



The \$10 TV Computer Project: Current Results

International Development Design Summit 2008

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COMPUTER AIDED LEARNING

Recent studies [1] have demonstrated the efficacy of Computer-Aided Learning (CAL) in developing contexts. CAL can be used to develop basic literacy or numeracy skills, which are necessary to obtain high paid work in the globalized economy.

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\$20


Educational TV-Computer

Building literacy, numeracy and computer skills with learning games and local content

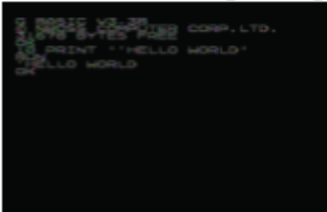
Math Games



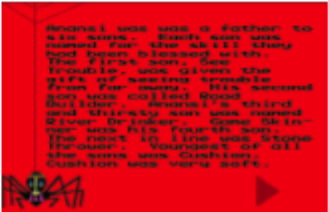
Typing Instruction



BASIC Programming



Regional Literacy Games



[1] Leigh Linden, Abhijit Banerjee, and Esther Duflo (2003) Computer-Assisted Learning: Evidence from a Randomized Experiment. Poverty Action Lab Paper No. 5 October 2003



PROFILE OF TARGET USER

Kofi is an eight years old second grade student who lives with his family in a village in Northern Ghana. Kofi's parents earn about \$2 a day from fishing and farming (yams and millet) to support a family of 7.

Kofi's family owns a mobile phone (\$30) they use to keep in touch with family in the city. They also own a used TV (\$60, powered by car batteries) that the family and other villagers watch in the evening.

If Kofi learns basic computer skills, he is far more likely to obtain work in an office in Sunyani (the nearest city), where the starting salary for a typist is 10 times his father's income.

**Case Study:
Ghana**

PROBLEMS

Even students who attend school are not receiving sufficient education. Some parents pay for tutors but this costly and rarely available in rural areas.

AS A RESULT

10% of 6th grade students can perform simple subtraction

24% can comprehend a paragraph of text.

**HOW CAN KOFI
MAKE MORE MONEY?**



Farmer
\$2/day

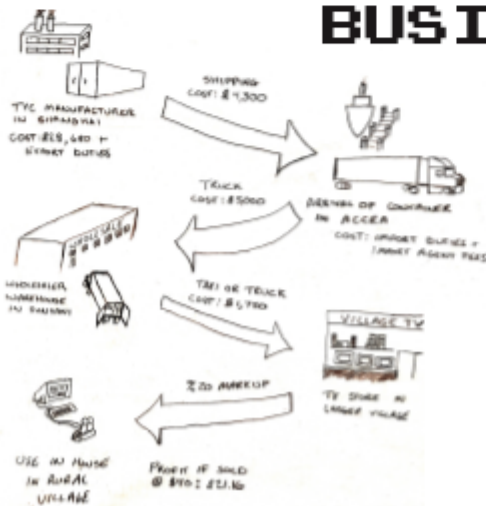


Office worker
\$2/hour

COMPUTER SKILLS

- Math
- Typing
- Reading
- Test Taking
- Critical Thinking

BUSINESS CASE



**Is it Profitable
To Sell TV-Computers
to Homes in Ghana?**

Price from Manufacturer: \$10
Shipping to Ghana: \$4
Wholesale Price: \$16
Retail Price in Village: \$20
Total Profit: \$4

Total Profit Per
40' Container: \$14,000

Selling to Schools?

Target Price: \$30
Schools in Sunyani Area: 2013
Number of TVC per school: 4
Total Cost per School: \$500

Total Profit for Sunyani
School District: \$150,000

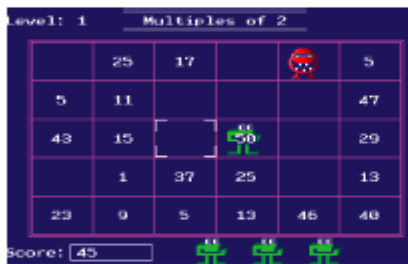
NON-PROFIT

subsidize design of educational games

national education efforts

open-source online community development

Reappropriate Apple II 8-bit Educational Games



"Number Munchers": a popular game on the Apple II, from the mid-1980s

FOR-PROFIT

essential to distribution

markets: households schools businesses

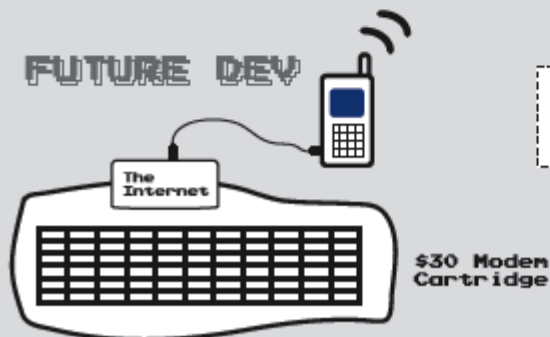
research and development

achieves sustainable product model

GLOBAL MARKET POTENTIAL:

~200 million households worldwide

FUTURE DEV



User-Friendly Software Development Kit

Pedagogy!

Software \$10 cartridge that can save content
256 MB

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Abstract

This project was proposed to the International Development Design Summit (IDDS) 2008 by Derek Lomas. Low-quality public schools create a vast need for supplemental education for the roughly 135 million households in our target markets of India, Brazil, and Ghana. This need can be met through private schools and tutoring, but is expensive and varies greatly in quality. Computer-Aided Learning has been shown to be an effective teaching mechanism, but the cost (>\$250) has kept computers out of reach for most families and schools. Furthermore, all of these countries are facing a lack of skilled workers as their economies grow and need inexpensive training tools. This IDDS project developed a business plan to market TV Computers (TVCs) to homes and schools that could not previously dream of owning a computer. The TVC can enable parents and educators to provide children with supplemental education at a price that's affordable for low-income groups. Increased access to education that's both fun and engaging will help the millions of people in our target markets grow their professional and personal skills and increase their future opportunities. We do not view this project as being in competition with the OLPC.

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- ** Suggestions, corrections, and questions are welcome. The contact for this report: William McIver, Jr. (mciver@acm.org).
 - Updated versions of the project report will be made available via <http://www.appropedia.org/IDDS> and <http://design4dev.wetpaint.com/page/TV+Computer> .
 - General correspondence about this project can be sent to tvcs.idds08@gmail.com .
 - Project Web sites:
 - Official IDDS 2008 wiki: <http://www.appropedia.org/IDDS>
 - Original wiki: <http://design4dev.wetpaint.com>
 - Our official blog: <http://playpower.org/blog/>

1 Problem Statement



Kofi is an eight years old second grade student who lives with his family in a village in Northern Ghana. Kofi's parents earn about \$2 a day from farming and fishing to support a family of 7.

Kofi loves outdoor activities like football and hunting in the woods. Kofi's house has a used TV powered by car batteries that the family and other villagers watch in the evening.

Due to adverse economic condition of the family and lack of high-level education, Kofi is deprived from advanced education which could help him get a much higher paying job (\$13/day) in a nearby city when he grows up.

1.2 Product description: the TVC

The television computer (TVC) which is the basis of this project is based on the 8-bit Nintendo (NES) Family Computer (Famicom) architecture. These machines were developed by Nintendo in the early 1980s. It was one of a number of video game console offerings at the time.

Famicom Clones

Famicom clones are currently being sold in India and other countries for between \$10 and \$25 USD. These are often represented on the packaging as "Educational TV Computers" or simply "Educational Computers." Brand or model names include MITASHI, Victor-60, and Victor-90. It remains unclear who or where the actual manufacturers are. See *Figure 1*.



Figure 1. One Famicom clone brand in India.

Low Price Point

The less than \$25 USD price point was the genesis of this IDDS 2008 project. The low cost of existing TVCs raised the question of whether they could -- with a few hardware enhancements and new software -- be the basis for a new class of computing platform that would be accessible to families and schools who cannot now afford even the \$200 to \$500 USD personal computers that have emerged in recent years.

Current Offerings

The current Famicom clone packages typically consist of a keyboard which contains the CPU and hardware interfaces, one or more game cartridges, two game controllers, a mouse, a light gun, power and AV cables, and an instruction booklet. The contents of one of these packages is shown in *Figure 2*. A close up of the keyboard is shown in *Figure 3*.



Figure 2. A Famicom clone being sold in India.



Figure 3. A close-up of a Famicom clone.

Necessary Enhancements to the TVC

To turn one of the Famicom clones discussed above into a more functional computing platform approaching today's norms, it would have to have a general purpose secondary storage system and a data communications system.

Current clones employ read-only memory (ROM) cartridges, which contain games. These are used by plugging them into the keyboard. By definition, data cannot be saved to this cartridge. Thus, any data that are entered by users, such as in the typing programs, are lost when the computer is powered down. What is needed is a persistent random access memory (RAM) system that allows users to save any data they create.

Additionally, the Famicom clones discussed above do not offer data communications capabilities. This precludes access to the Internet or even simple data transfers to other computers.

The viability of making these extensions is discussed below.

1.3 To whom would we sell the TVC?

An initial single market focus

The \$10 Famicom TV Computer clone has strong market potential given its price point. Nonetheless, we think that considerable care should be given to positioning this type of product in any developing region. This includes development economic, cultural and technical knowledge about a given market. Given time and resource constraints for IDDS 2008, it was prudent for us to focus on one market at this time: rural Ghana.

It is within our overall conception of this project to examine the feasibility of marketing the TVC in any geographic region where our analyses indicate that it can provide customers with the value discussed above and where there is a receptor capacity for it. Other markets that have been discussed thus far during IDDS 2008 – based also on our group's collective knowledge – included urban India and both urban and rural Brazil.

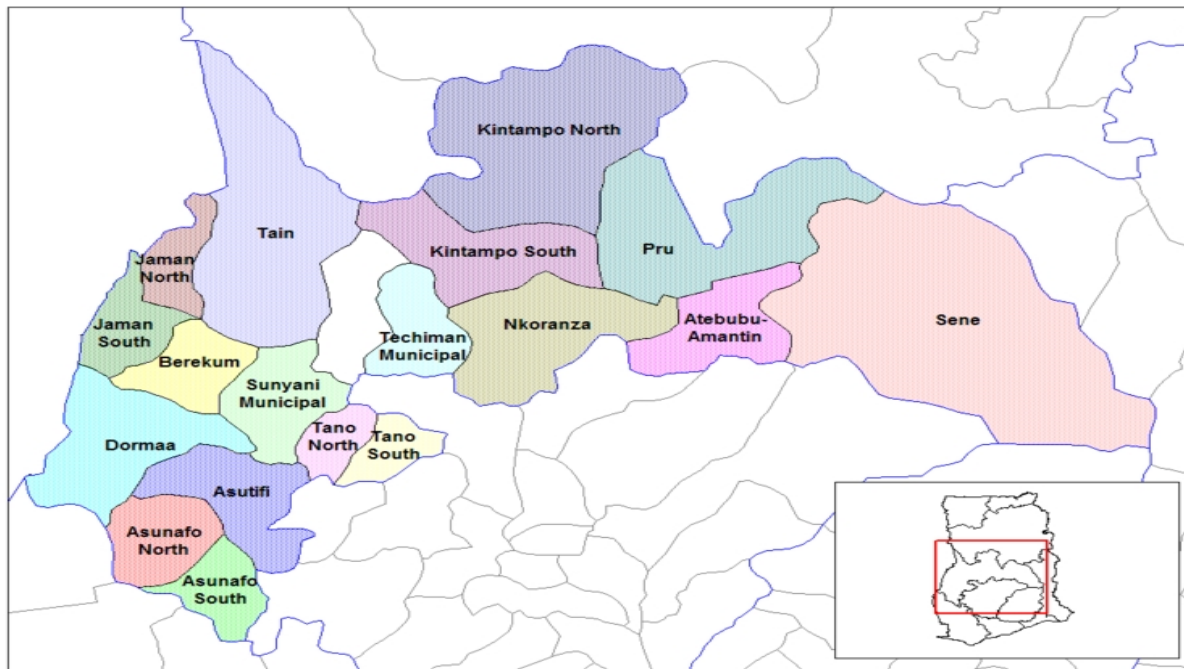
The global receptor capacity for the TV Computer is significant. Based on data from the International Telecommunication Union Dutta, Lanvin and Paua (2004) estimated that in 2002 one in three people in the world owned television sets and while only one in eleven people owned computers. This is out of an estimated global ownership of approximately 1.8 billion television sets and 550 million personal computers (Dutta, Lanvin, and Paua, 2004).

Specific geographic region: Rural Northern Ghana

Current plans are to focus on marketing the TVC in the geographic area encompassing the Kintampo North District Ghana as well as parts of the Tain and Boley Districts. Our team member, Rev. George Fuachie, is a resident and leader in the Kintampo North District and serves communities in the Boley and Tain districts. IDDS 2008 is also fortunate to have three other participants from Ghana, albeit from other areas of the country. It was prudent to develop a marketing plan for area for which we had available knowledge.

The Kintampo North District is within the Brong Ahafo Region of Northern Ghana. See *Figure 4*.

Brong Ahafo Region is in the central and western part of Ghana. Kintampo North District was created in 2003 when it was split from what is now Kintampo South District by President Kufuor. Bole district, which is part of the Northern Region, is shown in *Figure 5*.



*Figure 4.*Map showing Kintampo North District within the Brong Ahafo Region of Ghana.

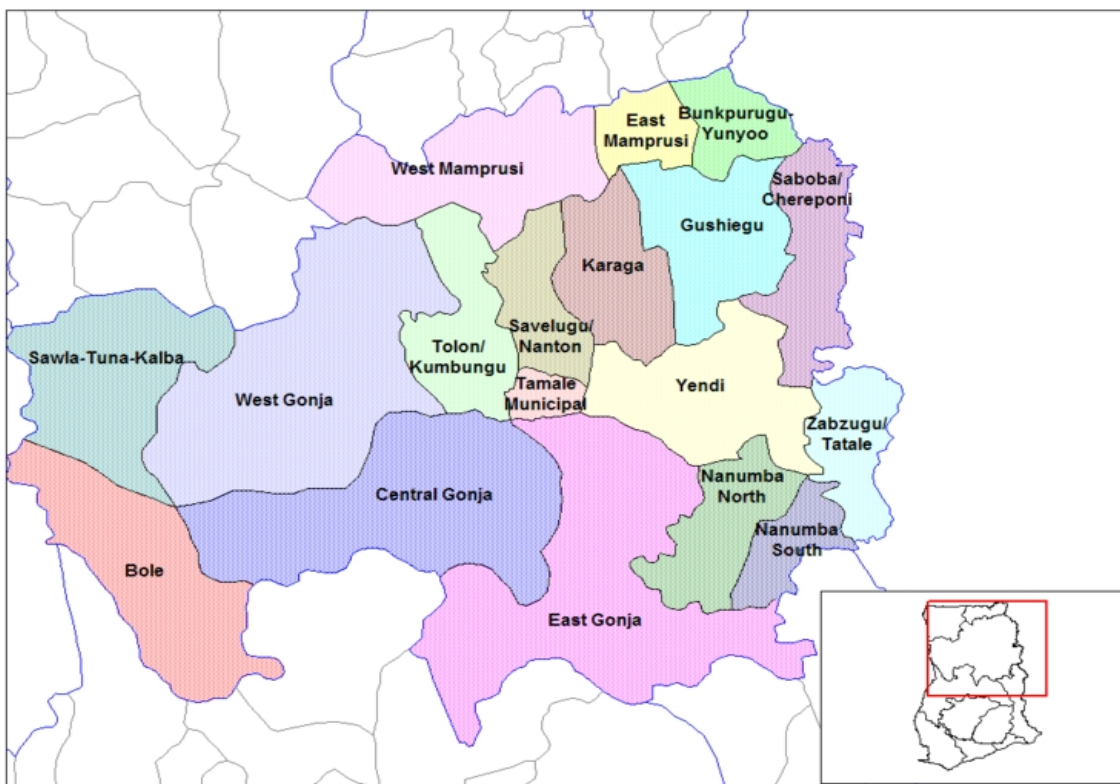


Figure 5. The Northern Region of Ghana, which contains the Bole District.

Demographics of Ghana overall

Population & Income

- The population of Ghana is over 23 million (CIA World Fact Book – Ghana).
- The median age is 20.4 years (CIA World Fact Book – Ghana).
- Ghana had a gross national income (GNI) per capita in 2006 of \$520 (US\$) (UNICEF, 2008).
- GDP per capita (PPP US\$) is \$2,480 (2005) (UNDP, 2007/2008).
- Population below PPP \$1 per day is over 44% (MDG Monitor, 2008).
- Unemployment rate: 11% (2000 est.) (CIA World Fact Book – Ghana).
- Population below poverty line 39.5% (2007 est.) (MDG Monitor, 2008).
- Ghana's 2000 census database has “18.9 million individuals grouped into 3.7 million households” in approximately 89,000 localities (Colulombe, May 2005).
- Ghana's 2000 Census reported that the median number of households over the 110 districts in existence at the time was 24,852 (Colulombe, May 2005)

Note: PPP has been shown to be problematic in characterizing poor people. See Sanjay G. Reddy and Thomas W. Pogge. (October 29, 2005) How Not to Count the Poor. Version 6.2. <http://www.columbia.edu/~sr793/count.pdf> or <http://www.socialanalysis.org> .

Literacy & Education

Attainment of the Universal Primary Education (UPC) objective within the Millennium Development Goal framework is a serious issue for Ghana. Advancement from primary to junior high school is based on exam results, which makes the quality of primary education an especially critical issue. The following statistics help to describe the literacy and educational situation in Ghana overall:

- The adult literacy rate (people aged over 15) is 57.9% (UNDP, 2007/2008).
- The literacy rate of 15 to 24 year olds is 70.7% (both sexes) (MDG Monitor, 2008).
- The net enrolment ratio in primary school education is 70.4% (both sexes) (MDG Monitor, 2008).
- The Gender parity Index in primary level enrolment (ratio of girls to boys) is 1.0 (MDG Monitor, 2008).
- The percentage of pupils who start grade 1 and reach grade 5 is 60% (both sexes) (MDG Monitor, 2008).
- Combined gross enrolment ratio for primary, secondary, and tertiary education is 50.7 (statistics as of 2005) (UNDP, 2007/2008).
- Most Ghanaian primary schools have no text books according to a 2007 Chicago State University press release announcing an initiative is developing text books for Ghana (http://www.csu.edu/urelations/CSUDistributesTextbooksinGhana_000.htm).
- Pupil / teacher ratio (primary) 35 (2006) (UNESCO, August 2008)
- Primary Qualified Teachers as percentage of teaching force is 70.8% nationally (2006/2007) and 55.9% in 40 of the most deprived districts (UNICEF, 2007).
- The ratio of pupils to trained teachers in pre-primary education is approximately 1:160, 2005 (UNESCO, 2008).
- The ratio of trained teachers to teachers for pre-primary education is approximately 25%, 2005. (UNESCO, 2008).
- The percentage of primary 6 students who achieved proficiency (> 55%) in English on Ghana's National Educational Assessment was 23.6% (Republic Of Ghana, 2006).
- The percentage of primary 6 students who achieved proficiency (> 55%) in mathematics on Ghana's National Educational Assessment was 9.8% (Republic Of Ghana, 2006).

Technology

- The ITU reports a widening digital divide, including in Africa (<http://www.itweb.co.za/sections/telecoms/2008/0805201425.asp?A=HOME&O=FPMN>). A “Connect Africa initiative” was announced, with the objective of connecting more than one billion people in Africa by 2012.
- The source of data for (Dutta, Lanvin & Paua, 2004) is the International Telecommunication Union.
- Ghana had an average of 77 television sets per 1,000 people (as of 2001). (Dutta, Lanvin &

IDDS 2008 – TVC Project

- Paua, 2004). Televisions: 1.9 million (2001) (CIA, 24 July, 2008).
- Ghana had an average of 27 Radios per 1,000 inhabitants (as of 2001) (Dutta, Lanvin & Paua, 2004). 12.5 million (2001) (CIA, 24 July, 2008).
- Main telephone lines in operation, 2001 242,122 (Dutta, Lanvin & Paua, 2004). 356,400 (2006) (CIA, 24 July, 2008)
- Telephone mainlines (per 1,000 inhabitants), 2001 87 (Dutta, Lanvin & Paua, 2004).
- Cellular mobile telephone subscribers, 2002 405,000 (Dutta, Lanvin & Paua, 2004). 5.207 million (2006) (CIA, 24 July, 2008)
- Personal computers, 2001 70,000 (Dutta, Lanvin & Paua, 2004).
- Households online (as % of households with computers), 2002, 75 (Dutta, Lanvin & Paua, 2004).
- Internet users (estimated), 2001 40,520 (Dutta, Lanvin & Paua, 2004).
- Personal computers (per 1,000 inhabitants), 2001, 93 (Dutta, Lanvin & Paua, 2004).
- Computers installed in businesses (per 1,000 inhabitants), 2002, 90 (Dutta, Lanvin & Paua, 2004).
- Internet users (per 1,000 inhabitants), 2001, 95 (Dutta, Lanvin & Paua, 2004). Internet users: 609,800 (2006) (CIA, 24 July, 2008)
- Computers installed in businesses (per 1,000 inhabitants), 2002, 90 (Dutta, Lanvin & Paua, 2004).
- Internet hosts: 2,899 (2007) (CIA, 24 July, 2008)
- Internet Service Providers (ISPs): 12 (2000) (CIA, 24 July, 2008)
- Ghana's Digital Access Index for 2002 is 0.16, which places it into the low access category (http://www.itu.int/newsroom/press_releases/2003/30.html). As a comparison Sweden was the highest with 0.85 and the U.S. had 0.77. The DAI includes the following components: infrastructure, affordability, knowledge, quality of service, usage.

Demographics of Kintampo North, Tain and Bole Districts in Ghana

Kintampo North and Tain Districts are within the Brong-Ahafo region. The Bole District is within the Northern Region. These districts are mostly within the rural savannah strata of the 2000 census. The following geographic and demographic facts have been located from various sources:

- The rural savannah strata of Ghana overall has 15% of Ghana's households or 555,000 households.
- Ghana's 2000 Census reported that Northern region 1,820,806 (Coulombe, May 2005)
- Bole District is 4800 square km. (GhanaDistricts.com)
- Bole District reported a population of 127,188, approximately 88% rural (Coulombe, May 2005)
- Ghana's 2000 Census reported that the Brong-Ahafo region has a population of 1,815,408 (Coulombe, May 2005)
- Kintampo North District has an area of approximately 5,108km² (GhanaDistricts.com).
- Kintampo North District has a population of approximately 96,358 (GhanaDistricts.com). Approximately 73% are rural (Coulombe, May 2005)
- Tain had a population of 85,216 in 2004 (GhanaDistricts.com). Approximately 70% are rural (Coulombe, May 2005).

Specific Market Segments

Based primarily on ethnographic input from Rev. Fuachie and combined with demographic data from a variety of sources, including UNDP, UNICEF, UNDP, and the World Bank, we have decided to examine the prospects of marketing the TVC to two types of customers in rural Ghana:

- (1) Primary and Junior High Schools (both public and private); and
- (2) Homes.

1.4 What value will consumers want from the TVC?

According to Rev. Fuachie and the other Ghanaian participants of IDDS 2008, potential customers in rural Ghana, and any other part of the country, would want or could be sold on education, job skills development, and entertainment.

The usefulness of skills development that is possible with the TVC are confirmed by other evidence. A 2002 article in the New York Times reported that data entry clerks in Ghana who were working at Data Management, a firm to which the City of New York had outsourced work, were making almost three times the minimum wage (Worth, 2002). A 2003 article in CNNMoney.com reported that data entry clerks in Ghana who were working for Affiliated Computer Services, a firm that processes medical claim forms for Aetna, were making ten times the minimum wage in Ghana at the time (Thomas, 2003).

We, therefore, conclude that the TVC would need to enable consumers to develop in the following areas :

- math, literacy, and critical thinking skills for basic primary education;
- preparation for entrance exams into junior high level;
- preparation for secondary and tertiary level exams;
- adult literacy and numeracy; and
- basic job skills, such as typing and accounting.

This would be achieved by the development of special content for the TVC. This is discussed below.

2 Approach: Use an existing low-cost computer as a platform for computer-aided learning

Newly manufactured 8-bit computers are currently available in India for a cost as low as \$10. These computers save money by connecting to an existing TV as a screen, however, they come loaded with accessories such as a full keyboard, mouse, 3 game controllers, and a suite of educational software and games. The educational content available on these computers is limited, but still powerful--for instance, a user can program in BASIC within 2 clicks of turning on the computer. We wish to make

use of these existing TV-Computers as a target platform for the design and deployment of higher-value learning games and educational software.

Several studies have been done to show that computer-aided learning can be surprisingly effective in a developing context. The radically low cost of these TV-Computers makes computer-aided learning directly affordable, without subsidy, to broad sectors of the market for which computers are not currently cost-effective. The three largest sectors of the market seem to include: families (to provide supplemental education to their children), schools (to provide computer education), and finally businesses (to train their employees).

Our goals are the following:

- 1 Increase the educational value of ultra-low-cost educational TV computers.
 - 1.1 Create a low-cost software production process.
 - 1.1.1 Develop software development kit.
 - 1.1.2 Develop method for contextual design of effective learning games.
 - 1.1.3 Facilitate local content production.
 - 1.2 Acquire existing educational software.
 - 1.3 Extend the physical hardware capabilities.
 - 1.4 Develop effective teaching methods that incorporate the TV-Computer.
- 2 Facilitate the dissemination of educational TV-Computers in appropriate markets.
- 3 Start a non-profit organization to facilitate and subsidize the design of effective learning games.
- 4 Encourage the formation of for-profit entities that create content and distribute TV-Computers.

3 Marketing

This marketing analysis was prepared in a large part through ethnographic research with Rev. Fuachie and the other three Ghanaians at IDDS 2008. Their insights were necessary in helping us understand issues that must be addressed in marketing the TVC in rural Ghana.

3.1 Market research

We were constrained during IDDS 2008 to performing market research through interviews with Rev. Fuachie and the other Ghanaian participants and statistics that we were able to gather. A thorough market analysis should include trials within Ghana where we attempt to sell TVC units in various market strata (e.g. rural and urban areas). Observational data and feedback from consumers would be invaluable in improving our product design and its marketing plan.

3.2 Initial product requirements

The product must meet the following requirements (at minimum):

- **Durability:** Rural Ghana is highly communal. A typical event is for large extended families to gather at night in their home compounds to watch a single TV. The TV is often brought outside of the house into a courtyard so that there is enough room for everyone to watch. This raises the prospect of many hands on the device and jostling to use it. The electronics would also need to be protected from the dust and moisture in the compound.
- **Power sources:** Electric service is far from universal in these areas. Families typically power their televisions with car batteries. The TVC is manufactured to be powered with AA batteries in addition to the common AC/DC power converter. A related issue is the need for a lighting source to see the keyboard at night, as many people lack bright lighting in their homes or compounds. The use of kerosene lighting is typical in this region, as was highlighted by Kurt Kornbluth during IDDS 2008.
- **Multiple inputs:** The communal nature of activities in rural Ghana means that the TVC should be shareable by 2 or even more people concurrently. For example, the Owari board game allows up to 6 people at a time. It currently supports two inputs. Future work might explore expansion to four players.
- **Culturally-relevant educational content:** General educational content as provided on existing versions of the TV computer would certainly be valuable. It would ideal, however, if content were provided with the TVC that provides a “cultural bridge” for students to computing. This might include the use or adaptation of traditional board games and stories.
- **Content for adults:** There is a great need for skills development and adult literacy training in Ghana. Thus, it would be ideal if content were developed specifically for adults and if content geared toward children could somehow involve parents so that they can learn alongside their children. Other ideas that have been discussed is the development of video or audio content that can run autonomously while an adult performs chores in the home. This would provide for hands-free entertainment and education.

3.3 Characterizing the market segments in rural Ghana

The market in rural Ghana can be characterized as follows:

- **Social Structure:** Rural Ghanaian society revolves around large extended families having a strong social structure and traditions. Decisions about purchasing a new product would be made through discussion with many family members and friends. Information about new would also be disseminated in this way.
- **Economic Activities:** The dominant economic activities in rural Ghana are agriculture and fishing. Many families run small farms or have fishing concerns.

- **Child labor:** Many families pull their children out of school to help with the family farm, fishing, and marketing. While this practice should be halted, it raises the need for complementary education in the home.
- **Markets:** Communal market days are held for the exchange of products and services. These are open air areas where people set up stalls and offer a wide range of products and services. This is a key area in which the TVC should be marketed.
- **Human development:** As the statistics in *Section 1* detailed, rural Ghana can be also be characterized as having fairly widespread primary school enrollment, but with a significant drop off for pupils who advance after year 5. The ratio for entry into primary school by girls is nearly 1:1, but girls are often pulled out of school to help with family work and to live with aunts when they are older. A significant proportion of adults cannot read. A significant proportion of adults are also unemployed.

3.4 A Persona: Kofi – Student in a rural Ghanaian village

We employed the user-centered design process of developing a “persona” (Pruitt and Grudin, 2003) to understand and describe the targeted demographic for the TVC in Ghana. Our persona is a young boy name *Kofi*. This persona was constructed in close consultation with Rev. Fuachie. Statistics presented in other sections of this document were also used to construct this persona. We anticipate the development of other personas in the future.



Kofi and his family

Kofi Chiu is a 8 year old boy living with his family in a small village named Ntareban close to the Black Volta river in the Kintampo district of Northern Ghana. Kofi’s father Kwabena Chiu supports

the family of 7 with his average yearly income of \$800 from growing and selling yams and millet on his small 1.3 acre farm. Kofi's mother Gifty Diabado usually takes care of the kids at home and occasionally grows peanuts in the farms. Kofi has 2 elder brothers who go to school and occasionally help their father in the farm. To make some extra money and provide food to the family, the eldest brother Mathias Chiu accompanies his father in fishing at 4 am in the morning before going to the school. They bring fish back home and the mother cooks some of them and sells the rest to make money. Kofi also has 2 sisters who help their mother with the daily chores like fetching water, washing utensils, and cooking at the home.



Evening activities at Kofi's house

In the evenings the father returns from the farms while the mother and the girls are busy preparing food for supper. The entire family usually eats together. Kofi's house also has a small TV that the father bought from the nearby city when he went there to sell some of his yams. The family usually brings the TV outside of the house in the main compound so their neighbours and other relatives can also watch it at the same time. The TV watching time is usually between 7-9 pm in the evening. Sometimes Kofi watches his brothers and sisters play the game of Oware before the bed time. Occasionally the parents tell the ancient Ghanaian stories of Ananzi before the bed time.

Kofi always wants to play with his father's cell phone when he is not around but the father does not allow that. The father bought the phone for about \$40 from the used electronics market in the city. He usually uses the phone to get in touch with the local yam distributors and contact friends and other relatives.



About Kofi's school

A few years ago the Government of Ghana started providing free education for all primary and junior high schools in Ghana. Since last year they have also started providing free lunch meals to all the students in the primary schools. Because of free education and meals most of the parents send their children to the school. Even though Kwabena and Gifty did not go to school, they really wanted their children, especially Kofi, to get educated.

Kofi is now in second grade at the Methodist Primary School in the neighbouring village of New Longoro. He has to walk about 3 miles one-way everyday to his school. This long walking distance makes it really difficult for young Kofi to get to school during the rainy season.

In the second grade Kofi studies how to read and write in English and some basic mathematics. Kofi's school has six small classrooms and usually there are about 35 students in one classroom. The school is trying to set up a computer lab but they haven't managed to get enough funding from the Ministry of Education in Ghana. The school also has a television set that they use for national distance learning sessions.



Kofi's favourite outdoor activities

During the weekends Kofi usually plays football with his friends or hunt rats in the woods. When needed Kofi sometimes helps his father in the farms. Sometimes he also follows his elder brothers when they go hunting for birds for fun. Kofi also enjoys playing hide and sick with his same-age friends in the village.

About Kofi's village

The village of Ntareban has about 50 small houses made of mud walls and thatched roofs. There are about 5 houses in one small compound where close relatives live together. There is a small clinic and a church in the village, but there is no school. The village is not on the main electricity grid and everyone uses kerosene lamps as a primary means of lighting. About 30% of the houses in the village have TV which they use it mostly during nights. Due to lack of electricity in the village most of them use the care batteries to power their TVs.

The neighbouring village of New Longoro has a school and a small credit union. This school is shared by 4 surrounding villages including kofi's. New Longoro is on the electricity grid and people from Ntareban come here to charge their car batteries.



How will TVC help Kofi shape his future?

Kofi's father earns about \$2/day from farming and fishing. Using the TVC with proper educational content Kofi can learn basic computer skills and get supplemental academic education. Kofi can be the person working in an office in the city earning \$10-\$13/day just by learning typing skills. Kofi can also use the TVC to help him prepare for the standardized test to get into a junior high school. Apart from the educational experience Kofi can also gain business skills and knowledge about farming and fishing (better techniques and market information) to help his father.

3.5 Business models

We are evaluating three types of models for disseminating the TVC. Paul Polak has encouraged us – and all IDDS 2008 participants -- to use a for-profit model. He makes a compelling case for this in his book *Out of Poverty* (2008:186). He contends, in part and in a more nuanced and comprehensive way than we present here, that most NGO models have not been effective in creating sustainable and scalable solutions nor have they been able to demonstrate measurable impacts.

Nonetheless, some in our group argue that while the TVC has survived within a for-profit business model, that model has not produced the hardware extensions nor advanced content development that would be necessary to turn it into a full fledged personal computer. These hardware extensions include adding a general secondary storage mechanism. Some game companies produced their own special cartridges that allowed players to save their scores or game states, but the TVC does not offer a general mechanism for storing content. The TVC also requires data communication capabilities to make it useful in today's networked world. More advanced content development is

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needed in the areas of: computer-aided learning, exam preparation, skills development software, and culturally-tailored programs and e-Books. One question is whether a non-profit function within the overall TVC project might better facilitate the funding of these extensions.

In the end, a hybrid model which integrates for-profit and non-profit operations might be the best for the TVC project.

For IDDS 2008, we have developed a TVC distribution model that estimates profitability under different price targets specifically for Northern Ghana. These are given in *Table 1*.

Table 1. TV Computer Distribution Model GHANA

	Assumptions	40 foot shipping container 2'x1.5'x3"		
	2390	cubic feet		
	0.75	cubic feet		
	3,187	TVC can fit into a 40' container		
			Number of Villages around Sunyani	250
Wholesale Cost of TVC	\$9		Average population around village	16,000
Total Cost of Filled Container	\$28,680.00		Average number of families around Village	2,000
			Average family size of	8
			Percentage of Households with TV	60%
Shipping Cost From Shanghai to Akra, Ghana	\$4,350		Number of Households with TV	1,200
<i>MIDDLEMAN in Akra</i>			Percentage of Families wanting TVC	50%
Shipping from Akra to Sunyani	\$4,000	40' container	Target MarketSize per Village	600
<i>MIDDLEMAN in Sunyani</i>			Target MarketSize across Villages	150,000
Shipping from Sunyani to a local village	\$7	per load	Likely Sales percentage	10%
<i>MIDDLEMAN in village</i>			Target Sals	15,000
Local Shipping to all vlages	\$1,750		Number of households in Ghana	3,700,000
Total Shipping Costs	\$10,100		Number of households with TV	2,400,000
Total Unit Costs in Village	\$12.17		Percentage of Households with TV	65%
Retail Mark-up percentage	20%		Percentage who want TVC	35%
			Target Marketsize	840,000
Price Targets	Profit	Total profit per container	Likely Sales Percentage	10%
\$14.60	\$0.00	\$0.00	Target Sals	84,000
\$15	\$0.33	\$1,053.33		
\$20	\$4.50	\$14,331.11		
\$25	\$8.66	\$27,608.89		
\$30	\$12.83	\$40,886.67		
\$35	\$17.00	\$54,164.44		
\$40	\$21.16	\$67,442.22		

3.6 Product distribution

Tariffs

We consider the TVC to be an educational product. The Office of the U.S. Trade Representative indicated in 2005 report that a “zero-rate duty” applies to educational materials in Ghana (USTR, 2005). Thus, we would seek an import license from the government of Ghana under this classification.

Distribution channels

Families tend to buy television sets in the larger cities or villages in their districts. A family must contend with transport costs to and from the location where the television are sold.

Shipping and distribution process & costs

Our current understanding of Ghana suggests that the following approach to shipping and distribution should be taken:

- (1) TVC units would be purchased from Shanghai. This would be on the scale of 3,200 units based on the volume of a shipping container.
- (2) A 40 foot shipping container would be used to transport the TVCs from Shanghai to Accra. This cost is \$4350.
- (3) TVCs would then be shipped from Accra to Sunyani by truck. The cost is estimated to be between \$500 and \$5000 dollars. Sunyani is the capital city of the Brong-Ahafo Region. See Figure 3. In 2005, it had a population of approximately 80,000 (http://www.mongabay.com/igapo/2005_world_city_populations/Ghana.html).
- (4) TVCs would then be distributed by taxis and trucks to approximately 250 village centers within the Kintampo North, Tain, and Bole districts where people buy television sets. This cost is estimated to be \$2,000. The cost to hire someone to take one load from Sunyani to an individual village center is \$4 an extra \$3 per load would be required for labor. Taxis and trucks would not have great difficulty during the rainy season (May to the middle of July).
- (5) Sellers in villages will demand an estimated 20% profit on all products.



Figure 6. Sunyani and Accra in Ghana.

3.7 Marketing issues and approaches

We developed two marketing approaches: one for schools and another for homes. The school marketing approach was further divided into separate plans for public and private schools.

For each marketing approach, we present a list of stakeholders. At the end of this section, we also present what is called a “persona,” which is a type of profile describing the primary customer or user of the TVC. This persona indicates relationships to the various stakeholders seen in these three marketing plans.

Marketing to Public Schools

The stakeholders for public schools are the following:

- Minister of Education, Science & Sports for Ghana
- Regional head of education (over several districts)
- District Director of Education
- Head teacher
- Village officials
- Best students / students
- Teachers
- The Parent Teacher Association (PTA)

Protocol and resource allocation methods dictate that marketing of products to public schools must begin at least at the level of the region minister of education, if not the national Ministry of

Education & Sports. It is at the same time necessary to gain buy-in at the school level – from both teachers and students. For these reasons, we decided that a two stage marketing approach was necessary in which all stakeholders are brought together in the second stage. Our proposed process is the following:

- **Stage 1 – Engagement with administrators:** During this stage, the regional Minister of Education & Sport would be approached. An indepth discussion would be sought with the minister on the potential value of the TVC would have in the schools under his/her jurisdiction. Ideally, the product could be demonstrated with young family members of the minister. An agreement to engage the school community directly would be sought. Unit sales would be attempted at this level.
- **Stage 2 – Engagement with the school community:** Each school district holds an annual festival which is an opportune time to market the TVC because it brings all the stakeholders together. Officials from the ministry, community leaders, teachers, and students gather for sports and educational events in a festive environment. Several students and teachers would be identified ahead of the festival. They would be trained in the use of the TVC so that they are prepared to demonstrate its use during the festival. The TVC would be demonstrated before the entire gathering in small groups to facilitate proper viewing. A few units would be offered as a prize to the school that wins the traditional festival competition. Unit sales would be attempted at this level.
- **Stage 3 – Seeking an agreement:** The results of Stage 2 would be discussed with officials and other stakeholders (if permitted by the ministry). An agreement to purchase the TVC would be sought. Terms would be agreed upon.

Marketing to Private Schools

The stakeholders for private schools are the following:

- Minister of Education, Science & Sports for Ghana
- Association for private schools
- Private parent teacher association (PTA)
- Proprietors for private schools
- Students
- Teachers

All private schools are subject to the jurisdiction of the national Ministry of Education & Sport. Most private schools in Ghana belong to the same industry association. Private schools can be engaged directly at the level of the association of private schools. Our proposed process for marketing to private schools is the following:

- **Stage 1 – Engage the national association:** The private schools association of Ghana must be approached first. Demonstrations of the TVC would be held. Permission to meet with the regional chapters of the association would be sought.
- **Stage 2 – Engage the regional association:** The regional chapter of the private would then be approached. Demonstrations of the TVC would be held. Proprietors of individual schools would be approached about purchasing units for their schools and for permission to engage their teachers, students and parent teacher associations. Unit sales would also be attempted at this level with individual school proprietors.
- **Stage 3 – Engage individual schools:** Teachers, students and parent teacher associations would be approached. Demonstrations of the TVC would be held.

Marketing to Families

Three venues for marketing the TVC to families will be explored:

- **Family Homes:** Door-to-door sales could be attempted. The advantage of this approach is might be an ideal setting to initiate social marketing (aka “viral marketing”). Large extended families gather in the evenings, often outdoors, to watch TV in their compounds. Demonstrations of the TVC would then have a relatively large home audience in the context in which the product would be used. There are a number of disadvantages to this approach. The housing density is relatively low in this region making travel between homes more expensive than in an urban setting. Most families are occupied during the day. Thus, the night time is virtually the only time that marketing could be attempted in homes. Many homes in rural area also have no electricity and use kerosene lighting. A low light environment is not conducive to demonstrating this product. A salesperson would have to carry supplemental lighting.
- **Village Markets:** People gather frequently during “market days” in or near their villages. This an ideal setting for displaying a product in front of a large audience. A special van could be outfitted with a number of televisions and TVCs to allow people to have a hands-on experience with the product. One possibility is to train selected local students in using the TVC and have them on hand during market day demonstrations. This local connection would foster social marketing between children and parents and between children in their schools.
- **Special Community Gatherings:** Community members can be called together for special gatherings by sounding a *gongon*, a traditional Ghanaian percussion instrument. Gatherings could potentially be called to present TVC demonstrations to large numbers of people.

3.8 Branding

An initial approach to branding has been developed working in dialogue with Rev. Fuachie during IDDS 2008. In addition, a brief scan of technology branding approaches in Ghana was performed using Web sources. A more indepth study of branding in Ghana is warranted. We have, however,

developed the following interim assumptions about branding:

- **Lack of brand presence:** Brand presence for consumer electronics does not appear to be strong in Ghana. Consumers appear to be attracted to products mainly through identification with general product categories (e.g. PCs as opposed to DELLs or Lenovos), price, and word-of-mouth. More research is necessary to confirm these assumptions.
- **Usefulness of cultural bridges:** Cultural tie-ins for the TVC are likely to be useful in lieu of a brand. These could be messages or images which show Ghanaians that they can appropriate the TVC for their own needs and cultural settings.

Following these assumptions, we developed a several concepts for packaging the TVC, which incorporated messages and images that would be familiar to across a wide range of geographic strata and ethnic groups in Ghana. Figure 7. depicts a hypothetical box which captures basic elements that might be employed. This is a decidedly less commercial representation than those seen in the market now for Famicom clones.



Figure 7. Prototype of a TVC box designed for the Ghanaian market.

This box design attempts to link Ghanaian vignettes to the use of the TVC and to a message about education. Here we see photos and drawings of traditional settings in rural Ghana: a school yard, a classroom, a typical home compound, a fishing village, and a family gathered to watch television. These are all centered around a stylized Ghanaian flag in the shape of the country to convey a sense of national pride in the product. A Ghanaian expression about education – which originated in the Ashanti language – is “learning gives knowledge and experience.” This is displayed on the box in English and four of the most common indigenous languages in Ghana (some translations are pending): Ashanti, Ga, Ewe, and Dagomba. The Ashanti phrase is: *Aɔɛsua ma nimɔɛ ne Suabunu*.

The back of the box would give basic information about its contents. A simple example is given in *Figure 8*.

TV Computer – Ghana

Connect this computer to any TV set to enjoy hours of fun games that are both educational and entertaining.

Plug in the game cartridge included in this box to gain access to these games.

Help improve your family's education and future by giving them a TV Computer!

This TV Computer – Ghana box includes with the following items:

- A keyboard
- 2 game cartridges
- 2 game controllers
- A power cable for a 12 volt car battery

Note: The TV is not included.

Figure 8. Prototype of a the back cover of the TVC box.

3.9 Advertising

Advertising the TVC in electronic media is also a possibility in rural Ghana. National and local radio and television outlets offer not only advertising, but the possibility to conduct interviews concerning the TVC project. Interviews are ideal for initiating social marketing processes. Further research is necessary to determine actual advertisement costs, but Ghanaian participants of IDDS 2008 think that individual one minute radio advertisements on regional FM stations can be purchased for less than \$5 USD. Additional research is required to determine appropriate advertising styles for the rural Ghana market.

4 Content for the TVC

4.1 Skills we want to teach

For Ghana, we have identified the following skills that important for success:

- skills in basic primary education (math, literacy, critical thinking, etc);
- preparation for exams into junior high level;
- preparation for higher level exams;
- adult literacy and numeracy; and
- basic job skills, such as typing, accounting.

The following is a non-comprehensive list of general skills that can increase economic and educational opportunities within many contexts:

- 1 Math
- 2 Reading and Writing
- 3 Typing
- 4 Computer Programming:
- 5 Business Skills
- 6 Health Education
- 7 Physics
- 8 Life Planning
- 9 Values
- 10 Critical Thinking
- 11 History

4.2 Developing culturally-oriented content for rural Ghana

The late computer scientist and education visionary Randy Pauch said “[t]he best way to teach somebody something is to have them think they’re learning something else” (2007). Daniel Roy of Education Arcade at MIT gave us the same message in the early days of the TVC project. His research and experience suggests that drilling and practicing games do not attract students. Roy also suggested that we examine the idea of developing story or adventure games (2008).

A subgroup of the TVC project team decided, in consultation with Rev. Fuachie, that a prudent starting point for content development for rural Ghana that would follow Roy's advice would be to adapt traditional Ghanaian games and stories to the platform. The hypothesis is that familiarity with these games and stories would provide a bridge into the technological environment of the TVC. The TVC could then be used to implement variations on existing Ghanaian board games and stories to incorporate additional concepts. The natural starting points here were the board game *Owari* and the collection of *Ananzi* stories.

Owari

Owari is in the class of Mancala games that are played in various cultures around the world. Owari fits some of the criteria we established for educational content for the TVC. It requires counting and encourages the development of critical thinking in forming game playing strategies. Owari is often played 1 on 1, but can be played as 2 on 2 or 3 on 3, therefore encouraging collaboration among team members. We envision the development of variations of Owari that are highly engaging and encourage the development of other skills.

The game board consists of cups or indentations in a board (or sometimes the ground) that represent “houses.” Each player or side has six houses. Two addition cups are used to hold stones that are captured from one's opponent. Each house is given four stones initially. See Figure 9. The typical rules of play in Ghana are then as follows (cf. <http://members.aol.com/sstev74322/owari11.htm>):

- 1 Players alternate in picking up the all of the beads from one house on their side of the board and of their choosing.
- 2 The player who has the turn must “sow” one bead in each of the houses that follow in an anti-clockwise direction around the board the house from which they picked up the stones. The player then examines the house into which they deposited their last stone.
- 3 Depending on the number of stones now in this house, there are different courses of action:
 - 3.1 If the last house into which a stone was deposited does not have 2 or 3 stones, no action is taken and the other player has a turn.
 - 3.2 If the last house belongs to the opponent and the number of beads is 2 or 3, the player collects all of those beads.
 - 3.3 If a player collects beads, then they look at the next to last house to see if it satisfies the same criteria as 3.2. If it does, then the player collects those stones as well.
 - 3.4 If the player has 11 or more beads – enough to wrap around the board – the player skips the house from which they picked up the stones while sowing stones.
- 4 When a player has no more beads, the game is over. The player without beads is the loser.



Figure 9. A traditional Oware (or Oware) board. Source: <http://en.wikipedia.org/wiki/Image:Oware-front.jpg> (GFDL).

We developed storyboards for Oware as part of a standard game design process. These are shown in Figures 10 through 17 below. These shown not only how the game is played, but one possible variation which can engage the players with simple arithmetic expressions showing the results of a move.

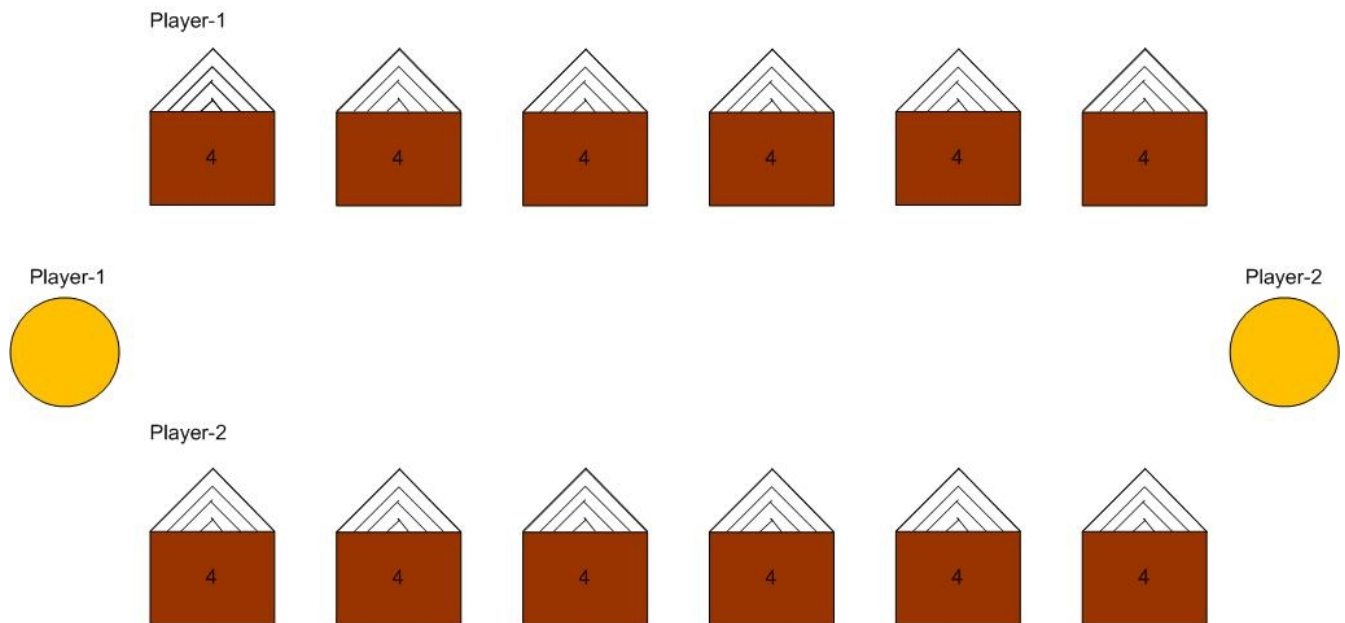


Figure 10. The initial state of the Oware game.

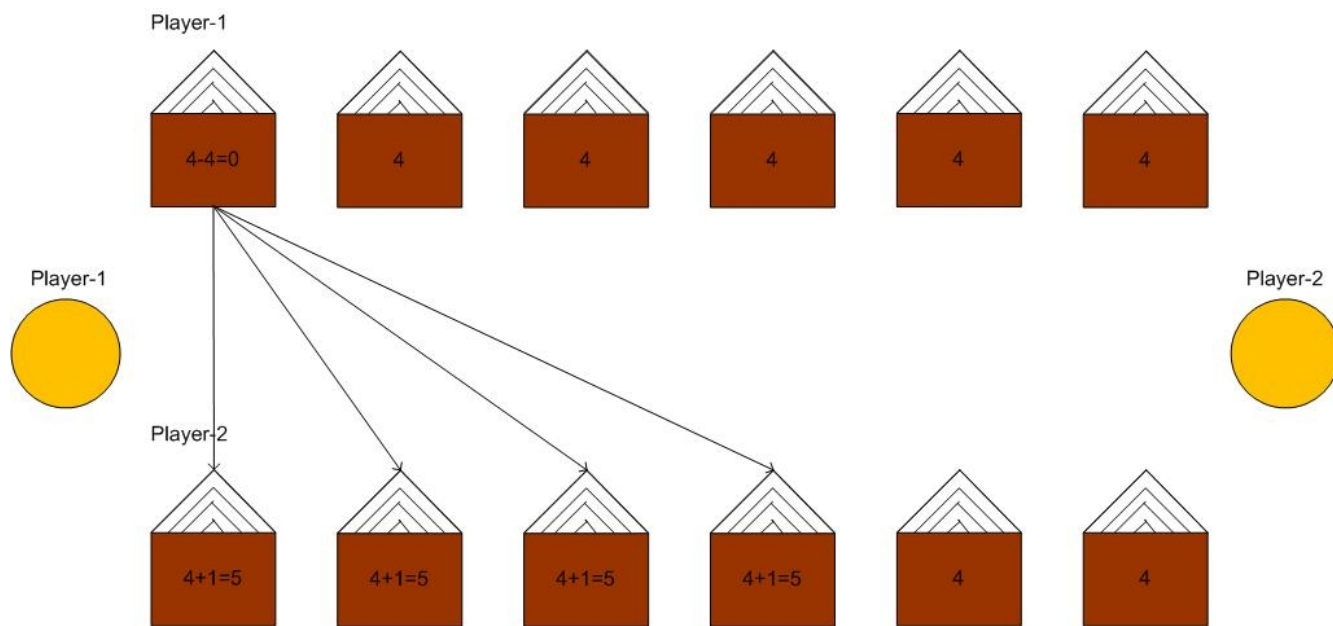


Figure 11. After the first move of an Owari game.

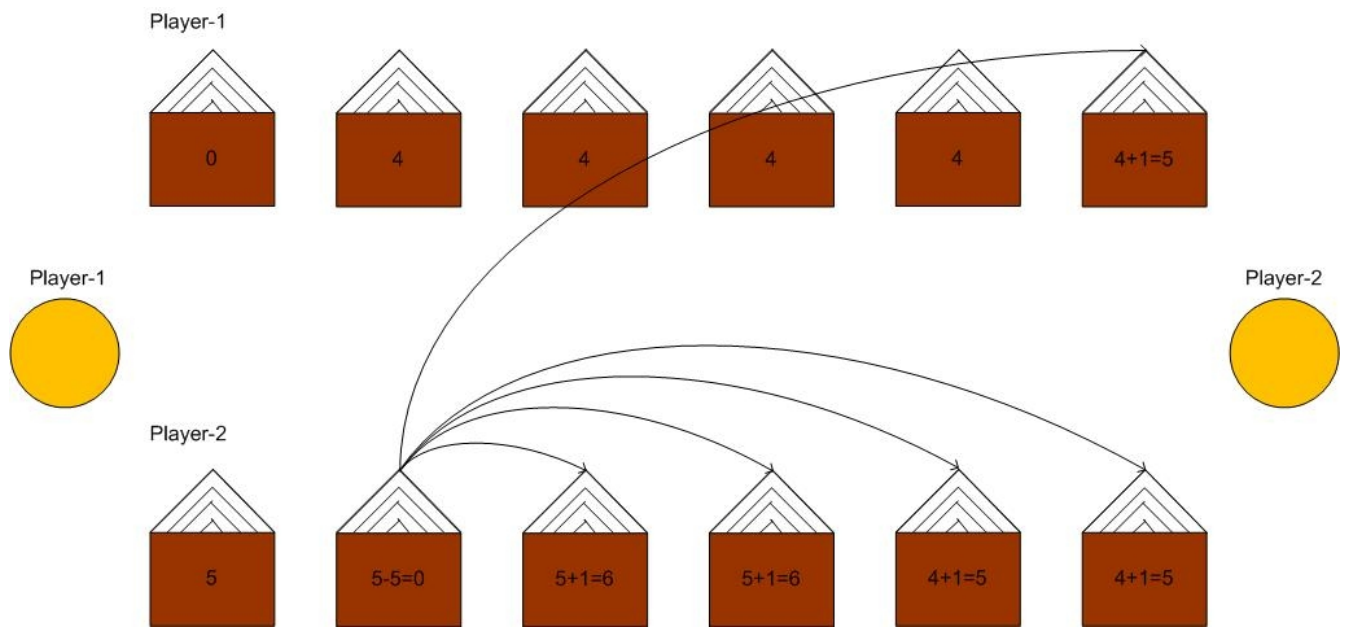


Figure 12. After the second move of an Owari game.

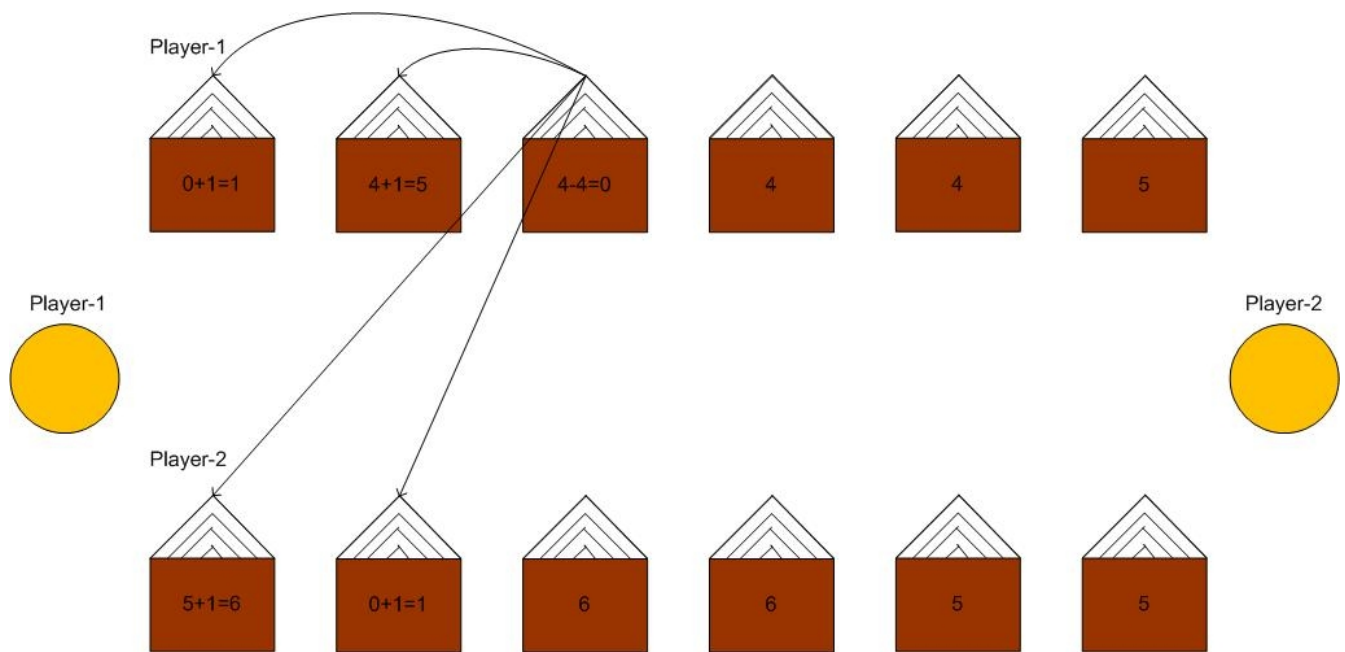


Figure 13. After the third move of an Owari game.

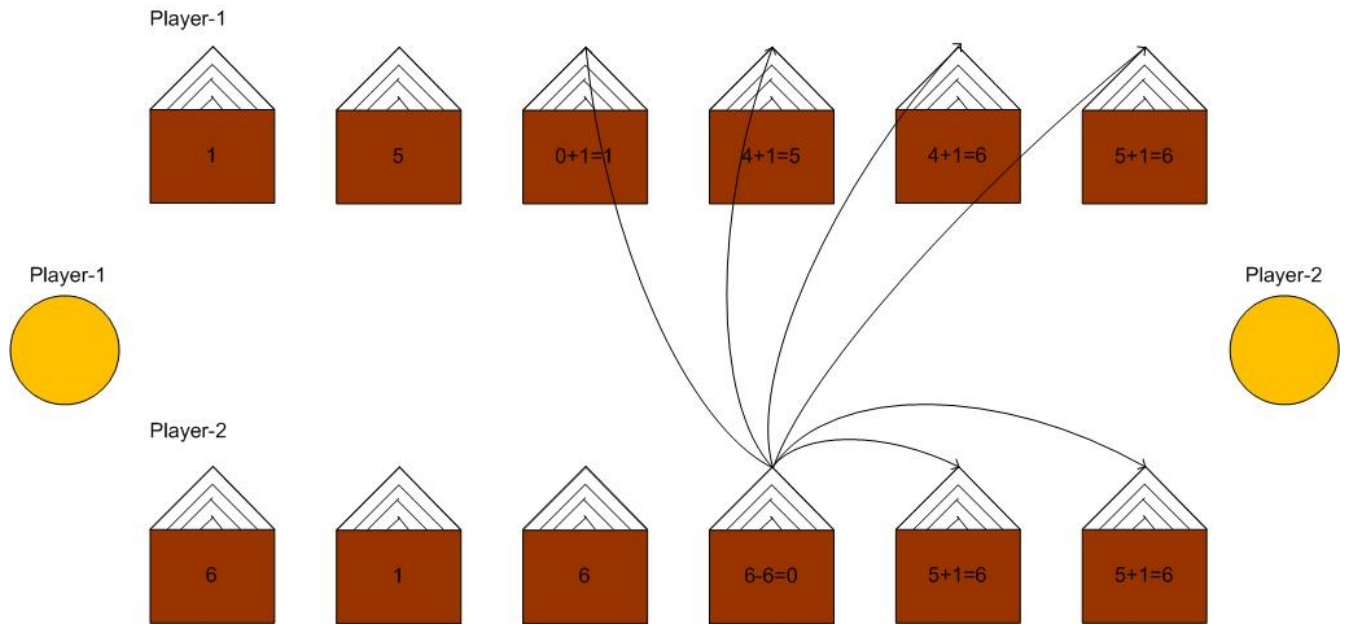


Figure 14. After the fourth move of an Oware game.

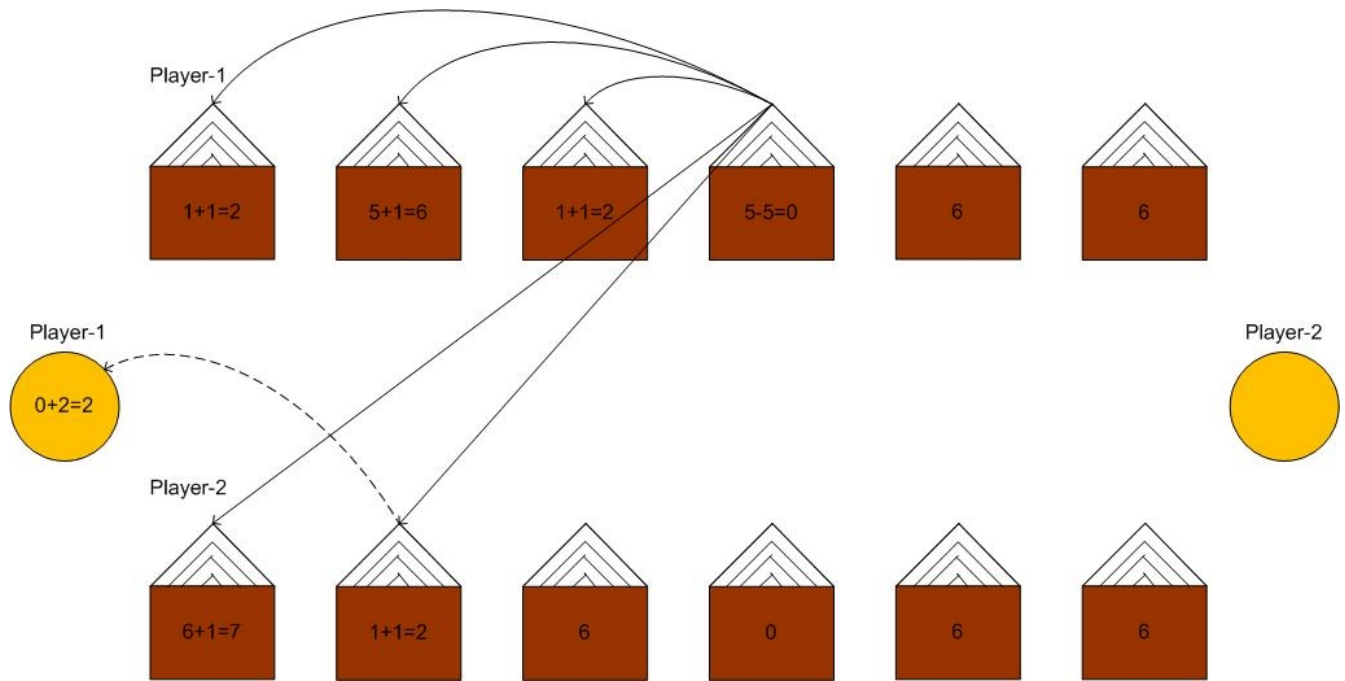


Figure 15. After the fifth move of an Owari game.

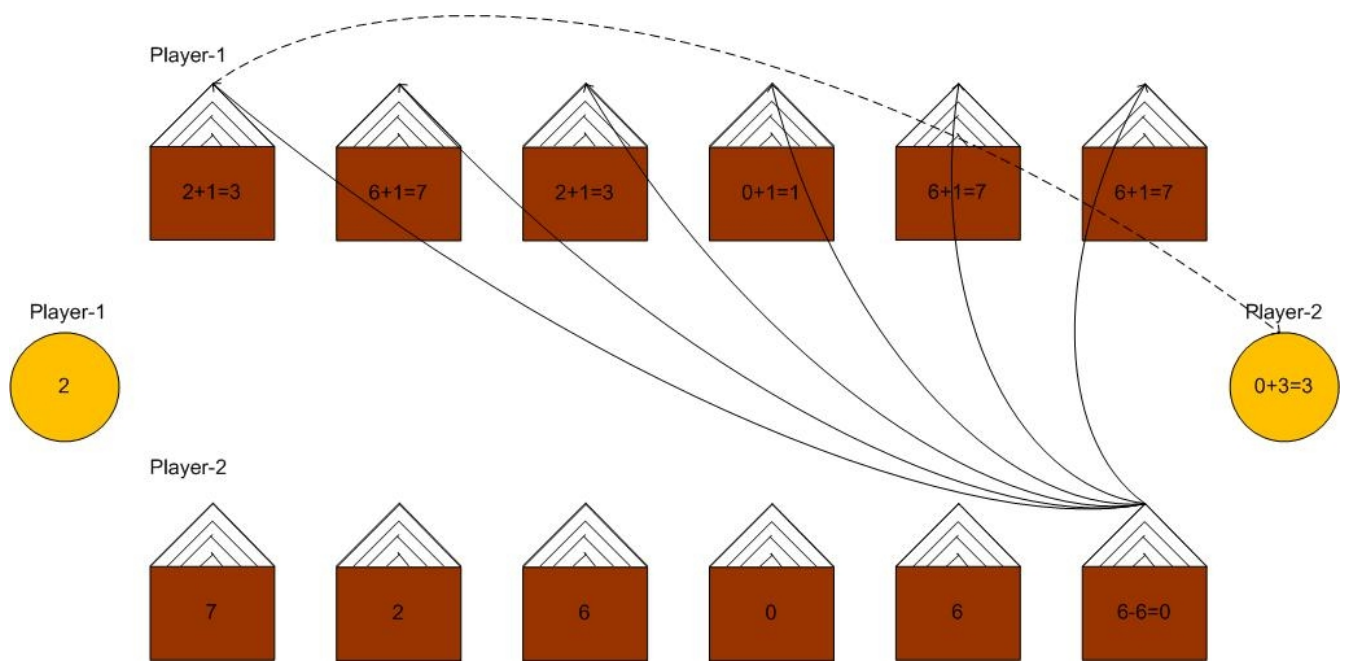


Figure 16. After the sixth move of an Owari game.

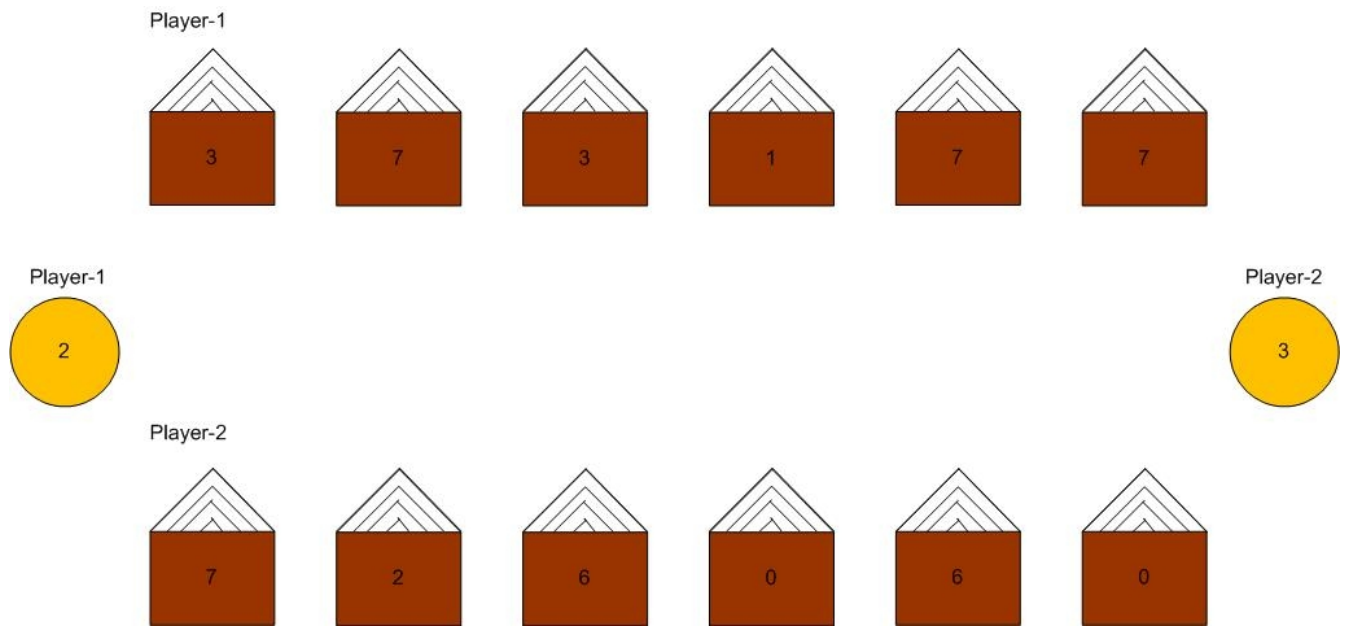


Figure 17. After the seventh move of an Owari game.

Anansi the Spider

The Anansi the Spider is the character within the most well-known collection of stories in Ghana. The Anansi stories are well-known in many other parts of Africa and the world (cf. <http://en.wikipedia.org/wiki/Anansi>). Anansi is a trickster. The stories are traditionally told within family settings, such as those described in our market analysis for Ghana. Beside entertainment, they are meant to teach children moral lessons. The advantage of using the Anansi stories as the basis for computer-aided learning is that they are well-known in Ghana and could, thus, provide a cultural bridge to the TVC. There are also many stories in the collection, thus, raising the possibility of a series of related story games.

One well-known example of these stories is *Anansi and the Baboon*. One rendering is given as follows:

Ananzi and the Baboon

ANANZI and Baboon were disputing one day which was fatter. Ananzi said he was sure he was fat, but Baboon declared he was fatter. Then Ananzi proposed that they should prove it. So they made a fire, and agreed that they should hang up before it, and see which would drop the most fat.

Then Baboon hung up Ananzi first, but no fat dropped.

Then Ananzi hung up Baboon, and very soon the fat began to drop, which smelled so good that Ananzi cut a slice out of Baboon, and said;

“Oh! Brother Baboon, you’re fat for certain!”

But Baboon didn’t speak.

So Ananzi said:

“Well, speak or not speak, I’ll eat you every bit to-day.” — which he really did.

But when he had eaten up all of Baboon, the bits joined themselves together in his stomach, and began to pull him about so much that he had no rest, and was obliged to go to the doctor.

The doctor told him not to eat anything for some days; then he was to get a ripe banana and hold it to his mouth; when the Baboon, who would be hungry, smelled the banana, he would be sure to run up to eat it, and so he would run out of his mouth.

So Ananzi starved himself, and got the banana, and did as the doctor told him; but when he put the banana to his mouth, he was so hungry he couldn’t help eating it. So he didn’t get rid of the Baboon, which went on pulling him about till he was obliged to go back to the doctor, who told him he would soon cure him. He took a banana and held it to Ananzi’s mouth; and

very soon the Baboon jumped up to catch it, and ran out of his mouth; and Ananzi was very glad to get rid of him. And Baboons to this very day like bananas.

— Recorded by Sir George Dasent.

(Source: <http://www.elfinspell.com/WitandHumor/14Ananzi.html> . From “West Indian Negro Wit and Humor” IN *The World’s Wit and Humor, Vol. XIV, Russian, Scandinavian, and Miscellaneous Wit and Humor*; The Review of Reviews Company; New York; 1906; pp. 284-290.)

We explored ways in which Anansi stories might be adapted to a computer-based setting. We designed a first version of a game based on *Anansi and Baboon* using collaborative design techniques. Our research indicates that there are a number of general models for designing such games. We will explore these indepth in the future. The method we developed was to decompose the narrative to give the player decision points related to the character dialogue. One flow would render the original plot of the story. Other paths would yield alternate lessons. We also found in this particular story that the orders from the doctor to Anansi to fast for three days opened the possibility for iteration with critical judgment points at each stage. In this case, the player can be given the choice to fast for another day or to eat. The player must face certain consequences for deciding to eat early. State diagrams for a first version of our game is given in *Figures 18* through *26*.

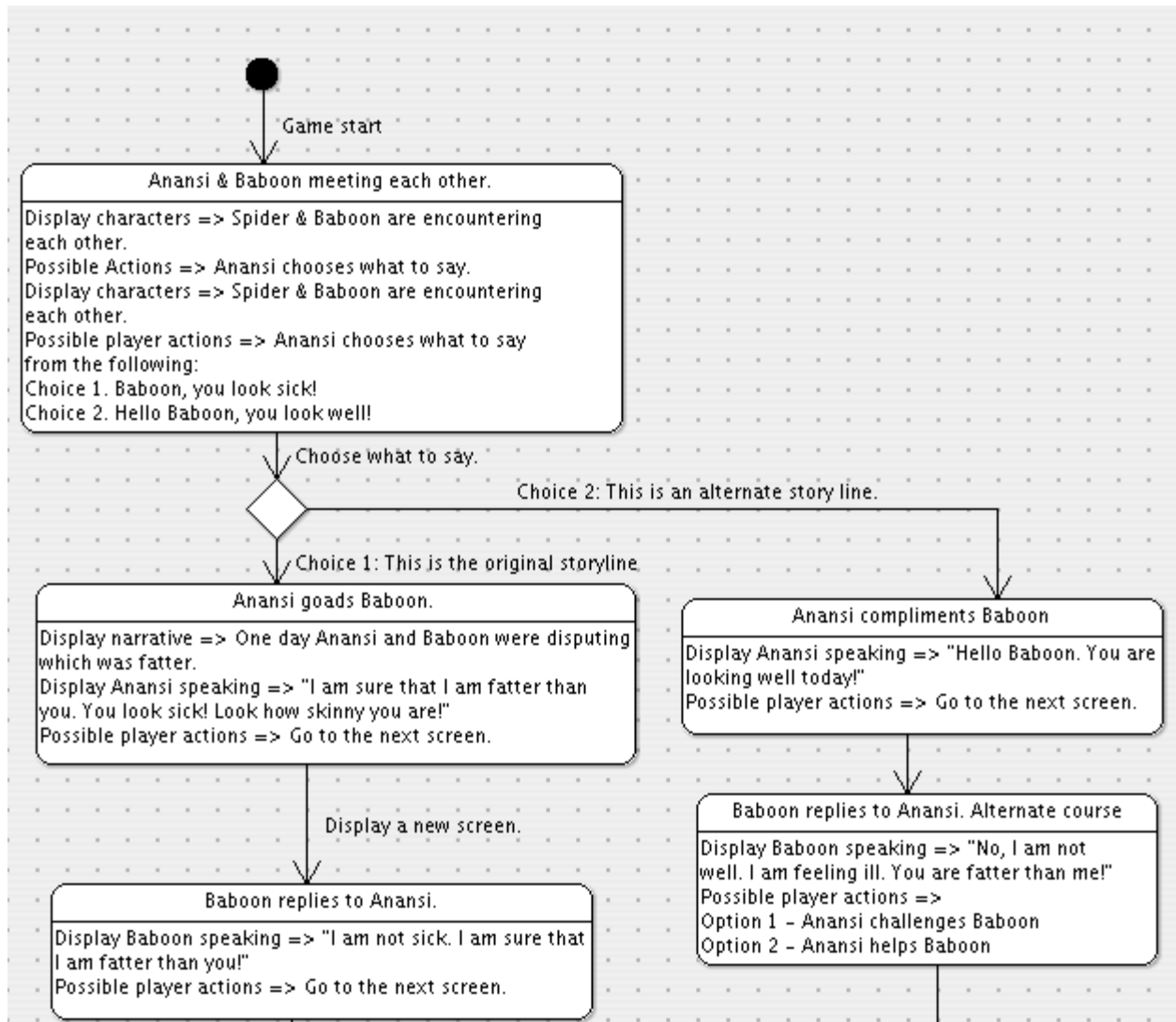


Figure 18: Anansi state diagram.

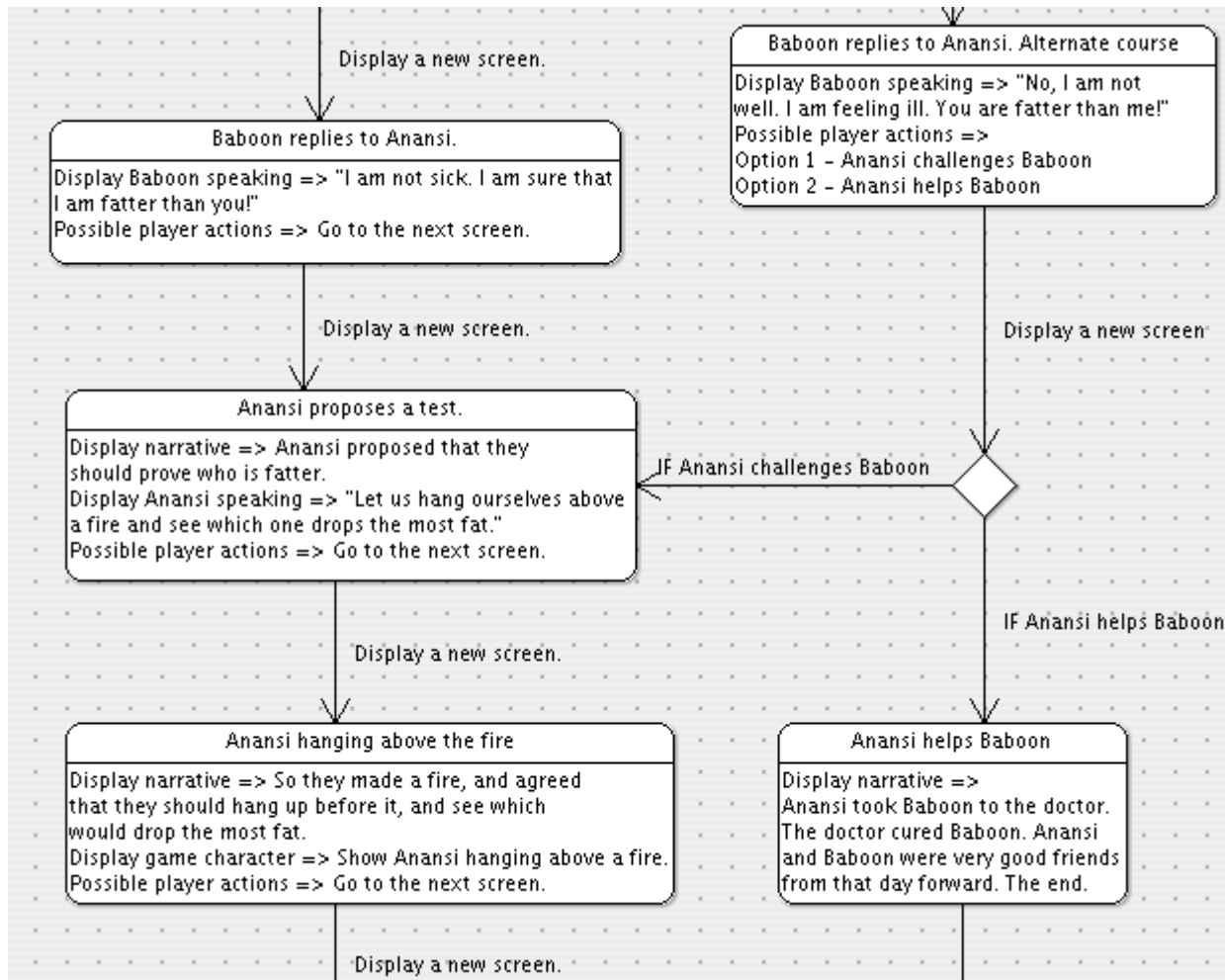


Figure 19: Anansi state diagram (continued).

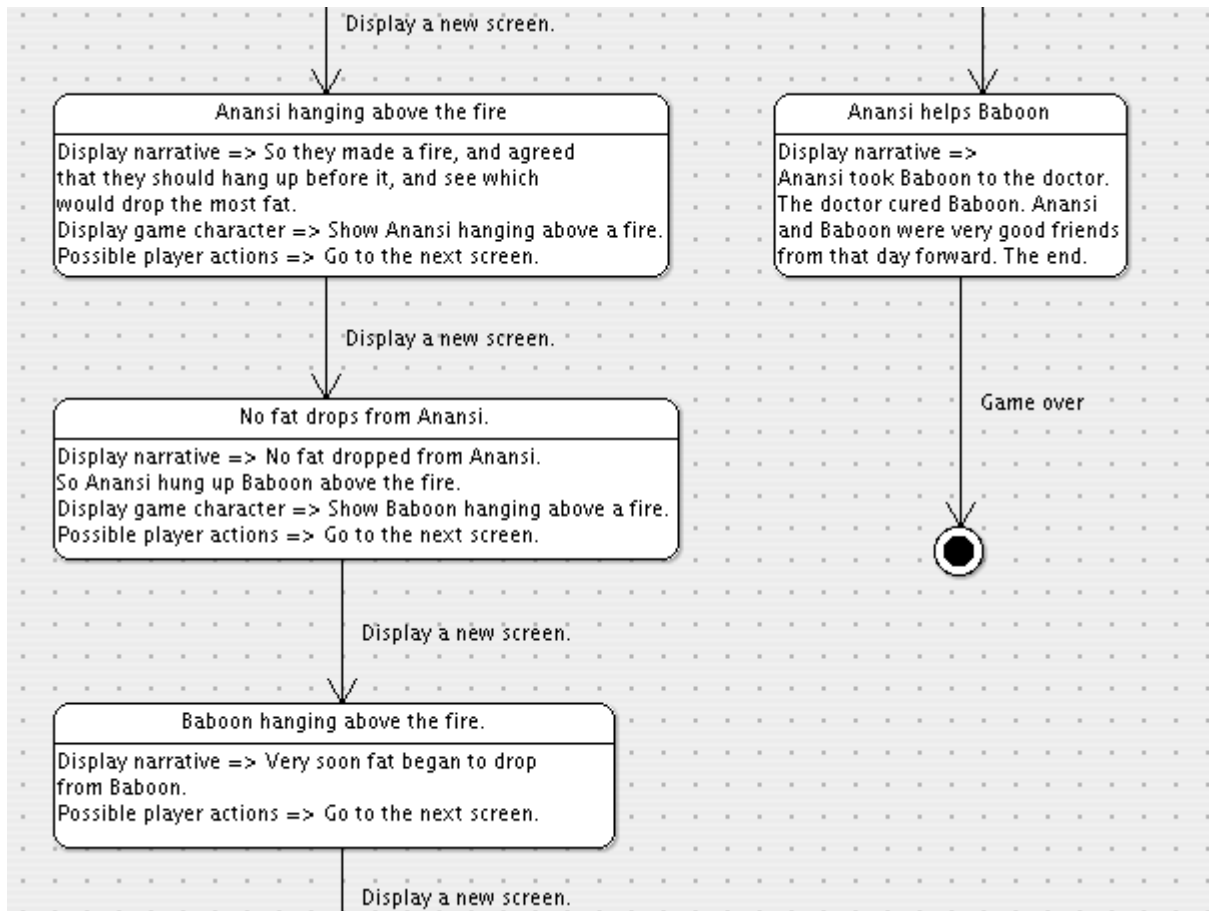


Figure 20: Anansi state diagram (continued).

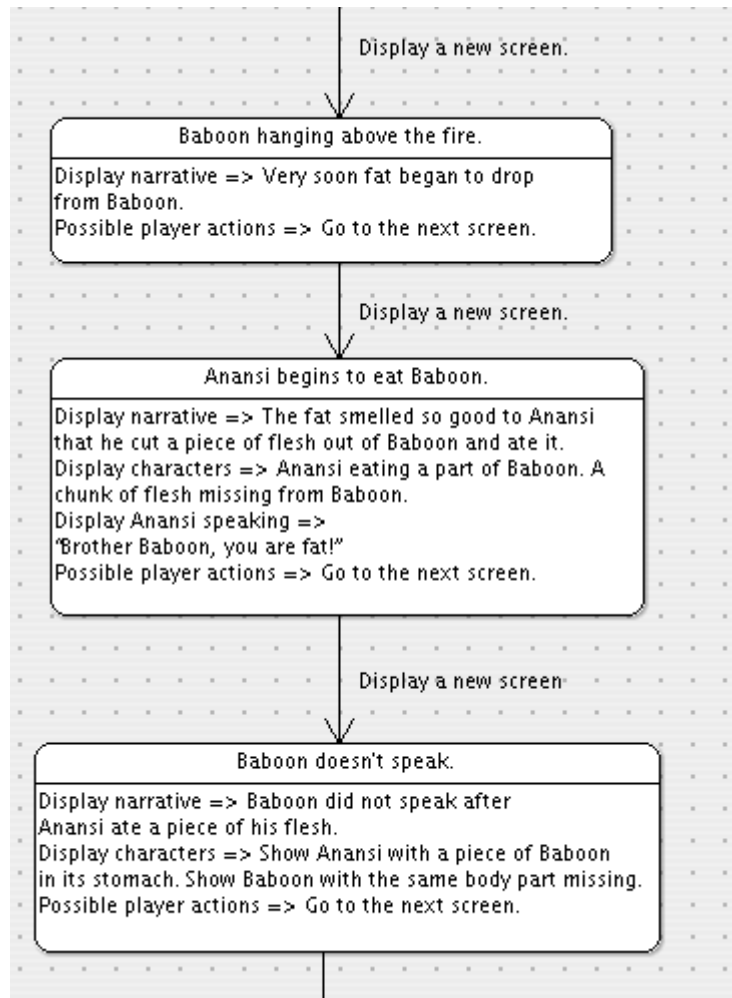


Figure 21: Anansi state diagram (continued).

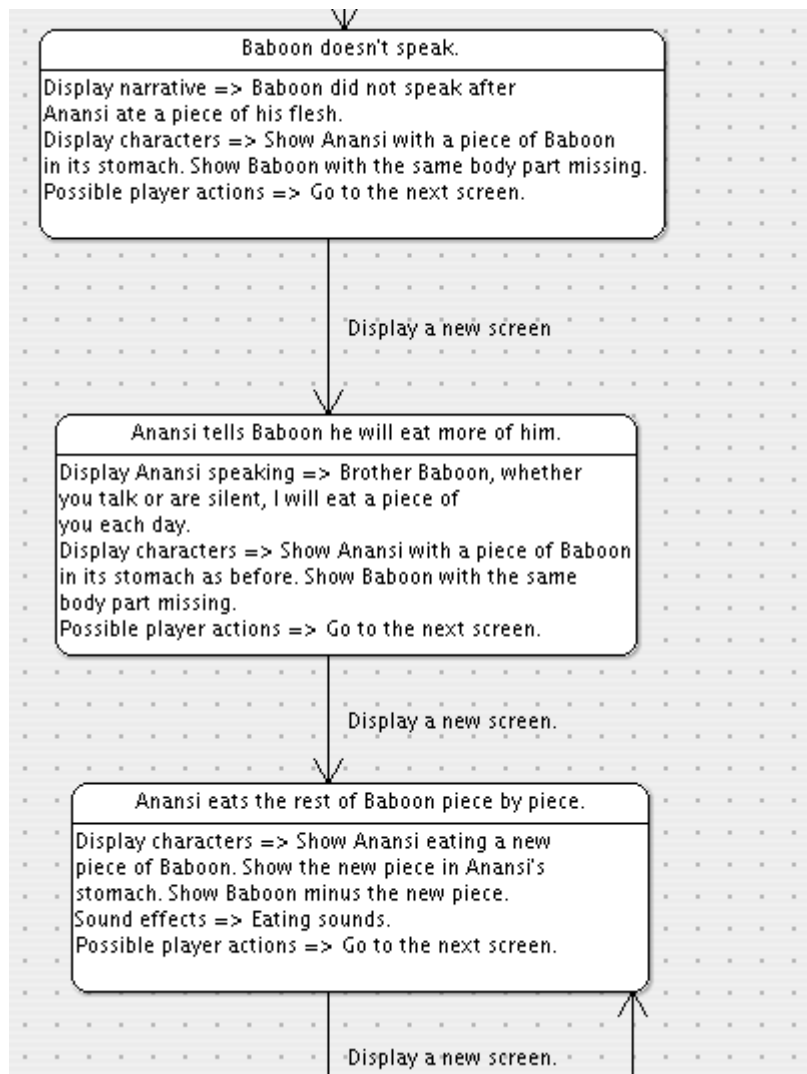


Figure 22: Anansi state diagram (continued).

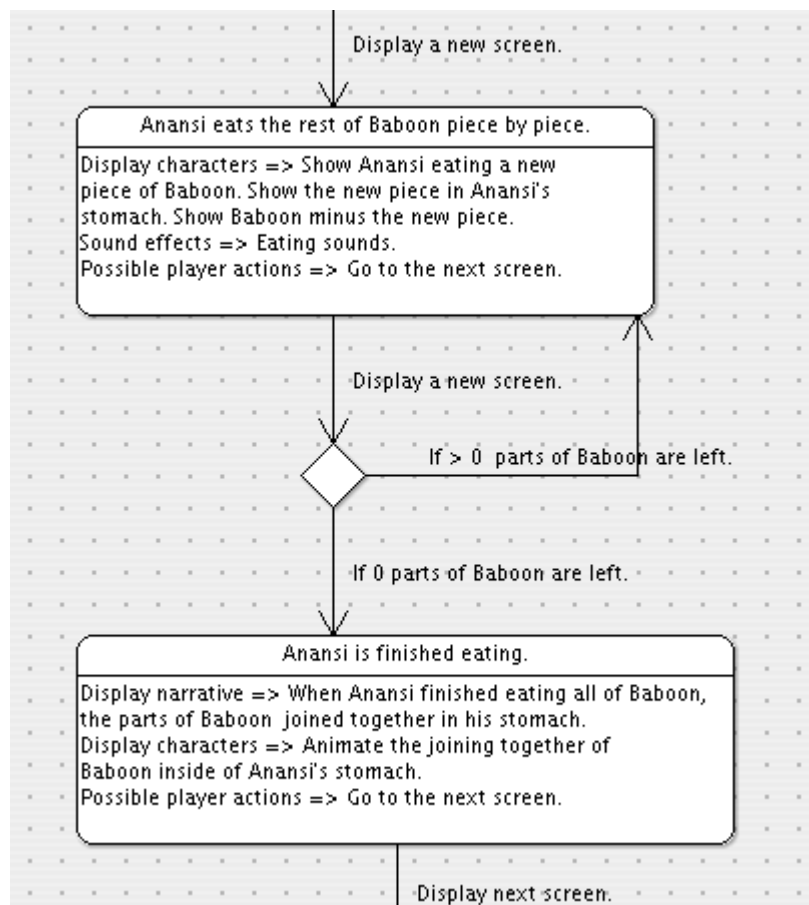


Figure 23: Anansi state diagram (continued).

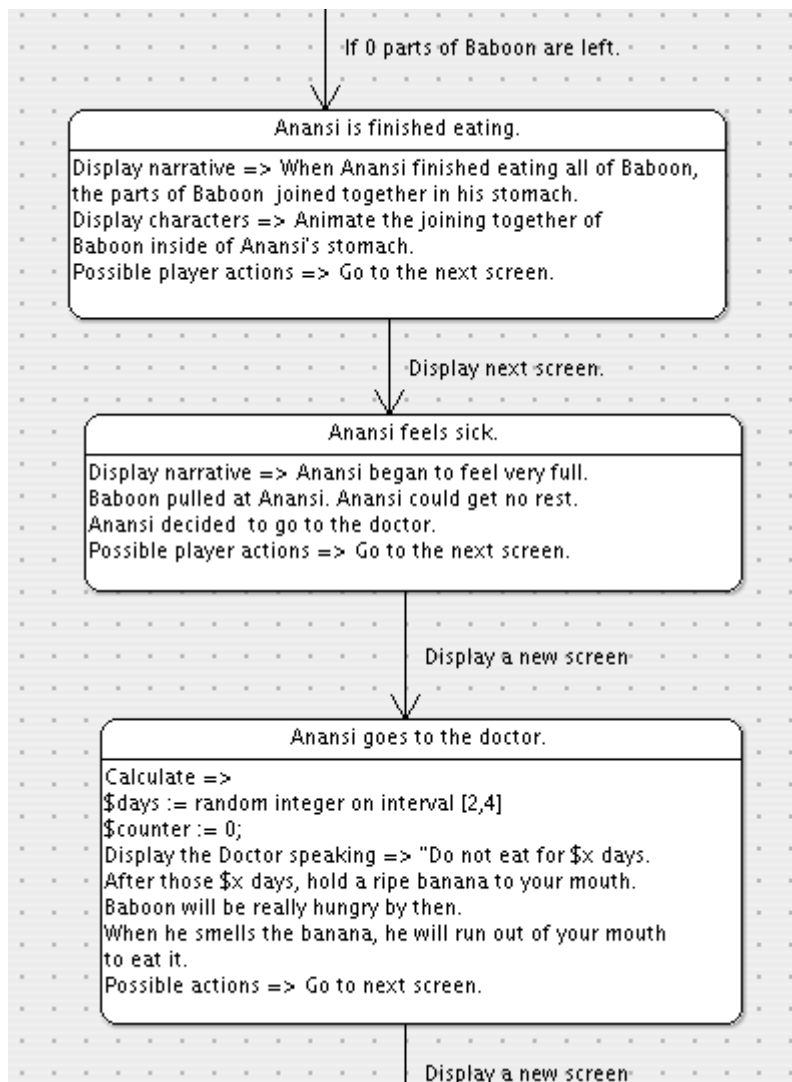


Figure 24: Anansi state diagram (continued).

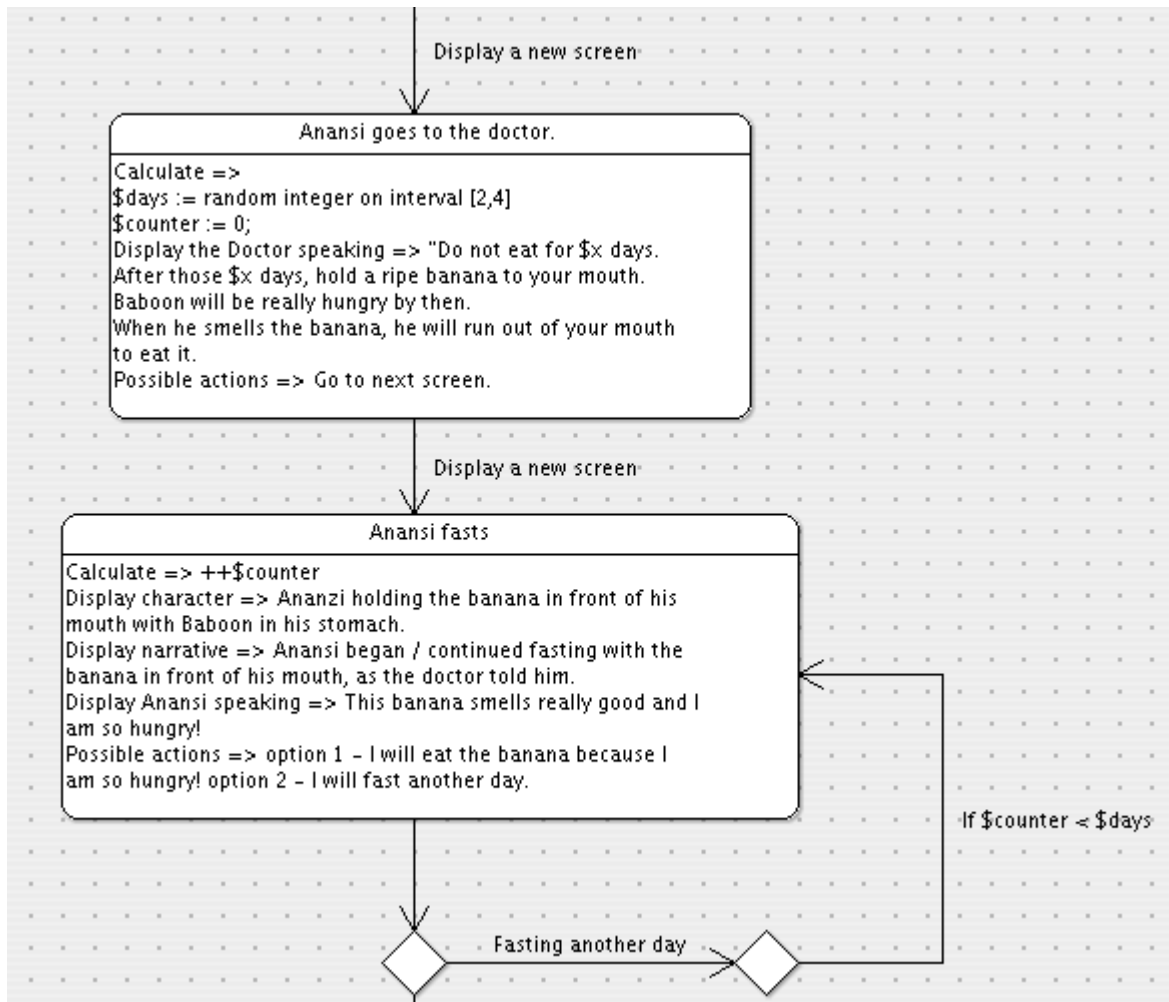


Figure 25: Anansi state diagram (continued).

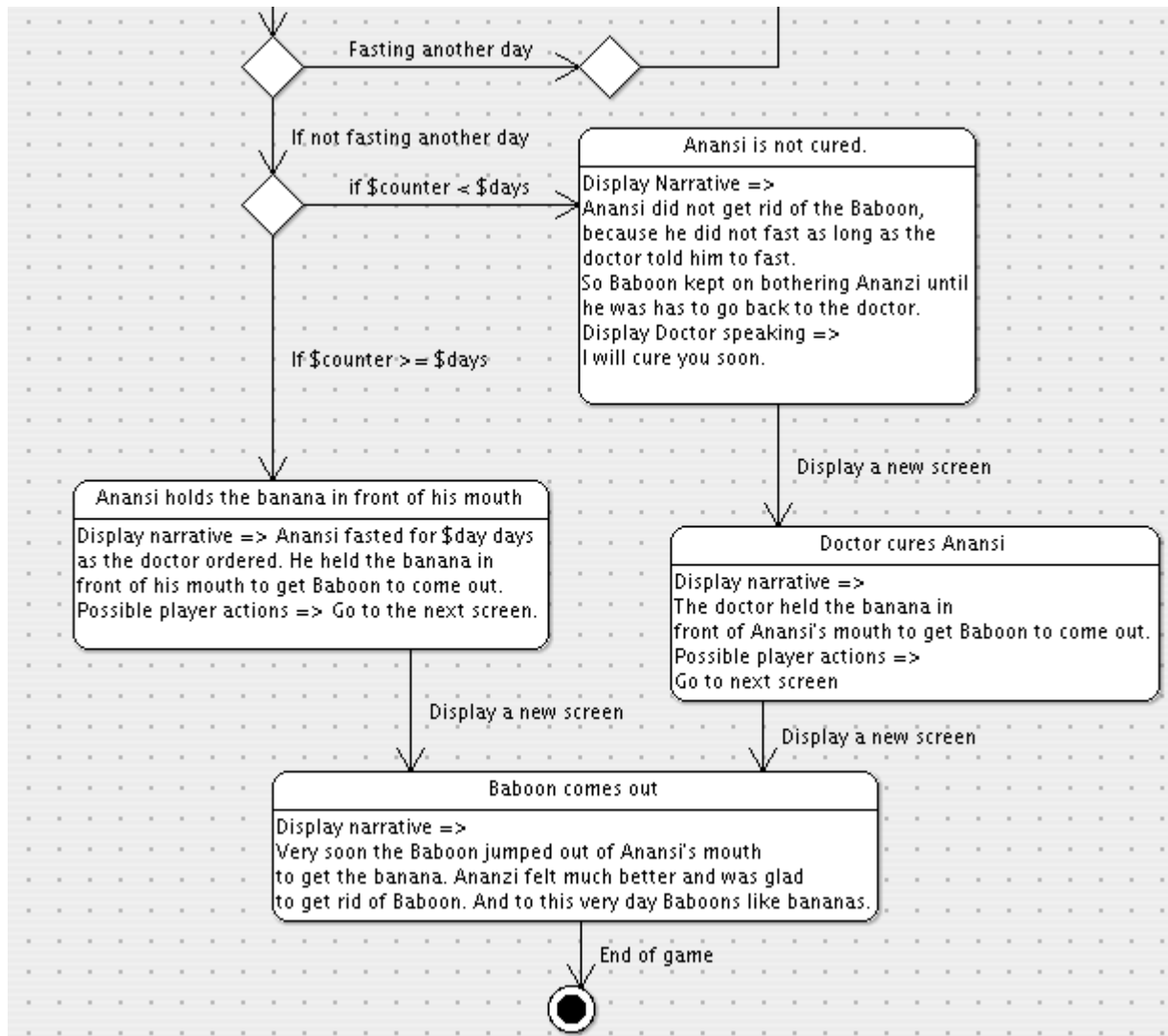


Figure 26: Anansi state diagram (continued).

5 Software Development for the TVC

Tools and other resources

Many tools and documentation for the TVC were identified during IDDS 2008. These include:

- The primary resource we used was Bob Rost's website (<http://bobrost.com/nes/>). He taught a course in programming for NES at CMU.
- NES emulators are used to run software as its being developed. Many are available for a variety of platforms, including Mac OS X, Windows, and Linux.
- We used NES emulator - Jnes for Windows (<http://jabosoft.com/?categoryid=3>)

- The programming language NBasic can be used to write programs. This is a language developed by Bob Rost (c.f. http://bobrost.com/nes/files/nbasic_manual.html).
- Nbasic programs must be translated into assembly language which must then be translated into machine language (c.f. http://bobrost.com/nes/files/nbasic_2004_03_14.zip).
- Some useful nbasic code samples are here: <http://bobrost.com/nes/resources.php#demoroms> .
- Music can be developed for the TVC using MML using the PPMCK compiler (c.f. http://www.neonempyr.org/ppmck_guide.html).

Software development process

- Write the nbasic source code in any text editor. Save the file using a `.bas` extension. We used the Crimson text editor (c.f. <http://www.crimsoneditor.com/>).
- To compile and assemble the `.bas` file type the following command `nbasic filename.bas -o filename.asm` at the command prompt. This command will generate the assembly file named `filename.asm` (Tip: One can create a `.bat` file with this same instruction to perform the operation from Windows.)
- Type the command `nesasm filename.asm` to generate a `.nes` file
- Run this `.nes` file in your NES emulator to see the output. Typically this is done by opening the file via the *File* menu of the emulator.

Creating cartridges

Creating cartridges is relatively simple. It requires that the assembled software be “burned” onto an EEPROM chip. This is done using an EEPROM burner device attached to a PC. Software specific to the EEPROM burner is then used to transfer data to chips. The cartridge case is then assembled to contain the EEPROM chip for use with the TVC. One compatible EEPROM burner we identified was the: *SuperPro-Z 40 Pin Low Cost Universal Programmer*. This sells for about \$250 USD (c.f. <http://www.xeltek.com/product.php?productid=16225>).

6 Hardware enhancements

As discussed in *Section 1*, a number of hardware enhancements are necessary for turning the TVC into a fully functional computer. The minimum enhancements we wish to perform are:

- Adding flash memory to the cartridge;
- Adding data communication capabilities.

Our research during IDDS 2008 indicates that both enhancements can be achieved with relative ease. We did not have sufficient time to implement these features, but identified specific resources and approaches that might be used.

Flash memory enhancement to TVC

Ideally a user would be able to save to a flash memory chip in the cartridge. There has been some work to use flash cards to store multiple games on one cartridge. However, it is was an open question at first whether we could save a BASIC program or other data on a flash memory device.

Several system for saving BASIC programs and other content on the Famicom was implemented in the 1980s. Music compositions, etc. One such system was the Famicom Data Recorder, a cassette player/recorder that plugged into the TVC via 1/8 inch headphone jacks. Another system was the Famicom Turbofile II by ASCII. This was a "memory card" which was compatible with some of ASCII's Famicom games. See Figure 27. The switch on the left selects which of four memory banks you want to use and the switch on the right is a "write protect" (c.f. http://superfami.com/fc_turbofile.html).



Figure 27: One memory system for the Famicom.

Additional resources are here:

- Documentation for the creation of flash cartridges: <http://ameba.lpt.fi/~hataarto/nes/> and a discussion about this: <http://arstechnica.com/journals/thumbs.ars/2006/3/22/3291>
- Flash Based Cartridge sources: <http://www.retrousb.com/index.php?productID=133> and a discussion about them <http://www.vintagecomputing.com/index.php/archives/340> .
- Tools for NES hacking, including flash cartridges <http://www.retrousb.com/index.php?categoryID=86> .

Adding data communications capabilities to the TVC

At least one type of modem was developed for the Famicom. According to Famicom World (http://www.famicomworld.com/Shrines/Holy_Grails_Intro.htm):

In 1987, Nintendo attempted a bold feat: It wanted to link all of Japan's Famicoms through a complex network much like an amateur version of today's internet. "

According to N-Sider (<http://www.n-sider.com/contentview.php?contentid=213>):

"In 1988... president Hiroshi Yamauchi and Nintendo set about becoming a "communications" company and establishing its own "internet". The Nintendo Famicom would attach to an approximately \$100 priced modem called a "Communications Adapter" - developed by Masayuki Uemura's R&D 2 team - and into a phone line. This connection created the "Family Computer Communications Network System". Using a simple cartridge, the Famicom was essentially turned into an online enabled game system."

A 1989 advertisement for the use of the 'Famicom Internet' to make banking transactions can be viewed here: <http://www.youtube.com/watch?v=c5aErhrhqXs> .

Additionally, the Famicom Tsushin (communication) system allowed users to dial up at 2400 bps and connect to a value added network run by Nintendo and NTT. A user could check stock prices, horse race results, and send email. It was not very popular (c.f. <http://superfami.com/famitsushinsystem.html>). See *Figure 28*.



Figure 28: The Famicom Tsushin modem.

Finally, we located information about the Nintendo DATASHIP 1200. One quote about the product is (source: http://www.lingjr.com/collection_nin_fc_nes.htm):

But from description of it's manual, it should be some kind about TELE-BANKING & STOCK-MARKETING console, the ACCESS CARD comes with the DATASHIP 1200 made by a famous bank in Japan...it seem different ACCESS CARD for different service?

This package comes with those items : DATASHIP 1200, Communication controller, a.c.adaptor, signal switcher, ACCESS CARD, Manual & paper works, Original packing, Modem cable & AV Cable.

One approach that appears to be promising is the development of a device using a < \$10 IC Modem, which are now available (c.f.

http://semiconductors.globalspec.com/LearnMore/Semiconductors/Communications_RF_Wireless_Chips/IC_Modems?SrchItem=1&frmqry=ic+modem&kqid=93966309). An existing phone could then be used. Many phones have data pin-outs at the base of the phone. The phone might be attached to the machine under this approach via the cartridge interface.

Use a <\$10 IC Modem and plug a 1/16th inch headphone jack into any mobile phone. This way the computer could transfer data over the phone lines at >28kbps.

Robustness

Additionally, the TVC must be made more robust. We will explore this in future work.

Cradle-to-cradle concerns

A new TVC should not contribute to the environmental damaged caused today by computer equipment. It should be designed from a Cradle-to-Cradle perspective (McDonough and Braungart, 2002). This would entail the development of an end of life process for the TVC by which its components would be collected and reused or disposed of in an environmentally friendly fashion.

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- The Game Laboratory <http://gamelibrary.com/>
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