given subject. During this, play will be recorded. In prologue part players will select the ending of this play.

After this, players will watch the whole play they created and also can edit, remove/add parts, add VideoFX and SoundFX.

At the end, players will be asked to share their recording with friends and teacher.

Players will be rewarded by computer for usage of effects, timing, movement and usage of assets/tools in dialogue.

For subject specific scoring teachers will be allowed to define extra score criteria.

### 3.2.10. School Integration

Players will be able to match their school, class or teachers in the game. This will allow more integration between player, classmates and teachers. In this way

homework or class-works based on this game will be possible.

This integration will provide a potential medium to teachers for interactive school works based on syllabus.

### 3.2.11. New Characters and Game Levels

Players will earn experience with completed missions and this will give them opportunity to build more creative characters or to complete new missions. These experiences also will be used for to unlock new characters, like Tuzsuz Deli Bekir, Beberuhi, Yahudi, Zenne, Falcı etc..

Players will be allowed to specialize these characters and this will lead to new features or missions.

Levels in the game are more related with school education rather than the successes in game. All levels will be related to the subjects in the syllabus of the school.

For each new subjects in school, teachers will shift up players to the new level, without any discrimination. This means that, each player will be in the same level (so have the same missions) with his/her classmates but with different experiences, and may have more or less characters than classmates' have.

### 3.2.12. Environment

Traditional Hacivat-Karagöz shadow play is mostly subjected in İstanbul and mostly in the same neighborhood. In this game, environment will be a district of İstanbul.

Environment will be mostly historical İstanbul but in an unknown Ottoman Empire time. Thus, silhouette will have some assets of Istanbul in the district which we will call as "mahalle".

In mahalle, players will be in interaction with neighbors, shops and shopkeepers. Mahalle is an important fact in Turkish culture which will help us to express the culture to the players.

In the game each asset is related with culture and/or game. For example a pit/deep-hole in the middle of the environment will make players get interaction and there would be missions to get water from it or help/rescue a kitty fallen into.

Tree of life, grocery shop, barber, tailor are examples of traditional play assets.

### 3.2.13. Sound

Hacivat-Karagöz shadow play has a stylized music and sound fx with traditional music instruments. These instruments are important for keeping the culture alive but we need to mix them with today's popular music instruments and music style. This mixture music and fx's will make children more into the game.

### 3.2.14. User Interface and Controls

As we mentioned in introduction part, we are planning to design and build this game for touchscreen/tablet computer.

In this game, controllers (especially in dialogue play) play vital role. In our prototypes, we designed the scenes in 2D profile view of characters and scene with handle points to let players catch and move characters. With moving handles, characters, as ragdoll, will be moving with given velocity by handles and physical laws. These handles are the skeuomorphic reflection in 2D form of the sticks attached to the characters in traditional shadow theater.

Also players will be able to move characters' arm, leg, head etc independent from the whole character.

## **Chapter 4 Design**

### **4.1. Modeling Techniques**

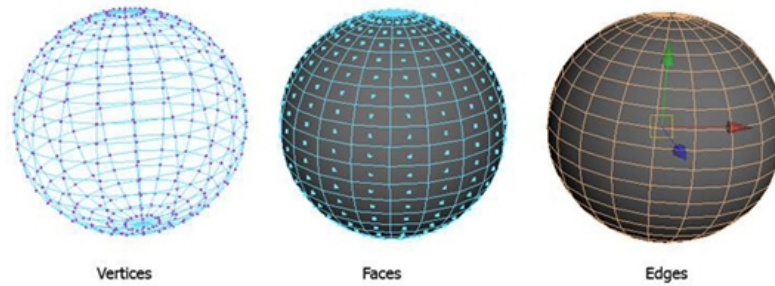
In modern 3D software, a few geometry models are supported. Each has different advantages in modeling, rendering or animation. There are also algorithms to transform types. Today, all of these geometry types can be transformed to polygon models and all modern 3D software and hardware support polygons. This is the reason behind the creation of 3D models using the Polygon model.

For building this game's assets, environment and characters we used the polygon modeling techniques and polygon sculpting techniques.

#### **4.1.1. Basics of Polygon Models**

In Euclidean geometry, any three non-collinear points determine a plane. For this reason, triangles always inhabit a single plane.

Polygons are the most common and most straight forward mathematical description of geometry.



*Photograph 4.1 A polygon modeled sphere, vertices, edges and faces [18].*

A polygon has vertices, edges and faces. At least three edges are needed for defining a polygon. Edges are defined by two vertices. In conclusion, each polygon needs to have minimum three vertices and three edges. Polygons with three vertices are called triangles, which is the simplest polygon in Euclidean space. Quads are polygons with four vertices (or edges) [18].

Polygons with shared vertices are called elements and in element each polygons called as faces. Each face has a normal which is important for algorithms especially in 3D rendering. Face normals define the front/back side of the face since most of the software do no render both sides of the face.

Polymesh or Polygon Mesh is the term of finite collection of vertices, edges and faces. Polymeshes satisfy the following conditions [19]

- Each vertex must be shared by at least one edge. (No isolated vertices are allowed.)
- Each edge must be shared by at least one face. (No isolated edges or polylines are allowed.)
- If two faces intersect, the vertex or edge of intersection must be a component in the mesh. (No interpenetration of faces is allowed. An edge of one face may not live in the interior of another face.)

Polyhedron is a polymesh with additional rules. These are [19]

- The mesh is connected when viewed as a graph whose nodes are the faces and whose arcs are the edges shared by adjacent faces.
- Intuitively, a mesh is connected if you can reach a destination face from any source face by following a path of pairwise adjacent faces from the

source to the destination.

- Each edge is shared by exactly two faces. This condition forces the mesh to be a closed and bounded surface.

Since Catmull-Clark algorithm can be applied to polygons with more than three vertices, and 3D sculpture software is mostly based on this algorithm, we preferred to use only quads in our models.

#### 4.1.2. Tools in Polygon Modeling

There are several tools commonly used in software products for polygon modeling. The algorithms of these tools may vary between software, however the results are always pure polygon models.

**Subdivide:** Subdivision is mostly applied with Catmull-Clark algorithm and some 3D software support preview and transformation during rendering.

**Boolean:** Boolean tools allow users to add/remove non intersecting parts of meshes.

**Extrude tool:** This tool is mostly applied to faces but also can be applied to edges and even vertices in some 3D software where Euclidean space is not a requirement. However, there can be problems during the transformation of the model to be used in other software or rendering.

### 4.2. Rendering Techniques

In arts, the term "render" means to represent in drawing, painting or to perform an interpretation. In computer science, render means, converting graphics from a file to a visual form. In real-time computer graphics, 3D rendering refers to the process of rendering a sequence of images with the animated effect of motion and the visual cue of depth.

Games and interactive applications have to render in real-time. The word "real-time" is often used to describe the high speed of the process and in graphics, it implies 30 fps (frames-per-second) or faster. The frame rate is important for creating an animation sequence.

Computer hardware and software have to work together in the most optimal way to



achieve the best image quality with an objective frame rate.

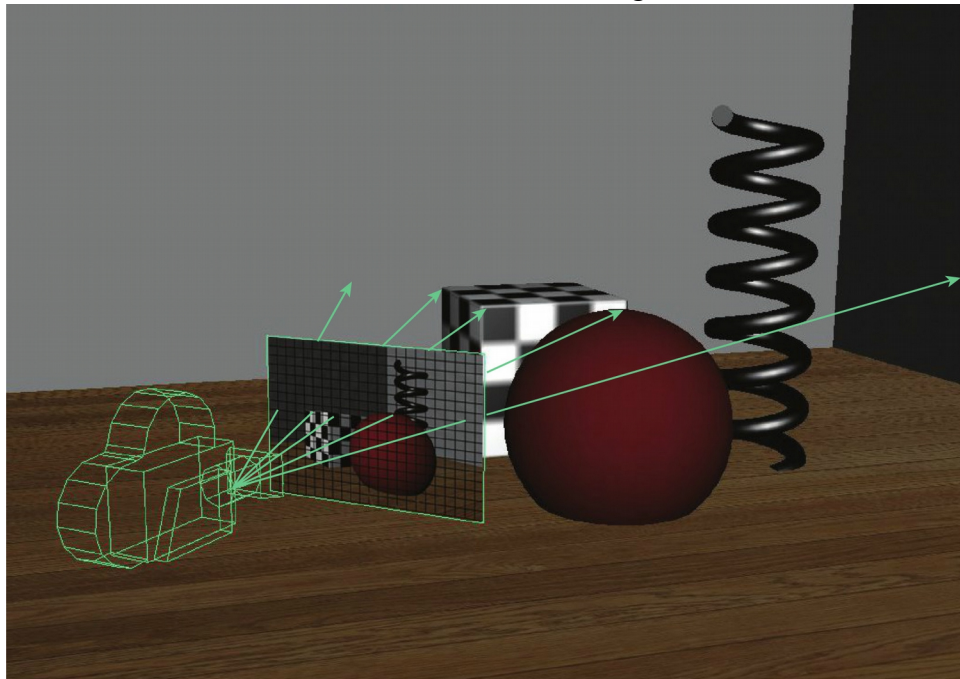
Today, modern computers have specialized hardware to handle graphic rendering. With these hardware in place, the CPU needs to focus only on tasks other than the graphic related ones.

For rendering, computers have some important algorithms;

- Scanline
- Ray Tracing
- Global Illumination
- Anti-aliasing

### **Scanline**

Scanline algorithm provides very quick renders. However calculating reflections, refractions or global illumination is not possible with this method. Scanline method works well with cartoon-like, flat, cell-shaded renderings.

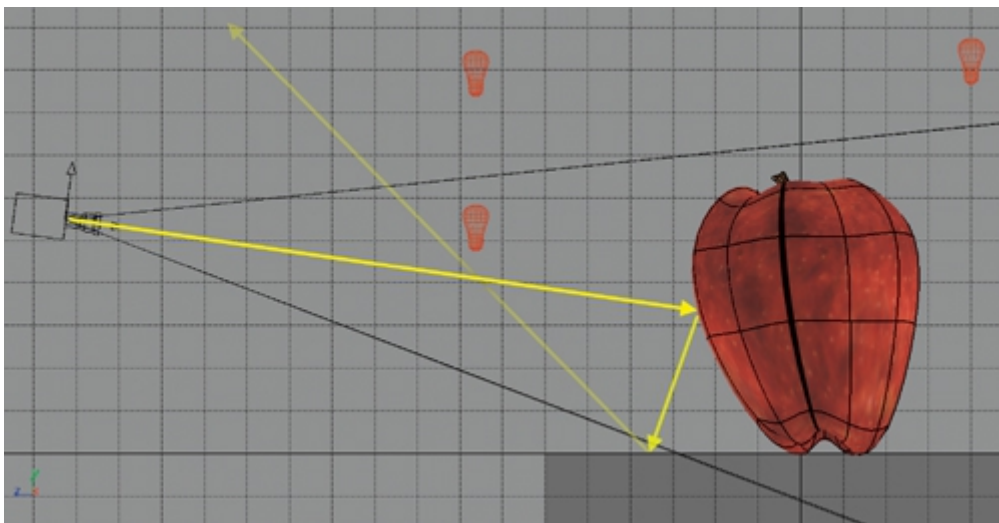


*Photograph 4.2 Representation of scanline render method [25].*

Scanline algorithm first calculates the polygon surfaces that are in the scene and are visible in the view of the camera by working row-by-row. This saves the engine from calculating the hidden polygons and objects and thus, saves system resources and improves the rendering time.

## Raytracing

Raytracing is an algorithm for calculating the reflection, refraction and shadow. In principle, it simulates journey of the photons in backwards. In real time, photons are shot from a light source, bounce around the scene and reach camera. In raytracing, render engine divides camera's field of view into pixels. For each pixel, a ray is projected from the camera and the sampling point from any objects it hits. With an anti-aliasing algorithm, engine can sample more than one point per pixel. If what the object ray hits is reflective, engine starts to calculate if any other object is reflected on the object's surface.



*Photograph 4.3 Raytracing method [22].*

Since the engine calculates rays and reflections through each pixel for raytracing, raytracing processes take relatively longer to render. To overcome this, there are various acceleration methods which require more RAM.

## Global Illumination

Global Illumination is a method which includes a group of different algorithms. Basically, it calculates indirect light as opposed to other methods. Indirect light is defined as the light that reaches the surface after bouncing off from another surface or after being scattered by the environment. This bounced light is not exactly the same with the raytracing but with global illumination, it is possible to calculate the ray tracing effect, which is known as ray-traced global illumination method.

## Anti-aliasing

In high quality rendering, anti-aliasing is a critical method. Anti-aliasing makes

renders more smooth, natural and photographic. Without anti-aliasing, pixels in rendered images are crispy and with more significant edges of objects which causes an artificial look. Anti-aliasing has two basic algorithms: over-sampling and filtering.

Over-sampling is a method which collects more data than needed to render in a given resolution. Essentially, it renders each pixel more than one sub-pixel data. Over-sampling does not blur image, it uses shading for representing sub-pixels. The disadvantage of over-sampling is that it needs more time to finish rendering.

Filtering is another method which needs much less time than over-sampling. There are various filtering algorithms, however their results is very similar to the blur effect. Thus, using excessive filtering can produce blurred images.

### **4.3. Game Engine**

Game engines are software systems which were designed to simplify and accelerate development of games. Mostly, game engines have an IDE (integrated development environment) inside and consist of render engine, physics engine, asset library, etc. Game engines play an important role in creating a workspace with seamless work flow between developers and designers.

There are lots of alternatives in game engines, some of them are specialized for specific game genres while others have more flexible game genres and each one has its different advantages/disadvantages.

Selection of a game engine is critical. Supporting wide range of platforms, performance, license requirements and supported technologies are important factors in this decision.

In this project, unity3d was chosen since it has wide range platform support, mild learning curve, free license, documentation, online-forum support and supported rendering technologies.

### **4.4. Leap Motion**

Leap motion is a device, for which the development started in 2010. Basically, it

tracks motion of hands with two infrared monochromatic camera, bundled with three infrared LED. These cameras transfer images to Leap software which analyzes and translates images to gestures on computer. It has the ability to recognize two hands with each finger. It can track hands in a cubic pyramid space above the device.

Leap Motion has a plug-in to integrate in Unity3D. In the development kit, -the hands' and fingers' positions can be acquired, as well as rotation and vectors of fingers and normal vectors of palms. Instead of working with low level information, Leap Motion can analyze the gesture of hands.



*Photograph 4.4 Leap Motion in use.*

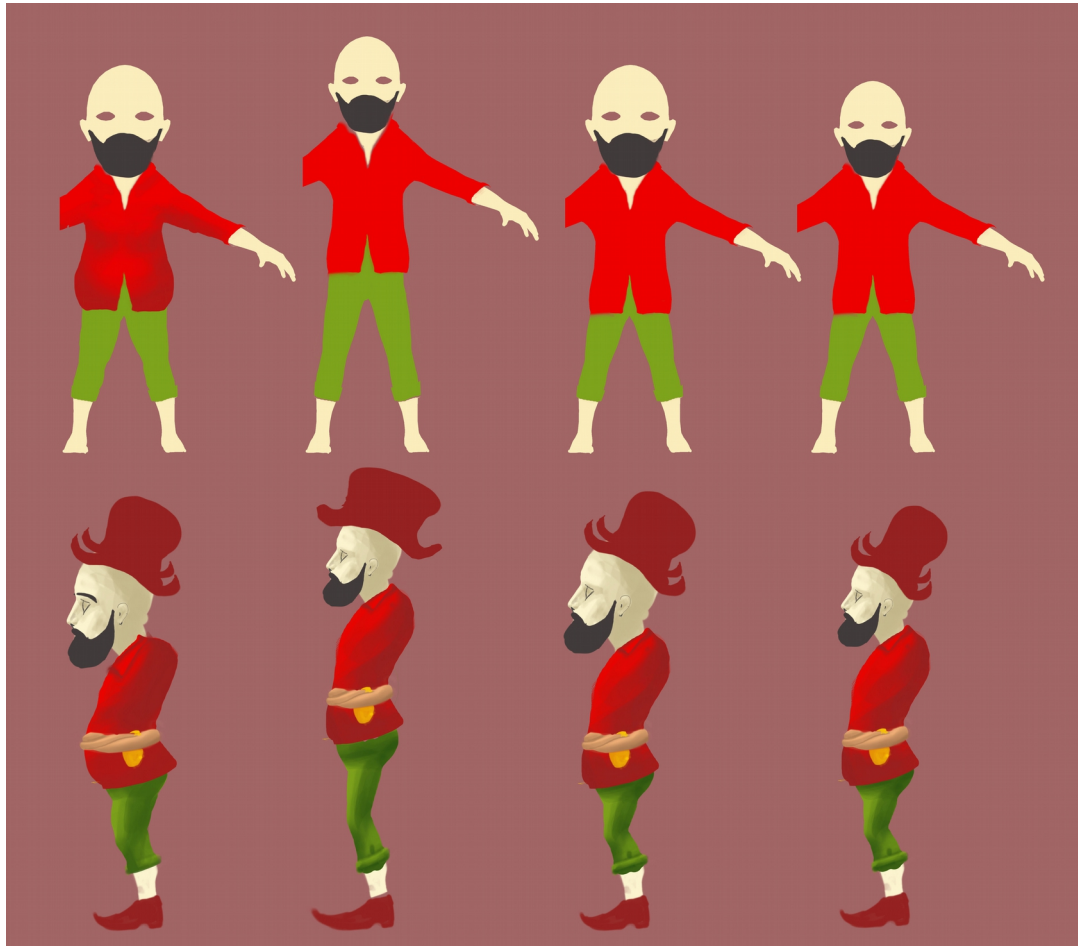
With leap motion, game can simulate the interaction similar to the real world. Freak n Genius, mentioned in Chapter 3.1.4, simulates body movements using Xbox platform and it's infrared camera. Hence, it creates a new case, instead of simulating a puppet show or shadow theater.

In this project, Leap Motion for HCI was used instead of a touch screen device. Hence we can create a closer experience to the original shadow theater.

#### **4.5. Character Design**

Today, traditional cartoons and photographic films are replaced by Computer Generated Images, mostly in 3D forms. This popular trend can be accepted as it is in accordance with preferences of children. Based on this, we aimed to transform the characters and assets to 3D forms. Moreover, these 3D forms can provide us new functionality in the game.

Characters and assets in traditional Hacivat-Karagöz play are designed with the miniature art culture which reflects the 17th century's style. (See Appendix A) The perspective in miniature art is totally neglected. A character's body is designed as the view of front but the head on profile view. These features are very bold in traditional Hacivat-Karagöz play, but characters are designed mostly with profile view [19].



*Photograph 4.5 Karagöz design variations and color codes.*



*Photograph 4.6 Color palette for concept design.*

It is clear that, shadow play characters are based on 2D miniature forms and cannot be modeled as 3D directly. Hence, we need to redesign the characters in 3D. Our main goal is to keep the designs as close as possible to the original design with model references in Appendix A. On the other hand there is a lack in terms of various design aspects such as forms and colors.

For computer games and movies, modern design aspects play an influential role for playability, and

strengthening the story. Hence, forms/silhouettes of the characters and color codes should be modified in the traditional play.

In design, our goals are to differentiate the characters from each other in terms of silhouette and color codes. We aimed to make character designs express their personalities stronger than before to achieve this.



*Photograph 4.7 Hacivat design variations.*

As stated in Chapter 2.1.2.A, Karagöz is a brave, uneducated, gypsy or nomad and represents the common man. He easily gets angry. In order to express his personality in design, a big hand to slap and ears bigger than normal are needed.

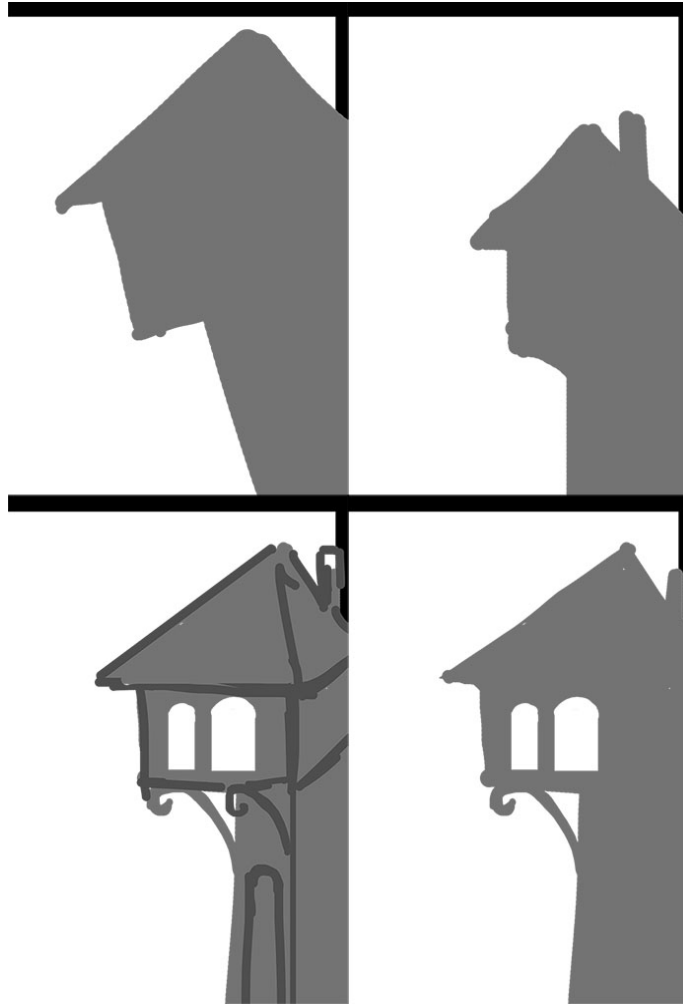
Karagöz's name literally means black eyed and the connotation meaning is brave in Turkish. In the traditional play, generally the characters are designed with big eyes. This can be a result of the tools and materials used. We decided to make his eyes big and dark but other characters' smaller. For the common Turkish man, a fat belly is essential. He can have a darker skin than he has and bigger ears to make contrast with his misunderstanding of foreign words.



*Photograph 4.8 Karagöz-Hacivat concept design decisions.*

As a totally opposite character of Karagöz, Hacivat is respected, easygoing and well educated man and speaks foreign languages. To make a contrast in silhouette with Karagöz, he should have a fit body, lighter skin and smaller nose. With these changes in mind, Hacivat is designed to look healthier and more cultured than Karagöz.

As seen on reference images in Appendix A and Photograph 2.7 Karagöz's clothes is mostly red while Hacivat wears green. In traditional plays, mostly the colors are over saturated. These features, i.e. the way characters dress, are kept. However, some details are added in order to express the personalities stronger.



*Photograph 4.9 Concept design in silhouette for Karagöz's house.*

In order to fulfill the preferences of children on cartoon characters, we planned to make the heads of figurines bigger than the ones in the original play. (See Photograph 4.12)

Over saturated colors are used on clothes and on characters whereas less saturated colors are used in the environment. Thus, we tried to distinguish the characters from the environment.

Different textures on clothes are used to make the difference between

characters as well. Hacivat's clothes has a more precious and delicate pattern and texture. In contrast, Karagöz's clothes with stripe show him cheap.

Since we plan the game in a Role Playing genre with customizable characters (as stated in Chapter 3.2.2 and Chapter 3.2.7), these concept designs and models will be starting point. Referencing from these concept designs, we need to design customizable parts of each character with scopes. Players will be free to select style of the character's parts or get new clothes. Thus, there should be hundreds of different materials, face, hair, nose types for each character.



## 4.6. Modeling

In this phase, we re-modeled the 2D concept drawings in 3D forms. As mentioned in Chapter 4.1, polygon modeling techniques were used for modeling the characters. In addition to these basic tools, a sculpting program was used which is a polygon modeling tool that makes the polygon modeling similar to sculpting in real life. This feature gives users the ability to focus on the more artistic side of modeling instead of the mathematics behind it.

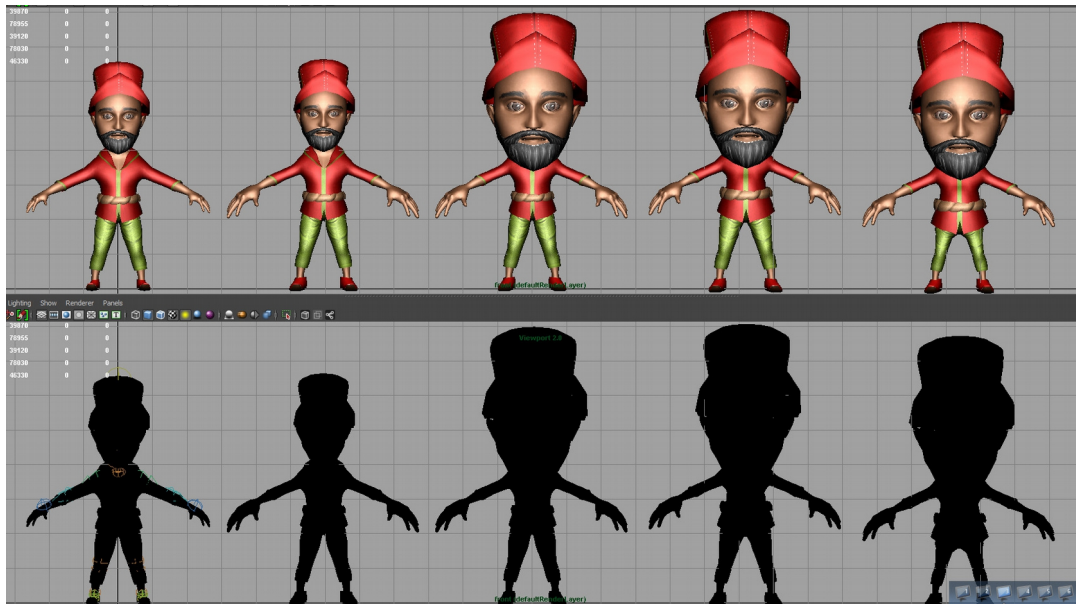


*Photograph 4.10 Screenshot during 3D modeling/sculpting of Karagöz.*

For the base mesh modeling, we started with a standard polygon cube with basic tools and moving vertices. After shaping the silhouette of the figure in low-poly, the mesh was transferred to the sculpting program. For sculpting, subdivisions were created inside the program. Catmull-Clark based subdivision algorithm is used also keeping the low-poly version of the mesh to achieve this. Photograph 4.10 shows the subdivided mesh of the Karagöz figure. This was an early screenshot before going into the details.



*Photograph 4.11 Sculpted Karagöz figure in high-poly.*



*Photograph 4.12: Karagöz 3D model in various body proportions.*

With 3D sculpting programs, we added more details to the Karagöz character. Photograph 4.11 shows the detailed Karagöz character in high-poly.

As we mentioned in previous chapter, cartoony proportions were planned for characters but the concept design (so initial 3D designs) was not covering this plan. Since modern 3D applications are flexible on pipeline of modeling, we are able to change the body proportions on the sculpted 3D model without losing details. Photograph 4.12 shows the body variations works with silhouette and painted view; from left to right, initial model from concept design, model with bigger hands, model with bigger hands and bigger head, same model with shorter body, big head model

with short neck and short legs. Thinking on silhouettes of these models is a better approach for designing easy to recognize characters.

There are various techniques for texturing the model, such as painting a 2D UV Map or directly painting onto the high-poly mesh. work, in this project we used both of it. We first painted onto mesh then for small details we used 2D painting applications on to UV texture-map.



*Photograph 4.13 A textured low-poly mesh of Karagöz with default shade/render configurations.*

## 4.7. Transferring Assets to Game Engine

As mentioned in the chapter 4.1, the Karagöz figure was modeled in low poly and was converted into high-poly mesh for details. Since game engines (mentioned in 3.4) have to work with real-time rendering capabilities and the computers used by end users are not powerful enough to render high-poly meshes in real time, it was necessary to use low-poly meshes for production.



*Photograph 4.14 Painted texture-map for Karagöz mesh.*

In order to save the details made in Zbrush, they were baked from high-poly mesh, into texture-map, bump-map and displacement-map for low-poly mesh. During rendering, engines add these details using different algorithms to get similar details with the high-poly models.



*Photograph 4.15 Karagöz's house modeled and textured.*

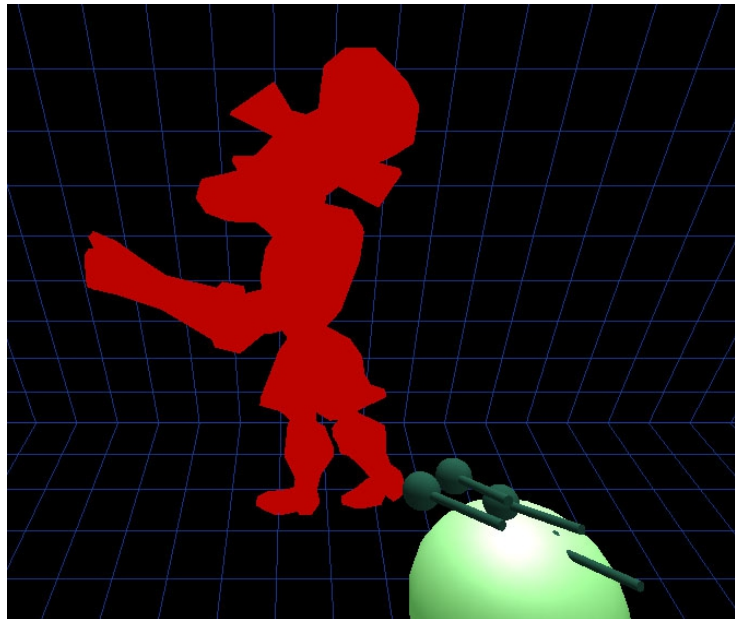
Even the base-mesh model, mentioned in the beginning, can still be high for real-time rendering in some platforms, e.g. tablet computers. Thus, it is necessary to create new meshes in lower-poly to be able to play the game in tablets and smart phones but lower poly models will be in less detailed in 3D form.

## 4.8. Interaction Design

For human-computer interaction tests, a scene was set up in Unity 3D game engine. In this scene, low-poly, traditional-2D design based 3D mesh was used. For moving the characters in the game, mesh was modeled in 4 pieces and was brought together with a Hinge Joint component in Unity. These pieces represent the silhouettes of head, body, arm and legs.

In addition, a low poly polygon sphere was created on the scene for controlling our character. The body piece of the mesh was the root of the character and all other pieces joined to the body. Body is assigned as a child of the sphere controller in the scene. Thus, moving the scene or resizing will affect only the body. Since other pieces are jointed to the body, they would only related for movement (hinge joint doesn't transfer size changes). With the configurations of these joints, pieces' movements are not sharp which simulates the traditional play figures virtually, e.g. swinging legs below the body.

Using Leap Motion and it's Unity libraries, user can move the sphere controller. Leap Motion libraries make it possible for the game engine to recognize and analyze player's both hands and to transfer it to the 3D scene with location, state of the palm, hand and fingers. In our test scene, these libraries were used for analyzing if the



*Photograph 4.16 Test scene for Leap Motion controller and Karagöz figure.*

player has touched to sphere. If player has touched, sphere follows the movements of hands in 3D, along with the body mesh of the character and jointed pieces on it. The hand was also programmed as well as the head and legs to interact with the player hand. Thus, user can only move the character's head, arm and legs without the sphere.

Since Leap Motion supports two hands at the same time, player can move two characters at the same time or while moving one character, player can move the other pieces unrelated to the body movement.

For future work, our 3D modeled character is planned to be transferred into the game scene and assigned interaction with Leap Motion. Also new game scenes can be created which use other interactivity techniques such as touchscreens.



*Photograph 4.17: Alternative UI design for controlling characters on touchscreen device.*

## **Chapter 5 Conclusions**

Shadow Theater is an important cultural heritage in the history of humanity. In both Republic of Turkey and the Ottoman Empire, Hacivat-Karagöz is regarded as an entertainment element as well as an educational tool. This well known play can be used as a starting point to establish an educational tool for next generations. In order to reach this goal, it is essential to use the latest technology and techniques.

In this study, our focus was to create an environment to apply new methods for education and keeping students' attention in the game. Our study revealed that, Role-Playing genre is more suitable for this aim.

Our study evolved with the detailed game documentation, the designs and HCI design. This study was based on today's modern game perspective and modern education methods and is believed to be a milestone to bring them together in a digital education environment.

This work and the associated game design will be more valuable after the Fatih project and similar projects go live.

Feedback after presentations and interviews we made with a few educationalists are provided information about the usage of this game. In summary the feedback is listed below;

- Some topics in Turkish Education Syllabus are suitable to use in the game.
- Primary school students, between age 7 and 10 are the most convenient focus group.
- Foreign language classes for elder students are also suitable for the game.

- Inducing critical thinking after class and home works is vital for the usage.

A future work of this thesis is generating an end-user game from this game outline by completing the details of HCI, UI, game missions and 3D model design. A large multidisciplinary team is needed to achieve these goals.

While re-designing characters, keeping the exact traditional designs was not possible. Also the traditional design approaches did not work for a real-time, interactive, 3D computer game. During the design phase, some changes were made on to the conventional character designs. These changes were made in order to express the personalities of characters in-depth and to have more coherent designs in 3D world. For building a figure for the game, several steps, such as texturing, shading, lighting, are as important as 3D modeling. Transferring these models into low-poly meshes (relatively small number of polygon triangular faces) are also very important for a game design. Having low-poly meshes are necessary for optimizing performance in a game engine and using design assets efficiently. A suitable recommendation for future work would be to improve and re-iterate over the mentioned steps and transferring the 3D meshes to low-level polygon meshes.

Admittedly, for improving and modernizing the education system, more educational games need to be developed. This study proves that it is possible to convert Hacivat-Karagöz play to an educational tool and with the help of this game, we can facilitate the transfer of cultural heritage to next generations as well as improving their social skills.



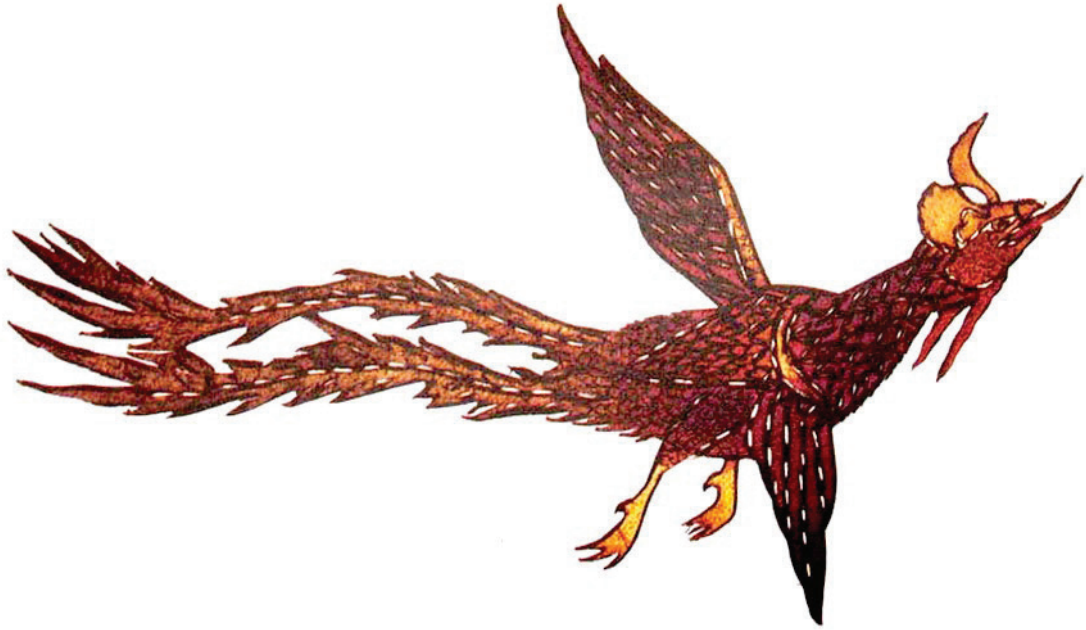
## References

- [1] M. Prensky, "Digital Natives, Digital Immigrants," *Horiz.- MCB Univ. Press*, vol. 9, no. 5, Oct. 2001.
- [2] R. E. Clark, "Media will never influence learning," *Educ. Technol. Res. Dev.*, vol. 42, no. 2, pp. 21–29, Jun. 1994.
- [3] "Fatih Projesi Web Sayfasi - Yenilik ve Egitim Teknolojileri Genel Müdürlüğü." [Online]. Available: <http://fatihprojesi.meb.gov.tr/tr/english.php>. [Accessed: 18-Apr-2014].
- [4] M. And, *Dünyada ve bizde gölge oyunu*. Türkiye İş Bankası Kültür Yayınları, 1977.
- [5] P. Stott, M. Bruce-Mitford, "Indonesia, VI: Theatre," *Grove Art Online*.
- [6] F. Fan Pen Chen, "Shadow Theaters of the World," *Asian Folk. Stud.*, vol. 62, no. 1, p. 25, Apr. 2003.
- [7] O. Özcan, "Cultures, the Traditional Shadow Play, and Interactive Media Design," *Des. Issues*, vol. 18, no. 3, pp. 18–26, Summer 2002.
- [8] C. Ünlü, *Turkish Shadow Play Karagöz with sound records*. Kalan Müzik, 2008.
- [9] D. Düzgün, "Geleneksel Türk Tiyatrosu," *Yeni Türkiye Yayın. Türkler*, vol. 15, pp. 487–496.
- [10] M. And, *Geleneksel Türk tiyatrosu: Kukla, Karagöz, Ortaoyunu*, 6 vols.
- [11] Dr. A. Blatner, "Role Playing in Education." [Online]. Available: <http://vcell.ndsu.nodak.edu/~ganesh/seminar/Role%20Playing%20in%20Education.htm>. [Accessed: 19-Mar-2014].
- [12] B. H. Sørensen, B. Meyer, and S. Egenfeldt-Nielsen, *Serious Games in Education : A Global Perspective*. Aarhus: Aarhus University Press, 2011.
- [13] L Jarvis, K Odel, and M Troiano, "Role-Playing as a Teaching Strategy," Sacramento State University, Apr-2002.
- [14] P. B. Paula, "Biography and Role Playing: Fostering Empathy in Abnormal Psychology: EBSCOhost," *Teach. Psychol.*, vol. 29, no. 1, pp. 32–36, Feb2002.
- [15] S. de Freitas, P. Maharg, *Digital Games and Learning*. Continuum International Publishing Group, 2011.
- [16] C. Inman, V. H. Wright, and J. A. Hartman, "Use of Second Life in K-12 and Higher Education: A Review of Research," *J. Interact. Online Learn.*, vol. 9, no. 1, pp. 44–63, Mar. 2010.
- [17] *Turkey's FATIH Project: A Plan to Conquer the Digital Divide, or a Technological Leap of Faith?* RTI International, 2013.
- [18] "Modeling with polygons - TOI-Pedia." [Online]. Available:

- [http://wiki.bk.tudelft.nl/toi-pedia/Modeling\\_with\\_polygons](http://wiki.bk.tudelft.nl/toi-pedia/Modeling_with_polygons). [Accessed: 08-Dec-2013].
- [19] P. J. Schneider and D. H. Eberly, *Geometric Tools for Computer Graphics*. Burlington: Elsevier, 2002.
- [20] B. Şişman, “Türk Gölge Oyunu'nun Konularının ve Suretlerinin Güncelleştirilmesi (Turkish),” *Update Subj. Images Turk. Shad. Play Engl.*, vol. 1, no. 6, pp. 610–616, Feb. 2009.
- [21] M. And, *Karagöz*, 5 vols. Ankara : Kültür ve Turizm Bakanlığı, 2010.
- [22] “Wayang Kulit Show,” *Broken Simulacra's photo stream*, 2006. [Online]. Available: [http://www.flickr.com/photos/broken\\_simulacra/](http://www.flickr.com/photos/broken_simulacra/).
- [23] “UNESCO Culture Sector - Intangible Heritage - Khmer Shadow Theatre,” *UNESCO Culture Sector - Intangible Heritage - 2003 Convention* :, 2003. [Online]. Available: <http://www.unesco.org/culture/ich/en/RL/00108>. [Accessed: 27-Dec-2013].
- [24] A. Beane, *3D Animation Essentials > Chapter 7: Understanding Visual Effects, Lighting, and Rendering - Pg. 239e*. Sybex, 2012.
- [25] J. Birn, *Digital Lighting and Rendering, Third Edition: Proquest Tech & Business Books*. New Riders, 2013.

## **Appendix A References of Traditional Karagöz Character Design**

The following pages provide images from the book of Metin And [21], to show the artistic side of Hacivat-Karagöz and example character designs.



A.1- A Phoenix Bird Design - Producer: Ragıp Tuğtekin



A.2-Snake Design - Producer: Unknown



A.3- a Stork - Producer: Metin Özkan



A.4- “Kavak Cini” - A Genie - Producer: Hayali Küçük Ali



A.5- "Kastamonulu" - The Man from Kastamonu - Producer: Metin Özkan



A.6-Karagöz with Tortoise Body - Producer: Hayali Küçük Ali



A.7- Karagöz with Rooster Body - Producer: Hayali Küçük Ali



A.8-Karagöz Selling Boza - Producer: Ragıp Tuğtekin



A.9- Karagöz is Fishing - Producer: Unknown



A.10-Karagöz as Grocer - Producer: İsmail Hakkı Baltacıođlu





A.11- Folk Dancing Team - Producer: Unknown



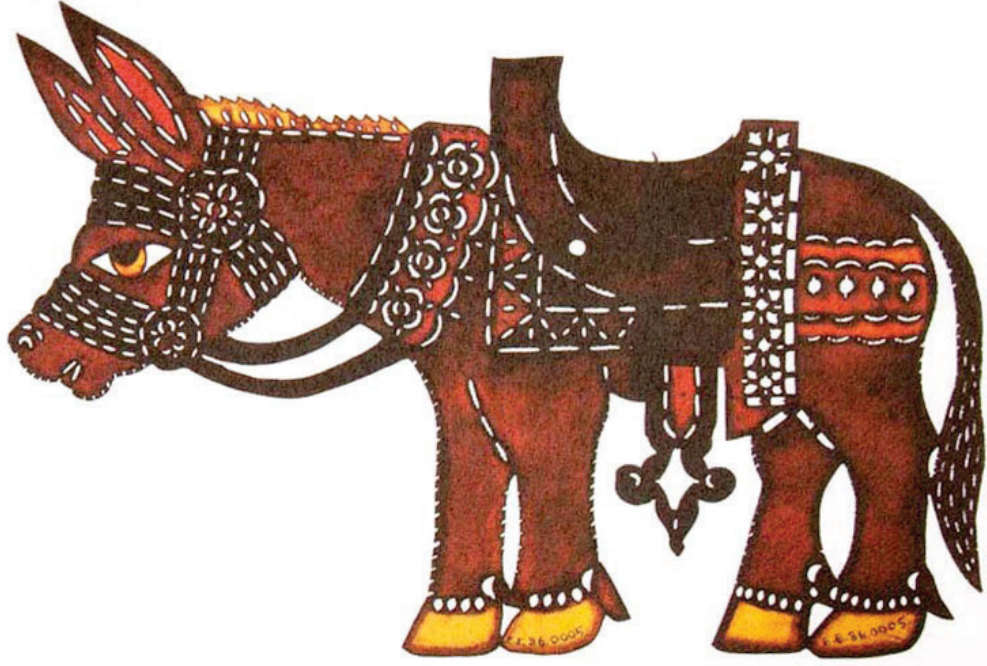
A.12-Hacivat with Butterfly Body - Producer: Unknown



A.13- A “Göstermelik” Design for 23 April National Sovereignty and Children’s Day  
Producer: Unknown



A.14- Feraceli Zenne - Producer: Metin Özlen



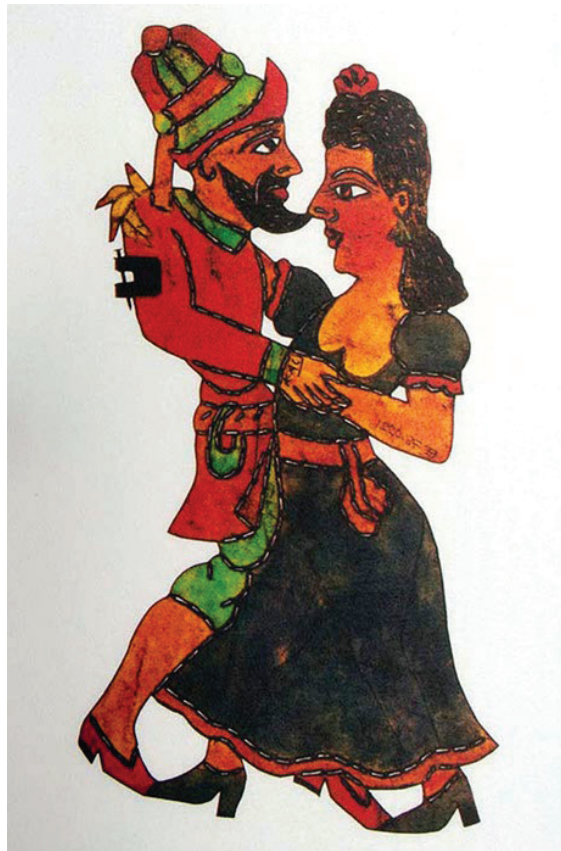
A.15- Donkey - Producer: Metin Özlen



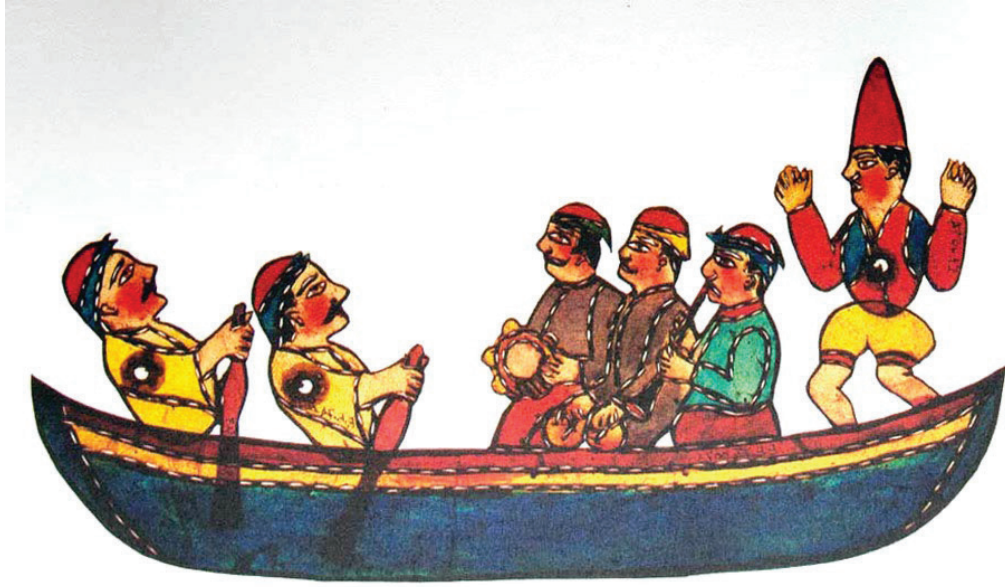
A.16- Karagöz as Ramadan Drummer - Producer: Unknown



A.17- Guests - Producer: Ragıp Tuğtekin



A.18- Hacivat is Dancing - Producer: Unknown



A.17- Musicians on Boat - Producer: Ragıp Tuğtekin



A.18- "Beberuhi" - Producer: Unknown

## **Appendix B Mission Example Story Boards**

The following pages provide illustrations as draft scenes for mission examples in game documentation.

## B.1 Mission 1



B.1- The blackmagic spell have affected Karagöz and transform him to a human-animal alike form.



B.2-Player will be asked to design 4 legged Karagöz. After the design is completed player will play with this new human-animal character and try to reverse this curse in order to get back original Karagöz design.

## B.2 Mission 2



B.3- Player will be asked to design an unlocked character, Beberuhi. After the design is completed, player will be allowed to play with Beberuhi as well.



### B.3 Mission 3



B.4- Player will have the option to work at different stores/jobs.



B.5-Player have to complete task in grocery store, to earn more money.

## B.4. Mission 4



B.6- Player is asked to help an old lady on street as his/her duty.



B.7-Player is going to help an old lady to carry her packages.