An Early Danish Computer Game

The Case of Nim, Piet Hein, and Regnecentralen

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Abstract: This paper reports on the development of Nimbi, which is an early computer game implemented at the Danish Computer Company Regnecentralen in 1962-63. Nimbi is a variant of the ancient game Nim. The paper traces the primary origins of the development of Nimbi. These include a mathematical analysis from 1901 of Nim that "killed the game" as the outcome could be predicted quite easily; the desire of the Danish inventor Piet Hein to make a game that eluded such analyses; and the desire of Piet Hein to have computers play games against humans. The development of Nimbi was successful in spite of considerable technical obstacles. However, it seems that the game was not used for publicizing the capabilities of computers – at least not widely – as was the case with earlier Nim implementations, such as the British Nim-playing computer Nimrod in 1951.

Keywords: Computer game history, Piet Hein, Nim, Regnecentralen, Nim.

1. Introduction

On 9 July in 1962, Regnecentralen in Copenhagen employed Søren Lauesen, a nineteen-year old mathematics student. Søren Lauesen – now professor and my colleague – recently told me about his first project: The development of a computer program playing a variant of the ancient game Nim. Before I embark on the story let me introduce the other players: the French-American mathematician Charles L. Bouton, the British game playing computer Nimrod, and the Danish inventor and poet Piet Hein.

2. Nim and its Players

The game Nim has been played since ancient times. Its origin is obscure, but some hold that it originates in China [12]. The game is simple:

> *"Initially we have any number of heaps, each containing any number of tokens (usually matches). In the simplest form, two contestants play alternately, and may pick up as many matches as they wish at one time from one pile, but they must take at least one match. The aim is to avoid taking the last match of all*[1]*."* [2, 304].

[1] In another version the player who takes the *last* token wins.

The game has two definite advantages. Firstly, we can play it with almost any object (stones, matches, coins etc.) and in any numbers. Secondly, in spite of its basic simplicity, it remains intellectually challenging even for experienced players as the complexity can be increased by adding heaps and/or tokens.

In 1902, the French-American mathematician Charles L. Bouton of Harvard University published an in-depth mathematical analysis of the game, based on binary numbers [1].

> *"It is the writer's purpose to prove that if one of the players, say A, can leave one of a certain set of numbers upon the table, and after that plays without mistake, the other player, B, cannot win. Such a set of numbers will be called a safe combination"* [1, 35].

Bouton succeeded and provided a simple method that enabled players to analyze the game. By conceiving the heaps as binary numbers and applying a simple adding rule, the player can easily tell whether a position is safe or not. This contrasts the earlier state of affairs, where an experienced player could overview only simple Nim games with relatively few heaps and tokens.

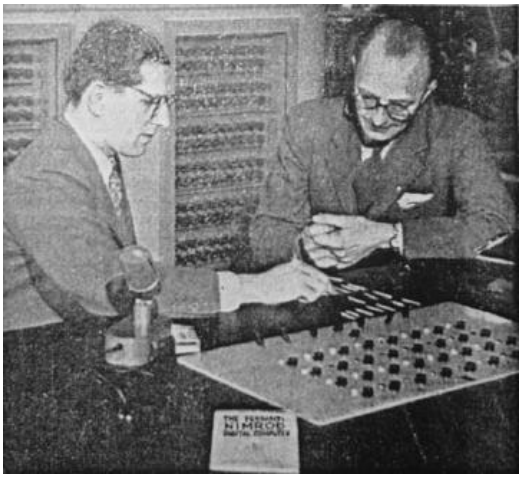

Figure 1: The game board of Nimrod, the Nim-playing computer

In 1951, the British computer company Ferranti developed the Nim-playing digital computer Nimrod, see Figure 1.[2] Nimrod was designed to illustrate the principles of automatic computers in general and was the first computer exclusively designed to play a game [2, 201]. Nimrod appeared for six months at the Exhibition of Science during the 1951 Festival of Britain in London and took on all comers [2, 286]. It was later on display at the Trade Fair in Berlin. Germans had never seen anything like it and came to see it in thousands. It was necessary to call out special police to control the crowds. The machine became even more

[2] From http://jwgibbs.cchem.berkeley.edu/nimrod/desk.html

popular after it had defeated the Economics Minister Dr. Ludwig Erhardt in three straight games [2, 287].

As to Bouton's work, the Danish poet, inventor, and mathematician Piet Hein was put off by it:

> *"Bouton's thorough analysis of the game, that instantly in principle destroyed the ancient game, called for a response ... that could reestablish the lost dignity as an unbeaten game."* [6, 5].

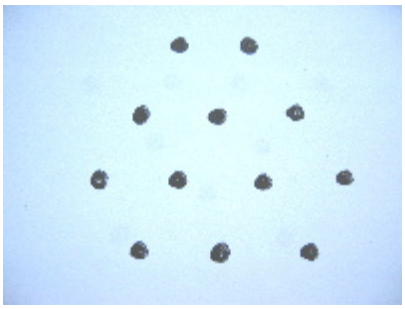

Figure 2: The layout of the Nimbi game

Piet Hein even referred to Bouton's work as the "murder on Nim" [5]. Piet Hein intended to create a variant of Nim that would bring the game beyond such analyses while retaining the simplicity of the game. He succeeded in 1945, see the game board in Figure 2 [6]. Note that each token is a member of three lines (laterally, diagonals up-left and up-right) and how the shape is a triangle with the corners cut off. The rules of Nimbi are the following:

> *"A move consists in removing one or more tokens from the board. If more than one token are removed, they must be consequtive on the same line. The one removing the last token has lost."* [5]

This game was published in an article in Scientific American in 1958 [4] and has been the subject of mathematicians' analyses under the name Nimbi [3].

3. The Development of the Computer Game

Since the invention of the game in 1945, Piet Hein had a dream of programming a computer to play the game against humans. This dream came nearer when Norbert Wiener introduced Piet Hein to Niels Ivar Bech, head of Regnecentralen. This happened when Norbert Wiener stayed in Piet Hein's home in Rungsted the preceeding summer while finishing the book God and Golem, Inc.

> *"The game problem appealed immediately to Bech's taste for diverse tasks, to create a meeting place, where non-professionals could get contact, even dialog, with a computer and get a convincing direct impression of (a minimum) of computers' level of intelligence".* [5]

The game was so complex that Piet Hein did not know how to make a winning strategy, so he thought that computers could be useful here [10]. Søren Lauesen was asked to develop this game only one week after his employment. The project began in July 1962 and was completed in August 1963 with close collaboration between Søren Lauesen and Piet Hein. The game was implemented on the Gier computer, the first transistorized computer developed in Denmark [7]. The development entailed many challenges, among these the central game algorithm, the input/output, and the board representation in Gier.

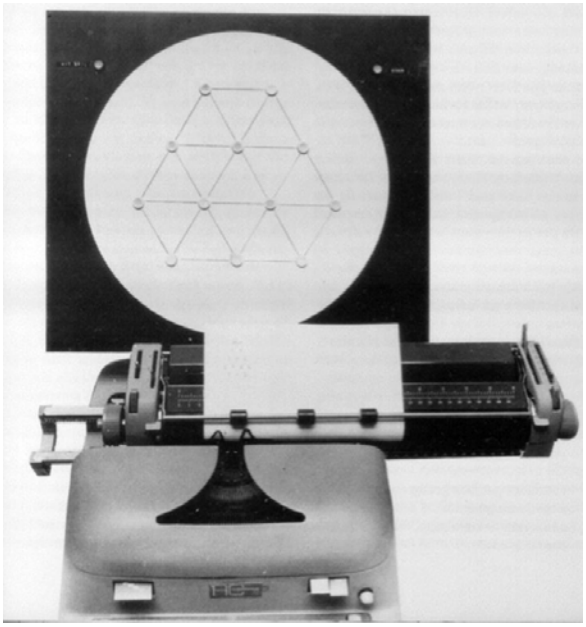

Figure 3: The Gier Nimbi game board and the IBM console

The heart of the game is the data structure representing the game and the algorithm enabling analysis of positions and moves. Søren Lauesen reported that after several days of pondering on how to find the right move in a given situation, the solution dawned to him on a ferry crossing the Great Belt. It is based on a mathematical analysis with safe positions.

The input/output was designed as a 2+3+4+3 hexagon board, see the Figure 3.[3] The tokens were buttons with lights that players could press when human players made their moves. Søren Lauesen reports that there were extensive discussions with hardware engineers on this issue.

Another major design problem was how to represent the 12 board positions in Gier. This was handled by letting bits 28-39 in the multiplication register represent

[3] From http://www.datamuseum.dk/site_dk/rc/NIB/kap19.shtml

the positions as on/off. This special solution evidently implied writing the program without multiplications!

The final program was but a mere four pages of Gier assembly code and four pages of tables [8]. In addition to playing the game, the program also provided a log of the game played, printed on the typewriter. If a game was interrupted, the program could tell if it was theoretically possible to win the game [9].

4. Perspectives

We now discuss two wider aspects of the development: the role of games in computer publicity and the synergy between computers and games. The predecessor of the developed Nim game variant, Nimrod, created much publicity for Ferranti and for computers in general in 1951. According to Piet Hein's son Hugo Piet Hein, Regnecentralen did use the computer game for promotional purposes. However, it did not seem to have attracted significant interest by the public. In 1951, computers were strictly confined to highly specialized calculation tasks in specialized application domains that were unknown to the public at large. Ten years later, that picture had changed somewhat, even in Denmark. Apart from the general increase in public awareness, computers gained much public exposure when Regnecentralen provided successful computer support for the Danish parliament election on 15 November 1960, which was broadcast on television [11]. This publicity aspect had an interesting side effect. When Regnecentralen brought up the question of charge for the development expenses, Piet Hein allegedly opposed it. He argued that Regnecentralen had to see the game as a publicity opportunity.

Games have always fascinated people and computers have played a major role here in the last decades. The Nimrod and Piet Hein's Nim variant are early examples of computer games simulating traditional board games such as tic-tac-toe, draughts, and chess. Later, simple computer games in their own right appeared such as Space War and Pong. These games utilized the graphical and interactive capabilities of later computers. In the next decades, computer games underwent an immense growth technically, culturally, and financially. Computer games have evolved into a set of genres of its own–from simple strategy games like Tetris and PacMan to game worlds such as Civilization, Everquest and World of Warcraft. These are rich digital societies that mirror real life in many ways – probably far beyond the imagination of the creators of the early computer games of the 1950s and 1960s.

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