BOARD GAME STUDIES

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Centro Inter-Universitário de
História da Ciência e da Tecnologia
(CIUHCT)

Published by

Evolution for games

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Abstract: *The function-focused model of biological evolution is applied to board games studies. After a brief survey on the recent framework of evolution, a comparison between biological systems and games is performed. "Life" and "death" are defined, together with the application of the concept of "random change" and "competition". When applied to games, the evolutionary model seems to robust enough.*
Keywords: Software; Rules; Mutation; Competition; Complexity

Introduction and reported evolutionary studies of games

The extension of concepts from one field of the science to another one is a powerful source of inspiration. However, these extensions must be always carefully controlled, since free analogies could lead easily to incorrect conclusions. In this respect, the concept of "evolution" has gained an increasing success from the early works in the middle of the 19th century. It has been widely applied to several processes that change over time, even in common life and in current speeches, but not always properly.

Many works focused on the production of game variants in general (Schmittberger, 1992), and Chess variants in particular (Pritchard, 1994), (Duniho, 2005), (Neto, 2005), since Chess is the abstract game that has been most studied during the centuries. However, in these works, the concept of "evolution" was not clearly stated. For example, the term "ludeme" was used by Parlett (1990), that credited it to Borvo and Berloquin (Parlett, private communication). It was modelled on the words "ludus" and "gene" and indicates the characteristic game elements, as a clear analogy with the biological gene. Neto preferred the word "mutator", that describes better the action of his operators (Neto, 2005). Furthermore, some phylogenetic maps were drawn by Eagle (1998) and Voogt (Voogt, 1999), to rationalise

the plethora of Mancala games, but some difficulties were observed. For example, these games evolved from ancestors having sometimes easier rules and sometimes more complex rules (Voogt, 1999).

Two case studies confirmed these difficulties.

(a) Race games

Race game is a typical instance of a development of an idea along the time. In these games, the winner is the player who firstly arrives to a finish line (Parlett 1999). In the oldest type of these games (*Hyena game*, or *Mehen*), pegs were moved according to the toss of some randomisation devices (dice, sticks, and so on). In the *Game of Goose*, or in *Snakes and Ladders*, eventualities could occur in some spaces of the track and alter the outcomes deriving from the simple toss of the dice. In *Ludo* and *Parcheesi*, the race game was enriched by the possibility of capturing opponent's pieces. In *Malefiz*, players had to manage (to overcome or to place) barriers. In recent games, such as *Hare and Tortoise*, *Cartagena*, or *Die Oster Insel*, the progress of the pegs was determined mainly by a strategic management of the players' resources, with marginal element of luck.

The development of these games along the centuries seems to be the limitation of randomness and the involving of the players' skill. However, nowadays *Games of Goose*, *Ludo* and *Ludo*-like games, such as *Rüssellbande*, are still commonly played, together with the other ones, that require a higher skill degree.

(b) Connection games

Hex is a connection game that was proposed independently by Hein in 1942 and by Nash some years later. It is played on a rhombic board made up of hexagons. Two players in turn put one of their pieces on an empty hexagons on the board and attempt to connect two opposite sides of the board. Complex strategies arise from these simple rules, and a general winning strategy is unknown (Browne, 2000).

Hex is the precursor of several different connection games (Browne, 2005). For example, *Bridg-It* was proposed in the early 1950s by Gale, and by Schensted and Titus. The game is topologically equivalent to the Shannon's "*Edge-Switching game*" (Browne, 2005). It was abandoned when a pairing winning strategy was found. On the other hand, an unsolved and successful connection and blocking game is *Twixt*. The *Game of Y* was proposed in the early 1950s, by the same Shannon and by Schensted and Titus.

The game is played on a triangular board tiled with hexagons, with the goal of establishing a chain that connects all three sides of the triangle (Browne, 2005). Several other games with more complex rules or more complex board patterns have been reported. Up to now, *Hex* is the most played connection games, and only *Twixt* and *Y* succeeded sometimes in challenging its success (Browne, 2005). In this case, the attempts of producing a more interesting games by introducing new and more complex features have not yielded a more successful product.

In summary, cases (a) and (b) confirmed that a more controlled definition of the term "evolution" needs to be applied to games.

A brief survey of the original biological model follows, to look for inspiration and a better application of the concept of evolution.

Evolution in living organism

In the past years, Richard Dawkins popularised a successful approach to describe phenomena that are subjected to evolution (Dawkins, 1976) (Dawkins, 1986).

The concept of evolution is applied to "living" organisms. In a simplified model, an entity can be considered living if: (i) it is able to growth as a consequence of exchanges of matter and energy with the environment; and (ii) to reproduce. This model of life is oversimplified, since it is well-known that some "living" organism (mules, or workers ants) are unable to reproduce, but it is satisfactorily complete for the present purpose. In this simplified model, life can be thought as a mix of "hardware" and "software", if terms from the computer sciences are borrowed. The hardware is the physical body. The software is the set of instructions for the correct acting and reproducing of the hardware. In the living organisms, the software is coded into the nucleic acids (DNA or RNA), that are the molecules that supervise the synthesis of the key intermediates of the biochemical process (*e.g.* proteins and enzymes).

Dawkins' description focused on the software of the living entities, discarding the complexity due to a different hardware. Hence, the focus is moved from the form to the function. In this framework, evolution is described by the occurrence of two sequential processes, mutation and competition.

Mutation

The mutation is a random change in the genetic instructions that could be caused by many different agents (errors in the transcription of the genetic material, radiation, chemical agents, and so on). Usually these mutations cause an immediate and fatal damage to the living entity. On the other hand, even if it occurs seldom, the modified software is able to survive and later to reproduce, thus yielding a son that will inherit its modified genetic material.

Competition

The old (not mutated) species and the new (mutated) one, and their respective descendants, compete in the environment for the available resources. Competition should not be thought as a bloody fight. Evolutionary competition represents merely the ability of one entity to reproduce itself more efficiently than the other ones, thus overcoming them numerically. In this framework, mutation could not be "rational", according to a naive judgement. For example, it is hard to find a rationale in the enormous tail of a peacock, a tail that exposes that specie to its predators. However, that tail is indeed the final result of the evolution, probably because it is a sexual call and it ensures many descendants to its owner.

This two steps model (mutation and competition) is difficult to accept, because the competition of biological systems occurred over many millennia, a time interval that is far beyond the common experience. Only the scientific evaluation and interpretation can disentangle the puzzles of the evidences.

If this model is accepted, the problem of arising of complex organisms as the final product of the evolution is approached from a different point of view. In fact, only complex systems reached a steady state because only systems with a high number of interacting components are able to prevent or to correct the misprints in the reproduction of its software. The need for an accuracy in the reproduction of complex, and thus slowly-mutating species, is not a contradiction with the request of mutations because, rigorously speaking, a species that underwent a mutation is different from its parent, since it owns a different software.

First extension of the evolution

The reported model answers to a large number of biological questions and it was successfully extended also to other software based systems. For example,

a virus is a borderline entity between the "living" cells and the "inanimate" macromolecules, since it carries only short ribbons of nucleic acids, surrounded by a protective jacket (the "capsid") (Villarreal, 2004). It has no exchange of matter and energy, as other living entities do. It lives as a parasite into the cells of other organisms, its only ability being the extraction of the molecules for its reproduction from its host, according to its software (Villarreal, 2004). Therefore, a virus is an almost pure software system, and fits well into Dawkins' description. Evolution of common viruses (for example the flu virus) is commonly and thoroughly investigated.

Further extensions of the evolution

The way of acting of a virus has inspired a further striking application. The pirate programs capable of reproducing, damaging and spreading from a computer to another one are called "computer viruses". Even for these programs, indeed pieces of pure software, the concepts of evolution has been appropriately applied (Kephart *et al.* 1997).

Another metaphor was introduced by the same Dawkins (Dawkins, 1976), as a middle way between a serious hypothesis and an intellectual provocation. He observed how the ideas, the scientific theories, but also the fashion and the urban legends, act as parasites of the brains and reproduce by leaping from a brain to another one. Dawkins suggested to call these ideas, that are indeed pure software, as "mental viruses", or "memes", because they reproduce as parasites of a certain host brain. Differently from a virus or a computer virus, a meme has no clear instruction about its reproduction, but this event occurs because there are some hidden acting mechanisms that are able to stimulate the host system (*i.e.* the "infected" brain) "to spread the contagion". A meme is a piece of pure software that is able only to replicate, as computer viruses usually do. As an extension of the virus metaphor, also memes dynamic has been investigated from an evolutionary point of view, even if some conclusions were questioned. In particular, meme metaphor was found to be excellent to describe existing phenomena, less useful when predictions need to be made.

In conclusion, the focus on the software of some odd systems (living entities, viruses, computer viruses) has yielded useful evolutionary studies.

Games and evolution

Could evolution for games be investigated as occurred in the previously cited systems? What are life and death for games? What are the hardware and the software of a game? What is the reproduction of a game? The answers to these questions define the modes and terms of application of the concept of biological evolution to games.

The object

It is easy to agree about the fact that a game is a mixture of hardware and software (see for example, Kramer, 2000). The board, the pegs, the dice and the other gaming equipment constitute the hardware. The set of the rules, that supervises both the correct acting and the establishment of the end, is the software. If so, the software focused framework of the evolutionary investigations prompt us to focus only on the rules of the games.

Life and death

"A game is *living* if it is played. Otherwise, it is *dead*" is a statement that can be agreed easily. The phenomenon of hybernation, as it occurs for some viruses, is nice to be added to the discussion. *Reversi* is a good instance. The game was played at the end of the 19th century and then it was forgotten for decades. Martin Gardner cited it as an interesting board game (Gardner, 1966). Only some years later, a Japanese corporation re-proposed it (with minor revisions) under the name *Othello*. Since then, this game has been one of the most popular until nowadays. The point is that hardly a 19th century game fits and survives into the current tastes. At the same time, hardly a virus, that was frozen and that returns to life, is able to survive into a mutated environment.

The causes of the "death" of a game are manifold. For example, a game is abandoned if it is clearly unbalanced toward a player (Schmittberger, 1992), or if many draws are observed (Schmittberger, 1992), as occurs for *Tic-tac-toe* on a 3x3 board. Games are abandoned also if they are solved, as occurred for *Bridg-it* or *Nim*.

Reproduction

The "reproduction" of a game can be borrowed from the meme metaphor, in which a game reproduces itself if it is able to "infect" the brain of the players and to induce them to play it and to "spread the contagion". As for

the meme metaphor, this statement describes clearly the phenomenon, but gives little help to foresee if a game will be successful.

At this stage, the main points of the evolutionary, software focused framework are checked by comparing the previous points, that were stated for the biological evolution, with the same points applied to games.

(1) A modification in the software (the rules) originates a new game

It is well-known that every modification of the rules originates a new game, that in general was indicated as a "variant" of the parent one. It must be underlined that even small mutations can have deep consequences. A striking example is the difference between the board game *Risk* and its Italian version *Risiko* (Cardellicchio and Albertarelli, 2003). In this last game, the defending player can oppose three dice to the three dice of the attacking player. It seems only a tiny advantage for the defender, but a completely different game arises from this mutation, unbalanced in favour of the defender. Therefore, the attacking player must plan accurately its moves to avoid ruinous consequences.

Another example is *Shogi*. *Shogi* is sometimes described as a mere Japanese Chess, since the purpose of the game and the movements of some of the pieces resemble those of the western Chess. However, the introduction of the rule of the dropping of the captured pieces changes deeply the strategic plans of *Shogi*.

(2) A mutation is random and could also be a not rational one

Chess is a good confirmation to this point. In the eighteenth century, two great chess-players published their works on Chess, the French Philidor and the Italian Ponziani. Rigorously speaking, they did not play the same game (Chicco and Porreca, 1971). Ponziani firmly refused the French *en-passant* capture. On the other hand, in the Italian Chess, a pawn could be promoted only to replace a piece that had been previously captured. Furthermore, "free-castling", *i.e.* the free swapping of the king and the rook to any two squares chosen by the player, was also allowed in Italy. From a "rational" point of view, it is difficult to find a rationale for an *en-passant* capture and for a player that owes two Queens, or three Bishops. However, the Philidor Chess became the established Chess (Orto-Chess, as it was sometimes called (Pritchard, 1994)) even if Ortochess is "an arbitrary object, far from being

perfect", as reminded by various scholars (Pritchard, 1994), (Schmittberger, 1992).

A criticism to point (2) is that it is difficult to accept that the creative and deliberate action of an author of games should be considered a random event. However, this criticism is only a man-centred perspective. In fact, from an evolutionary point of view, the only relevant aspect is that a novelty arises, regardless of how it was brought. A random events is the accident that sometimes occurred, as an oral unfaithful repetition, that is the main driving force in the production of family variants (Albertarelli, 2000). On the other hand, a professional author has a clear advantage over a random event, since he is well-acquainted with the past and the present trends of the game world and it is more likely that he (and not a random event) can produce a successful games.

The introduction of new game ideas has been investigated and classified (Salen and Zinnemann, 2004), (Neto, 2005), (Schmittberger, 1992). A first instance is the mimicry (with simplification) of events from real life, such as a ceremony, a battle, a race, or a bargaining. Chess was clearly inspired by an old battle.

Another driving force for the production of new variants is the deliberate mixing of ideas from one game to another one (Salen and Zinnemann, 2004), (Neto, 2005). *Chessgi* (or *Mad Mate*, or *Crazyhouse Chess*, or *Dropping Chess*) is the instance of extending the dropping of the captured pieces, that is a characteristic of *Shogi*, to Chess.

Another powerful driving force for the production of new games is the request for a more challenging one. For example, *Tic-tac-toe* on a $3x3$ board is a draw, but enlarging the board and changing the purpose of the game toward other targets (not only the 3-in-line one) can yield interesting games for skilful players (Gardner, 1983). Another instance that was discussed along these lines (Parlett, 1990) is the progressive enrichment of more complex features that moves Whist toward the more challenging Bridge.

Furthermore, during the centuries, a drift toward pure abstract games was also observed, since dedicated players are interested mainly on strategy and tactics, forgetting the theme features, if unnecessary. This simplification is a main driving force in the production of new variants and it was defined as "elegance", that is the combination of minimum rules with maximum strategy (Braunlich, 1994). Along these lines, Schmitterger (1992) observed that "a game may have complicated rules, but it should never have rules that are unnecessarily complicated".

Along these lines, it seems that *Hex* or *Go* were born in their ideal form, always elegantly challenging for their players, without any need for modifications.

(3) Most mutations are unproductive

Several games are known and every year new entries are introduced, both variations of old games and completely new releases. Family variants and professional authors yield a very large number of new games, but only a very small part of these new entries survives along the years.

(4) The mutations operate slowly until a steady state is reached

Chess is still a good example. Several small mutations were introduced during the centuries, one after the other. Actually, this game has reached its "steady state" and mutations are almost impossible, because millions of dedicated players, who spent hard efforts to play Chess at higher levels, oppose firmly to the introduction of new rules, even to eventual improvements, since these variations destroy their knowledge, and the hard work performed.

Along this lines, an intriguing anecdote was reported by Robert Abbott about his *Ultima*, a chess variant played with many not conventional pieces (Abbott, 1963). Since its introduction, some flaws were found. Abbott accepted some suggestions and proposed some modifications to overcome these flaws. The small community of *Ultima* players firmly refused them (Abbott, 2001), even if they were informed that these variations were classified as "improvements".

Conclusion

Games, as other software systems subjected to evolution, have rules that were originated by a random event. As created, the game ideas compete for their existence by stimulating the brain of the player to spread the knowledge and the practice of that idea. The evolution toward both easier or more complex rules can be both accepted, the first one being caused by the loss of the theme feature that originated the game, the second by a quest for more challenging situations. Games can reach a steady state, and hardly undergo mutations, if they remains challenging for the players and no request for further complication is needed (as in the case of Hex).

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The Board Game Geek web site (`http://www.boardgamegeek.com`) is a valuable and encyclopedic collection of resources about games in general, and the games cited herein.

On game psychology: an experiment on the chess board/screen, should you always "do your best"?

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Abstract: *It is noted that allowing, by means of some specific "unreasonable" moves, a chess program to freely occupy the centre of the board, greatly weakens the program's ability to see the serious targets of the game, and its whole level of play. At an early stage, the program underestimates the ability of the opponent, and by some not justified attack (advance) loses time and helps the other side to reach it in the development. Weak coordination of Program's figures, caused by quick advance of these figures, is also obvious at this stage. On a larger scale, the Program is taken out of its library by the unusual start and has difficulties to return to it, often continuing to play indecisively during many of the following moves. Direct use of these difficulties of the program, and the background psychological nuances, make the play more scientifically attractive and the competition scores gained against the "machine" are also dramatically increased. The present work is not intended to advance chess learning in the sense of chess art per se, but rather to better (more widely) put this game in the general scope of one's intellectual interests. This means some general reflections of the problem of keeping/having serious game targets in view of human psychology and education, and the associated modelling, by means of the "unsuccessful" (just as we are) chess programs, of what can happen in the world of human relations and competitions. It is suggested that programs be created with different weaknesses in order to model wrong human behaviour. The aspect of competition is also respected, and a specific variation of the game, named "Corrida", based on some variants of the performed experiments is suggested.*
Keywords: Game psychology; Children education; Chess "corrida", Program's frame; Challenge for the Player; Challenge for the Programmer; The idea of Alyochin's defence.

Introduction

General

An investigation in the field of the chess game is presented, although the chess *as the art* does not really interest us here, but the psychology of the battle revealed by the analysis of an unexpected weakness of a program that otherwise is considered as a strong one.

Chess is an ancient game:

> "Probably originating in India during or before 7th century, chess spread to Persia, to Arabia, and then to Western Europe". Its name and the term 'checkmate' are sometimes said to derive from the Persian 'shah', "king", and 'shah mat', "the king is dead".[1]

Let the latter occur only on the chess board, but this game (playing) includes many elements of human psychology which are really interesting: unexpected tactical tricks/combinations, smart strategic decisions, development of long-term plans using the weaknesses of the opponent, gradual enhancement of the position, systematic use of minor advantages, and even knowledge about what the opponent prefers or dislikes ("I am not playing against wooden pieces", Emanuel Lasker, Figure 1, right), and some others.

A keen interest in the high intellectual nature of chess, — a topic having some relation to our general culture, together with the professional target of automata theory and design, — led Claude Elwood Shannon in his interesting pioneering works [2, 3, 4] to some motivating, even philosophical (in [2] and [4] without any formula), arguments that provided the basis for developing chess programming.

The connection of chess play to human psychology is natural because this very flexible and rich in its possibilities game was invented and developed by humans for themselves. Though this connection is rarely considered, it is the reason for the author's *interest* in the topic and is one of the main focuses in the present *experimental* work. This work is also a logically-critical one, i.e. it criticises seeing chess play just as a type of competition. Let us, first of all, set our heuristic position in this investigation.

The educational slant of the present work is not so much associated with the victory problem, but much more with a psychological, even philosophical, meaning of the program's observed weaknesses. By analysing these unexpected weaknesses, we give, in fact, some advice for human education, and finally suggest to the Programmers to create programs with different
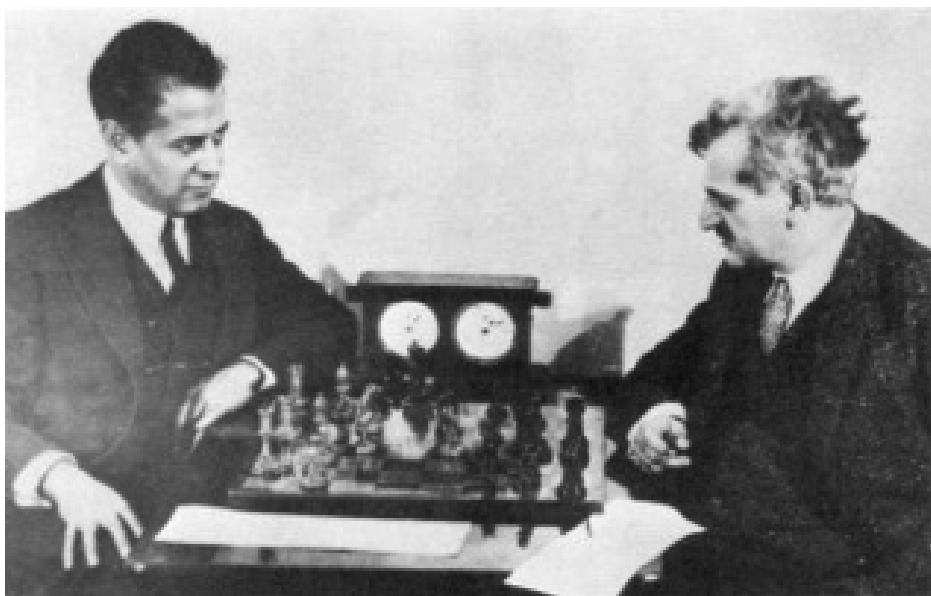
Figure 1: Hose Raul Capablanca (left) took the chess-crown from Emanuel Lasker, and passed it on to Alexander Alyochin. Each successful champion raised the state of the art of the game to a higher level with the last of which the best modern chess programs, however, successfully compete. However, is the machine-player really as smart as a human one? We argue that this depends on whether or not the human player can, — unexpectedly, for the machine, i.e. unexpectedly for its Programmer, — introduce new degrees of freedom in the policy (strategy and/or tactics) of the game. However, the Programmer is, first of all, a Scientist, while the Player is, first of all, a Competitor, and thus it is not a miracle that the machine finally wins. The Player should become a Scientist too, to start to see things more widely, even more philosophically, and the easiest way to cause a Player to become a Scientist is to cause a Scientist (a Mathematician, or a Psychologist, or even a System Theory Specialist) to become, to a degree, a Player. In other words, we call for a "scientific boldness" introduced into playing, while whether or not you win should not be immediate point.

kinds of weaknesses, allowing one to model, via the play, the human situations.

The competitive side will be, however, also respected, and based on some specific attempts appearing in our experiment we shall suggest a new dramatic version of chess.

Does the Chess Program really play without "nerves"? Sometimes we shall see the "iron machine" nervous, and sometimes even depressed!

In [2] and [3] Shannon lists four advantages of the machine over the human player:

1. Quick counting,

2. No mistakes (errors), just some program weaknesses,

3. Not lazy,

4. No nerves, i.e. no over or under estimations of its position.

For the last statement, a definition of nervousness seems to be required. A human is nervous when he is out of his usual logic, does not develop another stable one, and *thus* seeks solutions for the unexpected for him situations. The detailed experiment discussed below shows that in the sense of this definition, the programmers can give some nervousness to a machine by allowing it playing adventurously *when it has the impression (in our experiment, intentionally induced by us) that its opponent is a weak player.*

However, this possible nervous play is not the only problem of the program. We also show that if one succeeds, by some very unusual play, in taking the program out of its library, then, as a result of this, it is possible that the program will lose coordination of its figures and will start *and continue, for a long time,* to play much weaker than usual. Isn't this a typical *depression* state? When *defining* depression as *remaining* out of the program, we can say that in our experiments depression of the machine was often observed.

A description of our strategy in simple terms

It is very difficult to analytically describe the mutual coordination of the actions of the figures. Thus, for instance, considering figures of one color, let us assume that a Knight attacks square S of the board, and a Bishop

(or another Knight) attacks square T, and the Queen attacks both S and T. Now, let us remove the Queen. That the actions of each of the light figures were coordinated with that of the Queen does not mean that the light figures coordinate with each other, and several moves can be needed for obtaining such coordination. The situation with coordination, is not "transitive", i.e. not as "if a = c, and b = c, then a = b"; forced exchange the Queen can destroy the whole coordination.

The *specificity* of the situation under study (i.e. our strategy for White) is as follows:

1. White does not advance figures, letting them to be attacked by Black from distance, and the requirement of closeness of the figures of the opposite groups, for the battle to start, results in a situation in which the advance in space obtained by one side (Black) does not give to this side great advantage, unless Black is lucky to make mate. The latter is, however, not likely because of the confusion in the coordination of Black figures obtained during the *too free* advance of these figures. Thus, White is interested that the real fight should start close to its position.

Though the Program makes its first moves correctly, White is more (very) patient, and Black indeed soon demonstrates poor ability to correctly advance its forces (or create a firm position) in the too luxurious conditions given to it. Since the advanced black figures become poorly coordinated as a whole, and Black starts unjustified attacks that just help White to switch to a quick and easy development, the further play of White does not require high chess skills. (Thus my scores against the machine were drastically improved.)

2. The *initial position* that White reconstructs artificially and unexpectedly for Black, is just very suitable for pursuing the very simple and clear target of starting development only when the black figures are already close to the white figures. It sounds paradoxical, but if White had not any immediate trouble, it even can have an advantage at the initial stage of the *real battle* that thus starts. All this is somewhat similar to the case when one (an analogy for Black) is allowed to freely wave a long sward and attack another man, but if he does not hit him, he soon finds the opponent close to him comfortably operating with a knife. Some other "fight-type" analogies are suggested below in order to stress that the chess psychology is not something isolated and understandable only by professionals.

The role of the coordination of the figures

It is important to observe that when (as in a usual route of the game) Black is developed with difficulties, it also automatically/necessarily gradually develops *good coordination of its figures.* In terms of the fighting analogies, Black thus takes care to stay on the ground well. When it is developed (advanced) too quickly, then it has poor coordination of its figures, and the period of confusion of Black continues for significant time (the number of the moves). Early unjustified attacks of Black only enhance the coordination problem *that exists here anyway.* For instance, there is no early attacks in Game 6 below, and in several other given games it is also well seen that besides the early attacks, Black has a problem with the *coordination* of its figures.

The Program does not see how to use well the possibility of the free (or almost free) movement that White gives to it.

Let us start with the "laboratory notes and records" of our experiment and to the thoughts regarding its steps and results; a Diary of the experimentator. In order to feel the romanticism and beauty, the Reader is advised to play out at least some first 20–25 moves in the games considered. Games 1, 4, 5, 6, 7, 8, are, perhaps, most typical, but each of the given games is good evidence of the nervousness and/or depression of the Program in the context of our specific starting tactic-strategy. Specially note the "corrida"-version of chess, which is one of our final suggestions.

Some of the final games with the closed "tracks" of White Knights present the "Corrida" policy most clearly, and competitions between humans playing in such style against machine can be very interesting.

In general, the games presented in Section 2 give some rich experimental material for a programmer who would wish to find the strategy disadvantages and (mainly) the stability problems for such class of chess Programs as "KChess Elite 4" is. This program was chosen because it is a popular one, and because it otherwise (i.e. without the unexpected for it policy that we follow) usually *easily defeats me*; thus the effect is clear. The Reader is warned not to base himself on the exposing here that when taken out of its usual play, the Program is weak, and thus to conclude that the Program is weak in general; one should try this Program in regular games. (For me it is just strong.) Of course, the Reader is suggested to thus also try any other Program that he likes or that is available for him.

In fact, the choice of the program is not very important because, finally, our point is more psychological and educational than sportive, and one can enjoy analysing the unusual attempts with children who not neces-

sarily promise to become chess masters, just seek in chess a game of a wide intellectual scope.

From Alyochin's defence, to an Alyochin-type start, and then to the "Chess-Corrida": the Diary of the Experiment, and the thoughts on line

The observation

The following observation is not incidental. For a long time I have wanted to check a possible enhancement of the basic idea of Alyochin's defence (1. e4 Nf6; 2. e5 Nd5; 3. c4 Nb6; 4. d4 ...) in which Black allows White to take the centre of the board, and then attacks this centre. The point of the defence is that it does not appear to be easy for White to hold the centre.

Undoubtedly, it is very satisfactorily to show to your opponent that his advantage mainly makes him awkward, and I decided to go further with this idea, giving the relevant *initiative* to White (which is generally natural) and letting *Black freely* create its centre. This is obtained by White starting with knight(s) and returning it (them) to the initial place, giving Black some free moves.

Of course, the chess-program (Black) does not know that this is the policy of White, and starts to play reasonably, i.e. takes the centre, not trying to get mate immediately. However when realising that White plays weakly, Black becomes to be confused in the sense that it cannot choose a correct (serious) plan of the game, and its minor unjustified attacks allow White to quickly advance in its development. Below, we shall analyse this in detail and formulate the things more precisely.

The problem of the Program is that Black can be correctly developed only while overcoming difficulties starting from the very beginning of the game, i.e. if White plays well (as expected).

The experiment

The "KChess Elite 4" program (free from the Internet for a limited time) plays much better than I do, especially in combinations that the Program finds or initiates much, much better than I can. Its debut library is also much better than that of mine. When I try to play while "doing my best", then for each case where I win, the program wins some 8–10 games.

However, after starting my psychological experiment, I was amazed to

see that I had a win or a draw much more frequently, being almost equal to the program. Observe in the following three "introductory" games, with only 4 "free moves" in each, the relatively weak play of Black (the Program) in the period of the "confusion".

The first game:

1. Ng1-f3 Ng8-f6 2. Nf3-g1 Nb8-c6 3. Ng1-f3 d7-d5 **4. Nf3-g1** e7-e5 5. d2-d3 Bf8-c5 6. e2-e3 o-o 7. Ng1-e2 Nf6-g4 8. h2-h3 Qd8-h4 9. g2-g3 Qh4-h5 10. Bf1-g2 Ng4-f6 11. Nb1-c3 Rf8-d8 12. Bc1-d2 a7-a6 13. g3-g4 Qh5-g6 14. Ne2-g3 d5-d4 15. e3xd4 e5xd4 16. Nc3-e4 Bc5-b4 17. Bd2xb4 Nc6xb4 18. Qd1-d2 Nf6-d5 19. a2-a3 Nb4-c6 20. o-o-o Nc6-e5 21. f2-f4 Ne5-c6 22. f4-f5 Qg6-h6 23. Qd2xh6 g7xh6 24. Ng3-h5 Kg8-h8 25. Rd1-e1 Nd5-e3 26. Rh1-g1 Nc6-e5 27. Nh5-f6 Ra8-a7 28.Ne4-g3 Rd8-d6 29. Ng3-h5 Bc8-d7 30. Bg2-e4 Bd7-a4 31. g4-g5 h6xg5 32. Rg1xg5 Ra7-a8 33. Re1-g1 Ne5-g6 34. f5xg6 f7xg6 35. Be4xg6 h7xg6 36. Rg5xg6 Rd6xf6 37. Rg6xf6 Ne3-f5 38. Rf6xf5 Ra8-g8 39. Rg1xg8+ Kh8xg8 40. Rf5-d5 c7-c5 41. Rd5xc5 Ba4-e8 42. Nh5-f6+ Kg8-f7 43. Nf6xe8 Kf7xe8 44. Rc5-c7 b7-b6 45. c2-c3 Ke8-d8 46. Rc7-h7 d4xc3 47. b2xc3 Kd8-c8 48. Kc1-d2 a6-a5 49. Kd2-e3 Kc8-b8 50. Ke3-d4 Kb8-c8 51. Kd4-d5 Kc8-d8 52. Kd5-e6 Kd8-c8 53. Ke6-d6 a5-a4 54. c3-c4 Kc8-b8 55. Kd6-c6 Resigns

The second game:

1. Ng1-h3, Ng8-f6 2. Nh3-g1, Nb8-c6 3. Ng1-h3, d7-d6 **4. Nh3-g1** Bc8-f5 5. Ng1-h3 Nc6-d4 6. d2-d3 Bf5xh3 7. g2xh3 Nf6-d5 8. Bf1-g2 Nd5-b4 9. Nb1-a3 Nb4-c6 10. o-o e7-e5 11. e2-e3 Nd4-e6 12. c2-c4 Ne6-c5 13. d3-d4 e5xd4 14. e3xd4 Nc5-a6 15. Rf1-e1+ Bf8-e7 16. Bc1-g5 f7-f6 17. Bg5-h4 o-o 18. Na3-c2 Rf8-e8 19. a2-a3 f6-f5 20. Bh4xe7 Re8xe7 21. b2-b4 Re7xe1+ 22. Qd1xe1 f5-f4 23. b4-b5 Qd8-g5 24. Qe1-e2 Nc6xd4 25. Nc2xd4 Na6-c5 26. Qe2-g4 Qg5-f6 27. Ra1-d1 Ra8-e8 28. h3-h4 Kg8-h8 29. h4-h5 g7-g6 30. h5-h6 g6-g5 31. Nd4-f5 Re8-f8 32. Rd1-d5 c7-c6 33. b5xc6 b7xc6 34. Rd5xd6 Qf6-a1+ 35. Bg2-f1 Nc5-e4 36. Rd6-d7 Qa1-b2 37. Qg4-f3 Qb2-e5 38. Rd7-e7 Ne4-d2 39. Qf3-e2 Qe5xe2 40. Bf1xe2 f4-f3 41. Be2-d3 Nd2-b3 42. Re7xa7 Nb3-c1 43. Bd3-c2 Rf8-d8 44. h2-h3 Nc1-e2+ 45. Kg1-h2 Rd8-b8 46. Nf5-d6 Ne2-d4 47. Nd6-e4 Nd4-e6 48. Ne4-f6 Rb8-b7 49. Ra7xb7 Ne6-f8 50. Rb7-b8 c6-c5 51. Rb8xf8#

The third game:

1. Nb1-c3 Nb8-c6 2. Nc3-b1 Nc6-b4 3. Nb1-c3 Ng8-f6 **4. Nc3-b1** d7-d6 5. Nb1-c3 Bc8-f5 6. d2-d3 e7-e5 7. e2-e4 Bf5-e6 8. Ng1-f3 Bf8-e7 9. g2-g3 o-o 10. Bf1-g2 c7-c5 11. o-o Qd8-a5 12. Bc1-d2 Qa5-a6 13. Nf3-e1 Nb4xa2 14. f2-f4 e5xf4 15. Bd2xf4 Na2xc3 16. b2xc3 Qa6-b6 17. Ra1-b1 Qb6-c7 18. d3-d4 c5xd4 19. c3xd4 Be6-g4 20. Qd1-d3 Bg4-h5 21. Ne1-f3 Ra8-c8 22. Rb1-b2 Bh5-g6 23. Nf3-h4 Qc7-d7 24. Nh4xg6 h7xg6 25. e4-e5 d6xe5 26. Rb2xb7

Rc8-c7 27. Rb7xc7 Qd7xc7 28. Bf4xe5 Qc7-a5 29. Be5xf6 g7xf6 30. c2-c3
Rf8-c8 31. Rf1-c1 Be7-a3 32. Rc1-c2 Rc8-e8 33. h2-h4 Re8-e1+ 34. Kg1-h2
Ba3-d6 35. c3-c4 Qa5-h5 36. Kh2-h3 Re1-d1 37. Qd3-e4 Kg8-h7 38. Bg2-f3
Rd1-e1 39. c4-c5 Re1xe4 40. Bf3xh5 Bd6-b8 41. Bh5-f3 Re4xd4 42. c5-c6
Bb8-c7 43. Rc2-b2 Kh7-g7 44. Rb2-b7 Bc7-b6 45. h4-h5 f6-f5 46. h5xg6
Kg7xg6 47. Bf3-e2 Rd4-d6 48. Be2-b5 Rd6-d8 49. g3-g4 f5-f4 50. Bb5-a6 f4-
f3 51. Rb7xb6 a7xb6 52. c6-c7 Rd8-f8 53. c7-c8=Q Rf8xc8 54. Ba6xc8 b6-b5
55. Bc8-a6 Kg6-f6 56. Ba6xb5 f3-f2 57. Kh3-g3 Kf6-g5 58. Bb5-e2 f7-f5 59.
g4xf5 Kg5xf5 60. Kg3xf2 1/2-1/2

Checking stability of seeing game targets, using the same program (the fourth game)

The next experiment was as follows. Moving *both* of its knights forward and
back, White this time allows Black having not 4, but 6 first free moves.
Then, after creation the problem for Black, I make several steps (not very
few) of my own, and then, not being in any catastrophic situation, let the
Program play *for both sides*, assuming that it makes some optimal moves,
each time.

In view of the above observations, I was not surprised that White won,
because I assumed that White's play should be just enhanced by the Pro-
gram.

In fact, this assumption is not at all simple, and below, based on an
example, I have to criticise the play of the program *for any side* in the case
when the situation of one side is poorly understood by it. The interesting
but difficult question of whether or not the ability of the Program to be
stable in keeping its game targets can be checked, *using the program itself*,
arises. This is the game.

The fourth game:
1. Nb1-c3 Ng8-f6 2. Nc3-b1 Nb8-c6 3. Nb1-c3 d7-d5 4. Nc3-b1 e7-e5 5. Ng1-
f3 e5-e4 **6. Nf3-g1** Nf6-g4 7. h2-h3 Qd8-h4 8. g2-g3 Qh4-h5 9. e2-e3 Nc6-e5
10. d2-d4 e4xd3 11. c2xd3 Bf8-b4+ 12. Nb1-c3 o-o 13. Bf1-e2 Bb4xc3+ 14.
b2xc3 c7-c5 15. Bc1-a3 Rf8-e8 16. d3-d4 c5xd4 17. c3xd4 Ne5-c4 18. Ba3-c1
Re8-e4 19. Be2-f3 Ng4xf2 20. Ke1xf2 Qh5-f5 21. g3-g4 Qf5-f6 22. Kf2-e2
Re4-e7 23. Bf3xd5 Bc8-e6 24. Bd5xe6 f7xe6 25. Ng1-f3 Re7-f7 26. Rh1-f1
Qf6-h6 27. h3-h4 Rf7-c7 28. e3-e4 Qh6-g6 29. Nf3-g5 Ra8-d8 30. h4-h5 Qg6-
e8 31. Ra1-b1 Qe8-c6 32. Ke2-f3 h7-h6 33. Bc1-f4 h6xg5 34. Bf4xc7 Rd8-f8+
35. Kf3-g3 Rf8xf1 36. Qd1xf1 Nc4-d2 37. Qf1-c1 Nd2xb1 38. Qc1xc6 b7xc6
39. Bc7-d8 Nb1-a3 40. Bd8-e7 Na3-b5 41. Be7-c5 Nb5-c3 42. Kg3-f3 Kg8-f7
43. Bc5xa7 Nc3xa2 44. Ba7-c5 Na2-c3 45. Bc5-b4 Nc3-b5 46. Kf3-e3 Kf7-f6

47. e4-e5+ Kf6-f7 48. Ke3-d3 g7-g6 49. h5-h6 Nb5-c7 50. Bb4-e7 Nc7-d5
51. Be7xg5 Nd5-c7 52. Kd3-c4 Nc7-b5 53. Kc4-c5 Kf7-g8 54. Bg5-e3 Nb5-c3
55. Kc5xc6 Kg8-f7 56. Be3-f2 g6-g5 57. Bf2-e3 Nc3-e2 58. d4-d5 Ne2-f4 59.
Be3xf4 e6xd5 60. e5-e6+ Resigns

All the following games, except of the last one in Section 2.11, I again
play by my own against Black up to the very end.

Another game with the too early black Queen attack and the following "depression"

In this game, I again let Black to have 6 "free moves". The too early switch-
ing the Queen to attack is a typical mistake of the Program in the "overde-
veloped" state. But this time, an early Queen attack even led Black, *in a
rather late stage (27th move),* to lose one of its Knights in order to save the
Queen, which points at an unusual for it tactical weakness of the play of the
Program that seems to remain for a long time because of the problems after
the unusual start, — a case of the "depression" defined in Section 1.2.

A more general observation is that *the absence of serious targets prevents
Black from developing the combination type initiatively-tensioned game in
which the Program is much stronger than I am.* I would compare the Pro-
gram with a human player having a sanguine-type psychological character.
Such a person is energetic and patient in any work, even a very difficult one,
but only while the proper targets are continuously given to (put before) him.
(This giving is just what I do for the Program when I play normally from
the very beginning, honestly "doing my best", and the Program shows its
strength almost always defeating me.)

The fifth game:
1. Ng1-h3 Nb8-c6 2. Nh3-g1 Ng8-h6 3. Nb1-c3 Nh6-g4 4. Nc3-b1 e7-e6 5.
Ng1-f3 Bf8-e7 **6. Nf3-g1** Be7-c5 7. e2-e3 Qd8-h4 8. g2-g3 Qh4-g5 9. Ng1-
f3 Qg5-g6 10. Bf1-g2 o-o 11. o-o Nc6-b4 12. Nb1-a3 Qg6-f5 13.d2-d3 d7-d6
14. Nf3-d4 Bc5xd4 15. e3xd4 Nb4-c6 16. c2-c3 Ng4-f6 17. Na3-c2 Nc6-e7
18. Nc2-e3 Qf5-a5 19. b2-b4 Qa5-a6 20. c3-c4 Qa6-b6 21. Ne3-c2 Ne7-f5
22. c4-c5 Qb6-a6 23. a2-a4 Nf6-d5 24. b4-b5 Qa6-a5 25. Bc1-d2 Nd5-c3 26.
Qd1-e1 d6xc5 27. Bd2xc3 Qa5-b6 28. d4-d5 e6xd5 29. Bg2xd5 Rf8-d8 30.
Bd5-e4 Nf5-d4 31. Nc2xd4 c5xd4 32. Bc3-b4 Bc8-h3 33. Be4-g2 Rd8-e8 34.
Qe1-d2 Bh3xg2 35. Kg1xg2 c7-c5 36. b5xc6 a7-a5 37. Bb4-a3 Qb6xc6+ 38.
Kg2-g1 Ra8-a7 39. Ra1-c1 Qc6xa4 40. Rf1-e1 Ra7-a8 41. Ba3-b2 Re8xe1+
42. Rc1xe1 Ra8-d8 43. Qd2-f4 Qa4-b4 44. Qf4-e5 g7-g6 45. Bb2-a1 b7-b5 46.
Kg1-g2 Rd8-d6 47. Re1-e4 f7-f6 48. Qe5-e8+ Kg8-g7 49. Re4-e7+ Kg7-h6
50. Qe8-f8+ Kh6-h5 51. Re7xh7+ Kh5-g4 52. Rh7-h4+ Kg4-f5 53. Qf8-c8+

Kf5-e5 54. Rh4-e4+ Ke5-d5 55. Re4xd4+ Qb4xd4 56. Qc8-b7+ Kd5-e6 57.
Ba1xd4 Rd6xd4 58. Qb7xb5 g6-g5 59. Qb5xa5 Rd4xd3 60. Qa5-a6+ Rd3-d6
61. Qa6-c4+ Ke6-f5 62. Kg2-f3 Kf5-g6 63. g3-g4 Rd6-d8 64. Qc4-e4+ Kg6-f7
65. Qe4-f5 Rd8-d6 66. Kf3-g3 Rd6-d1 67. h2-h4 g5xh4+ 68. Kg3-f4 Kf7-g7
69. g4-g5 Rd1-d6 70. Kf4-g4 h4-h3 71. Kg4xh3 f6xg5 72. Qf5-e5+ Rd6-f6 73.
Qe5xg5+ Kg7-f7 74. f2-f4 Rf6-g6 75. Qg5-e5 Rg6-e6 76. Qe5-d5 Kf7-e7 77.
Kh3-g4 Re6-d6 78. Qd5-c5 Ke7-d7 79. Kg4-g5 Rd6-c6 80. Qc5-b5 Kd7-c7
81. f4-f5 Kc7-d6 82. f5-f6. Resigns

This time White returns to the initial position only at its 8th move, though in a more nontrivial manner

It appears possible to come to the initial position even later, — at the eighth
move, though in a less trivial manner, so that the play of Black at this period
is somewhat less free (I shall call below such a start as that of "almost free
moves"). The following game illustrates that in such a case the Program can
play not adventurously, but very indecisively.

   This experiment even suggests reconsidering the opinion that a machine
already plays better than a human player does. If I succeed in finding a
successful psychology against the Program which formally (usually) much
stronger than me, — why cannot a master find something relevant against
the machine that once defeated him? Finally, we have a player against
a programmer, both humans, and the player has to be not just a strong
competitor but also a psychologist, — against the scientist.

   Furthermore, the question of which machine is the strongest also becomes
open, while it is not checked whether or not such additional "psychological"
degrees of freedom can be used in chess programming.

   The sixth game:
1. Ng1-f3 d7-d5 2. Nf3-g5 Nb8-c6 3. Ng5-f3 Ng8-f6 4. Nf3-g1 e7-e6 5. Ng1-f3
Bf8-e7 6. Nf3-h4 o-o 7. Nh4-f3 d5-d4 **8. Nf3-g1** Nf6-e4 9. d2-d3 Ne4-f6 10.
g2-g3 Nc6-b4 11. a2-a3 Qd8-d5 12. Ng1-f3 Nb4-c6 13. Bf1-g2 Nf6-g4 14. o-o
Qd5-b5 15. Nb1-d2 Rf8-d8 16. Nd2-b3 f7-f6 17. e2-e3 d4xe3 18. Bc1xe3 Nc6-
e5 19. Nf3xe5 Ng4xe3 20. f2xe3 f6xe5 21. Qd1-f3 Rd8-f8 22. Qf3-e4 Be7-f6
23. a3-a4 Qb5-b6 24. a4-a5 Qb6-d6 25. Nb3-d2 g7-g6 26. Nd2-f3 Qd6-c5 27.
c2-c3 Qc5-b5 28. b2-b4 Bc8-d7 29. d3-d4 Bd7-c6 30. Qe4-c2 e5-e4 31. Nf3-e5
Bf6xe5 32. d4xe5 Rf8xf1+ 33. Ra1xf1 Qb5xe5 34. c3-c4 a7-a6 35. Qc2-f2
Ra8-d8 36. Qf2-f7+ Kg8-h8 37. Qf7-e7 Rd8-g8 38. Rf1-f7 Rg8-g7 39. Qe7-
d8+ Rg7-g8 40. Rf7-f8 Qe5-a1+ 41. Bg2-f1 Qa1-g7 42. Rf8xg8+ Qg7xg8 43.
Qd8-f6+ Qg8-g7 44. Qf6xe6 Qg7-d7 45. Qe6xd7 Bc6xd7 46. Bf1-g2 Bd7-c6
47. Kg1-f2 Kh8-g7 48. g3-g4 g6-g5 49. Bg2-f1 Kg7-f6 50. b4-b5 a6xb5 51.

c4xb5 Bc6-d5 52. a5-a6 b7xa6 53. b5xa6 Kf6-e5 54. a6-a7 h7-h6 55. Bf1-a6
c7-c5 56. Kf2-e2 Bd5-a8 57. Ke2-d2 Ke5-d5 58. Kd2-c3 Kd5-c6 59. Ba6-c8
Kc6-b6 60. Kc3-c4 Kb6xa7 61. Kc4xc5 h6-h5 62. g4xh5 g5-g4 63. Bc8xg4
Ba8-d5 64. Kc5xd5 Resigns

Again 8 almost free moves, but with a "drawing experiment" and the resulted strong depression in the play of Black

Let us add an element of art to our strategy. The *symmetric loops* (of a
leaf form), the same on each side, right and left, tracked by white Knights
before recreating the initial position, make some magic influence on the
Program. The whole play of Black is very weak, as if Black continues to
think what those symmetric loops by white Knights meant, and remains
non-concentrated. Black forgets about the necessity to finish developing of
its figures, and, at a stage, White becomes better developed.

Feeling this time very early that my position is already sufficiently strong,
I was even not sure in my 13. Nf3xe5, considering instead developing some
pressure in the centre, but Black soon loses an exchange, becoming inferior
in the material. That is, the simple persistent tactic of White *of exchange
and simplification* was the best one here too, keeping the advanced Black
very confused. (See also Section 2.11.) This is the game.

The seventh game:
1. Ng1-h3 Ng8-f6 2. Nh3-g5 Nb8-c6 3. Ng5-f3 d7-d5 4. Nb1-c3 d5-d4 5.
Nc3-b5 a7-a6 6. Nb5-a3 Bc8-f5 7. Na3-b1 Qd8-d5 **8. Nf3-g1** Nc6-b4 9. d2-
d3 o-o-o 10. a2-a3 Nb4-c6 11. Ng1-f3 Nf6-g4 12. h2-h3 Ng4-e5 13. Nf3xe5
Nc6xe5 14. Bc1-f4 Ne5-g6 15. Bf4-g3 Qd5-b5 16. b2-b3 Ng6-e5 17. Bg3xe5
Qb5xe5 18. Nb1-d2 Qe5-a5 19. e2-e4 Bf5-d7 20. Bf1-e2 Qa5-g5 21. Be2-g4
Kc8-b8 22. Bg4xd7 Qg5xg2 23. Qd1-f3 Qg2xf3 24. Nd2xf3 Rd8xd7 25. Nf3-
e5 Kb8-c8 26. Ne5xd7 Kc8xd7 27. f2-f4 f7-f6 28. Ke1-e2 e7-e5 29. f4-f5 g7-g6
30. Ra1-f1 Bf8-e7 31. Rh1-g1 g6xf5 32. Rf1xf5 Kd7-e6 33. Rg1-g7 Rh8-c8
34. Rg7xh7 Be7xa3 35. h3-h4 Ba3-c5 36. h4-h5 Bc5-a3 37. h5-h6 Ba3-d6 38.
Rh7-g7 Rc8-e8 39. h6-h7 Re8-h8 40. Rf5-h5 Bd6-f8 41. Rg7-g8 Rh8xh7 42.
Rh5xh7 Bf8-a3 43. Rh7xc7 b7-b6 44. Rc7-c6+ Ke6-f7 45. Rg8-a8 Ba3-c5 46.
Ra8xa6 Kf7-g6 47. Rc6xb6 Bc5xb6 48. Ra6xb6 Kg6-g5 49. b3-b4 Kg5-g6 50.
b4-b5 Kg6-g5 51. Rb6-c6 Resigns

Figures 2 and 3 illustrate the key points.

In Figure 2, we have White's initial position "recovered" after 8. Nf3-g1
Nc6-b4, before the forced answer d2-d3. Observe poor coordination of the
Black figures; this team does not really know what to do.

In Figure 3, we have the position before 25. Nf3-e5 Kb8-c8. That the

Figure 2: The seventh game. The recovered initial White's position, after the leaf-form two-sided loops Ng1-h3-g5-f3-g1 and Nb1-a3-b5-c3-b1. White's move; it will be d2-d3. Coordination of black figures is poor, and though the pawn at d4 is an unpleasant one, they do not form any real dagger.

move Nf3-e5 puts Black in a concrete trouble is not the point. The point is that White is already *better developed*, which is obtained by very simple, natural moves, starting from the position in Figure 2. Because of the better development, one can objectively (i.e. disregarding the concrete trouble caused by Nf3-e5) prefer the position of White, despite the lack of a pawn. For instance, White can organize a pressure on the Queen-side.

Some more general observations on line

1. The seventh and some other games, suggest that one can influence the character of the play of the program in some way by some such art-motives as the symmetric loops of the initial tracks of white knights are. The Programmers, even Shannon himself, hardly thought about such unusual possibilities of creating different levels of confusion of programs. If the Program has its own feeling of art, i.e. some logical impressionability to symmetry and systematicness, this impressionability is a primitive one. The symmetry of the initial Knights' tracks would hardly confuse a human player.

2. I start to notice that in the foreground of *competition* discussed in Section 2.1 is more weakly exposed in my psychological play against a machine. The

Figure 3: The *same* game after 17 moves. Though White lost a pawn, it is better developed. The black pawns' configuration is absolutely unchanged during these 17 moves. The pawn remaining on e7 especially well shows the confusion in the plans of Black during all of the 25 moves passed. If this pawn were to be at e6, Ne5 would not be a great problem. It seems that during these 17 moves Black mainly tried to coordinate its forwarded figures, forgetting about the development of the others. White's simple policy of expelling these forwarded figures and exchanging them made the *programming* target of their coordination *unrealisable* for the Program, and the depression of Black becomes deeper. The initial taking the Program out of its debut library means a very serious decomposition of the power/play of the Program that did not succeed in closing its "hand" (see Figure 2 again) into a fist.

psychological "Why?"s are more interesting than the competition problems. The focus is much more scientific. However, let us return to the experiment. Of course, there were games in which Black played well (stood firmly in its library) also in the context of the unusual start and I was quickly defeated. Since, however, the Program generally is a much stronger player than I am, none of my failures can be surprising. Let me thus continue only with the cases in which the Program clearly falls out of its main library, which is the possibility in focus.

A game with very early (wrong) decision of the Program that White is a very weak player

The following game is a striking example of Black's switch to a not serious sub-library and tends to quickly give mate. The move 2...Nb4 demonstrates the Program's extremely (surprisingly) early decision that White is very weak. The punishment comes quickly, even for the very careful style of White. Observe the ignorance by Black of the necessity of castling for its King.

The eighth game:
1. Ng1-h3 Nb8-c6 2. Nh3-g1 Nc6-b4 3. Ng1-h3 Ng8-f6 4. Nh3-g1 d7-d6 5. Ng1-h3 Bc8-f5 6. Nb1-a3 Nf6-e4 7. Nh3-g1 e7-e5 8. Ng1-f3 Bf5-e6 **9. e2-e3** Nb4xa2 10. Bf1-e2 Na2xc1 11. Ra1xc1 Be6-g4 12. o-o f7-f5 13. h2-h3 Bg4-h5 14. d2-d3 Ne4-g5 15. Nf3xg5 Bh5xe2 16.Qd1xe2 Qd8xg5 17. f2-f4 Qg5-g6 18. f4xe5 d6xe5 19 .Qe2-f3 Bf8xa3 20. b2xa3 Qg6-g5 21. Qf3xf5 Qg5xe3+ 22. Kg1-h1 Ke8-d8 23. Rc1-e1 Qe3-g3 24. Re1xe5 c7-c6 25. Qf5-e6 Qg3-g6 26. Qe6-e7+ Kd8-c8 27. Rf1-f7 Qg6xf7 28. Qe7xf7 b7-b6 29. Re5-e7 Rh8-d8 30. Re7-c7+ Kc8-b8 31. Rc7-b7+ Kb8-c8 32. Qf7-c7# 1-0

Back to the initial "art-tracks" by white knights, now performed in parallel; Black plays better but its advantage in the development disappears quickly (perhaps, the only game when I played satisfactorily)

This was a difficult game, showing that 8 "almost free" moves are close to the boundary of the unusual "generous" strategy that can be chosen by White.

The ninth game:
1. Ng1-f3 Ng8-f6 2. Nb1-c3 Nb8-c6 3. Nf3-g5 e7-e5 4. Nc3-b5 h7-h6 5. Ng5-h3 a7-a6 6. Nb5-a3 d7-d5 7. Nh3-g1 Nf6-e4 **8. Na3-b1** Bf8-c5 9. e2-e3 Qd8-h4 10. g2-g3 Qh4-d8 11. Bf1-g2 o-o 12. d2-d3 Ne4-f6 13. Nb1-d2 Bc8-g4 14.

f2-f3 Bg4-e6 15. Nd2-b3 Nf6-d7 16. Nb3xc5 Nd7xc5 17. Ng1-e2 Nc6-b4 18.
o-o Be6-f5 19. a2-a3 Nb4-c6 20. e3-e4 d5xe4 21. d3xe4 Bf5-e6 22. Bc1-e3
Qd8-e7 23. Ne2-c3 Ra8-d8 24. Qd1-e2 Nc6-d4 25. Be3xd4 e5xd4 26. Nc3-d1
d4-d3 27. c2xd3 Nc5xd3 28. Nd1-f2 Qe7-c5 29. Kg1-h1 Nd3-e5 30. Ra1-c1
Ne5-c4 31. b2-b3 Qc5-e3 32. Qe2xe3 Nc4xe3 33. Rf1-e1 Ne3xg2 34. Kh1xg2
Rd8-d7 35. b3-b4 Rf8-e8 36. h2-h4 Kg8-f8 37. g3-g4 Re8-d8 38. f3-f4 Be6-b3
39. e4-e5 Bb3-e6 40. f4-f5 Be6-d5+ 41. Kg2-g3 Bd5-c6 42. g4-g5 h6xg5 43.
h4xg5 Rd7-d5 44. Kg3-g4 Rd5-d2 45. Rc1-d1 Rd2xd1 46. Re1xd1 Rd8xd1
47. Nf2xd1 g7-g6 48. f5xg6 f7xg6 49. Nd1-c3 Kf8-e7 50. Nc3-d1 Ke7-e6 51.
Kg4-f4 Ke6-d5 52. Nd1-e3+ Kd5-e6 53. Ne3-c2 Ke6-d5 54. Nc2-e3+ Kd5-e6
55. Ne3-c2 Ke6-d5 56. Nc2-e1 Kd5-c4 57. Ne1-f3 Kc4-b3 58. e5-e6 Kb3xa3
59. Nf3-e5 Bc6-b5 60. Ne5xg6 Ka3xb4 61. Ng6-e5 Bb5-a4 62. g5-g6 c7-c5 63.
g6-g7 Resigns

**White returns to the initial position only at the 10th move,
the position soon appearing is closed and simple. In general,
Black plays well, and due to its very clear defence targets,
White plays satisfactorily. The game becomes "usual", but
having already many figures exchanged, White succeeds to
achieve a draw. Ten "almost free" moves are considered to be
the maximum for any reasonable experiment with this game**

In the following tenth game we "jump over" the period of the uncertainty,
i.e. over all the positions that for the Program are without any "best move".
For the 10 "almost free" moves given to Black, the period of its uncertainty
and depression already become irrelevant. As a rule, Black has the time to
be normally developed and to organise a crucial attack.

In terms of the time functions ("in other words"), we can say that while
in the previous games, there is a "singularity" in development of the game
at the moment when White started to play normally, in the game with the
maximal number of strange moves, the development of the game becomes
"smooth", almost as in a usual game (no real "shock" for Black).

Though also in the present game there is no very serious "cavalry" attack
of Black, helping White as usual, on the whole the advance of the black
figures, occurring during these 10 moves is systematic, very massive, and
we come to a sufficiently closed and "well-defined" position in which Black
successfully tries to increase the pressure, while White has the simple usual
defence targets, which helps it to play sufficiently well in order to achieve a
difficult draw. As usual, in order to simplify the situation, White tends to
exchange the figures, and, fortunately, the position becomes open too late

for Black to show its combinational force.

The tenth game:
1. Nb1-c3 Ng8-f6 2. Nc3-b5 Nb8-c6 3. Ng1-f3 a7-a6 4. Nb5-a3 d7-d5 5. Na3-b1 e7-e6 6. Nf3-h4 Bf8-d6 7. Nh4-f3 o-o 8. Nf3-g1 Nc6-b4 9. Nb1-c3 d5-d4 **10. Nc3-b1** Nf6-e4 11. d2-d3 Ne4-c5 12. Ng1-f3 e6-e5 13. g2-g3 Bc8-g4 14. Bf1-g2 f7-f5 15. o-o Bg4xf3 16. e2xf3 Qd8-d7 17. a2-a3 Nb4-d5 18. Nb1-d2 Qd7-f7 19. Nd2-b3 Nc5xb3 20. c2xb3 f5-f4 21. Rf1-e1 f4xg3 22. h2xg3 Qf7-f5 23. Qd1-d2 c7-c5 24. Re1-e4 Rf8-f7 25. Qd2-g5 Ra8-f8 26. Qg5xf5 Rf7xf5 27. Bc1-d2 b7-b6 28. Ra1-c1 Bd6-c7 29. Rc1-e1 b6-b5 30. Kg1-f1 Rf5-h5 31. g3-g4 Rh5-h4 32. Bd2-g5 Rh4-h2 33. Kf1-g1 Rh2xg2+ 34. Kg1xg2 h7-h6 35. Bg5-d2 Nd5-f6 36. Re4xe5 Bc7xe5 37. Re1xe5 Nf6-d7 38. Re5-d5 Nd7-f6 39. Rd5xc5 Rf8-e8 40. Kg2-f1 Re8-f8 41. Rc5-c6 Nf6-d7 42. Rc6xa6 Nd7-c5 43. Ra6-b6 Nc5xb3 44. Bd2-b4 Rf8xf3 45. Rb6xb5 Rf3xd3 46. Kf1-e2 Nb3-c1+ 47. Ke2-f1 Rd3-d1+ 48. Kf1-g2 Kg8-h7 49. a3-a4 Nc1-d3 50. a4-a5 Nd3xb2 51. a5-a6 Rd1-a1 52. Bb4-a5 d4-d3 53. a6-a7 d3-d2 54. a7-a8=Q Ra1-g1+ 55. Kg2xg1 d2-d1=Q+ 56. Kg1-g2 Qd1xg4+ 57. Kg2-h1 Qg4-c4 58. Qa8-d5 Qc4-f1+ 59. Kh1-h2 Qf1xf2+ 60. Qd5-g2 Qf2-h4+ 61. Qg2-h3 Qh4-e7 62. Qh3-f5+ g7-g6 63. Qf5-e5 Qe7-h4+ 64. Kh2-g1 Qh4-g4+ 65. Kg1-h1 Qg4-h3+ 66. Qe5-h2 Qh3-f1+ 67. Qh2-g1 Qf1xb5 68. Qg1-a7+ Kh7-g8 69. Qa7-a8+ Kg8-f7 70. Qa8-f3+ Kf7-e6 71. Qf3-e4+ Ke6-d7 72. Qe4-d4+ Kd7-c8 73. Qd4-c3+ Nb2-c4 74. Ba5-b4 g6-g5 75. Qc3-h3+ Qb5-d7 76. Qh3xh6 Qd7-b7+ 77. Kh1-h2 Qb7xb4 78. Qh6xg5 Qb4-d2+ 79. Qg5xd2 Nc4xd2 80. 1/2-1/2

Another such game; the helpful role of the tracks of white Knights suggests a new ("corrida") variant of chess

The next *game* also employing 10 "almost free moves" is somewhat different, because the long tracks of white knights "psychologically" caused Black to organize a sufficiently serious attack, and I was again lucky with a difficult draw. The role of the knights tracks will lead us to a constructive suggestion of a new version of chess.

The eleventh game:
1. Ng1-h3 Nb8-c6 2. Nh3-f4 Ng8-f6 3. Nf4-d3 d7-d6 4. Nd3-f4 e7-e5 5. Nf4-h3 h7-h6 6. Nh3-g1 Nc6-b4 7. Nb1-a3 Bc8-e6 8. Na3-b1 Nb4xa2 9. Ng1-f3 Be6-d5 **10. Nf3-g1** Bf8-e7 11. Ng1-f3 Na2xc1 12. Qd1xc1 o-o 13. d2-d3 Bd5xf3 14. e2xf3 Nf6-d5 15. Nb1-c3 Be7-g5 16. Qc1-d1 Nd5xc3 17. b2xc3 Qd8-d7 18. g2-g3 Qd7-c6 19. c3-c4 b7-b5 20. c4xb5 Qc6xb5 21. Bf1-g2 Qb5-b4+ 22. Ke1-e2 Bg5-f6 23. Rh1-e1 e5-e4 24. Ra1-b1 e4xd3+ 25. Qd1xd3 Ra8-e8+ 26. Ke2-f1 Re8xe1+ 27. Rb1xe1 Bf6-c3 28. Re1-d1 Rf8-e8 29. Kf1-g1 Re8-e1+

30. Rd1xe1 Bc3xe1 31. f3-f4 Qb4-d2 32. Bg2-e4 Be1xf2+ 33. Kg1-g2 Qd2xd3
34. Be4xd3 Bf2-d4 35. Kg2-f3 a7-a5 36. Kf3-e4 Bd4-g1 37. h2-h3 a5-a4 38.
Bd3-c4 a4-a3 39. g3-g4 c7-c6 40. Bc4-a2 d6-d5+ 41. Ke4-e5 Bg1-e3 42. f4-f5
Be3-c5 43. Ba2-b3 d5-d4 44. Bb3-a2 Kg8-f8 45. Ba2-b3 Kf8-e7 46. Bb3-a2
Bc5-b6 47. Ba2-b3 Bb6-a7 48. Bb3-a2 c6-c5 49. h3-h4 Ba7-b8+ 50. Ke5-d5
Bb8-d6 51. g4-g5 h6xg5 52. h4xg5 Ke7-d7 53. g5-g6 f7xg6 54. f5xg6 Bd6-e7
55. Ba2-b3 Be7-f8 56. Bb3-a2 Bf8-d6 57. Ba2-b3 Bd6-e7 58. Bb3-a2 Be7-f8
59. Ba2-b3 Kd7-e8 60. Kd5-e6 Bf8-e7 61. Bb3-a2 Be7-d8 62. Ba2-b3 Ke8-f8
63. Ke6-d7 Bd8-e7 64. Bb3-a2 c5-c4 65. Ba2xc4 Be7-g5 66. Bc4-a2 Bg5-f4
67. Ba2-b3 Bf4-h2 68. Bb3-a2 Bh2-g3 69. Ba2-b3 Bg3-f2 70. Bb3-a2 Bf2-e3
71. Ba2-b3 Be3-g1 72. Bb3-a2 Bg1-f2 73. Ba2-b3 Bf2-g3 74. Bb3-a2 Bg3-e1
75. Ba2-b3 Be1-d2 76. Bb3-a2 Bd2-g5 77. Ba2-b3 Bg5-e3. 1/2-1/2

I tried to realize the idea of 10 "almost free moves" in some more games,
but early attacks of Black often become crucial. After a dozen of games, I
concluded that 10 such moves is really the *maximum* against this Program.

Probably, for chess on more than 64 squares, and more figures involved,
the number of the strange moves might be increased, and, probably, there
should be a connection here between these figures/numbers, "10" and "64",
of which the first is close to length of the line of the board, i.e. to the square
root of the area, if to simplify the things.

Considering that the long initial tracks of White Knights bother Black
to confidently develop initiative, and that for a larger board there would be
more place for such tracks, one can suggest, say 10x10 board with 4 knights
(make the knights "double" at each side) instead of 2 for each side, two
more pawns for each, and all the rest as usual. (Or, at least, 8x10 with the
same number of figures as now.) Such a game at the initial stage would look
for White like a Corrida Bullfight, if White is obliged to return to initial
position. Seems to be interesting even for a competition.

Some other attempts of the "generous" start, and the "principle of symmetry" for the two-side play of the Program in the confusion state

I also tried some other "generous" (or half-generous) starts, not based on
the "dance" of the white Knights. All of them were less elegant as regards
the basic idea, and I would not recommend them for such an experiment.

In one of them, White started with d3 and then Qd1-d2-d1-d2 ... Soon,
one of the moves Qd1-d2 was responded to by Black by the unexpected
Ng8-h6. The next move of this Knight to the square g4 explained all, —
the sweetness of the square f2 was prevailing, and Black just used that the

Queen at d2 does not let Bc1xh6. I found this "killing straightforwardness" of Black unattractive.

Another attempt was b3 and g3 and then Bc1-b2-c1 ... and Bf1-g2-f1 ... This led to a mostly very difficult (and thus non-recommended) game, and at a certain stage to a very difficult to evaluate position in which White had two light figures against Rook and two pawns of Black.

Last, but not least, I returned to the idea of the fourth game (Section 2.3) and was trying to let the Program play for both sides, but now *immediately* after the reconstruction. My impression is that in such positions my patient approach is better for White than the energetic play of the Program for both sides. The Program makes White too active, which is not justified by its poor development, and I observed that White sometimes quickly gets into trouble.

This means that the Program has a "two sided" problem in estimating the strange position, i.e. for the Position of Black already confused, the program does not play well for either side. This is not strange, in fact, because the Program thinks also for both sides, and it is not so important which side of the board belongs to it.

However, let us be complimentary to the Program and show its following "successful" game, where Autoplay was used starting from the seventh move, causing White to win in a rather combinatory play, not in my style. This is the "successful" game.

Twelfth game:
1. Ng1-f3 d7-d5 2. Nf3-g1 Ng8-f6 3. Nb1-c3 d5-d4 4. Nc3-b1 Nb8-c6 5. Nb1-a3 e7-e5 **6. Na3-b1** Nf6-g4 7. f2-f3 Ng4-f6 8. e2-e4 Bf8-e7 9. Bf1-b5 o-o 10. Bb5xc6 b7xc6 11. Ng1-e2 Bc8-e6 12. o-o Ra8-b8 13. d2-d3 c6-c5 14. f3-f4 Qd8-d6 15. f4xe5 Qd6xe5 16. c2-c3 Be7-d6 17. Bc1-f4 Qe5-h5 18. c3xd4 Be6-g4 19. Nb1-c3 Rb8xb2 20. Bf4xd6 c7xd6 21. Qd1-c1 Rb2xe2 22. Nc3xe2 Bg4xe2 23. Rf1-f5 Qh5-g4 24. Rf5-g5 Qg4-h4 25. d4xc5 d6xc5 26. Rg5xc5 Be2xd3 27. Rc5-c8 Qh4xe4 28. Rc8xf8+ Kg8xf8 29. Qc1-a3+ Kf8-e8 30. Qa3xa7 Qe4-e5 31. Ra1-c1 Bd3-f5 32. Qa7-a8+ Ke8-e7 33. Qa8-a7+ Ke7-f8 34. Qa7-a8+ Nf6-e8 35. Rc1-d1 Bf5-g4 36. Rd1-b1 Bg4-d7 37. Kg1-h1 Bd7-f5 38. Rb1-d1 Bf5-c2 39. Rd1-f1 f7-f5 40. Qa8-d8 Qe5-e2 41. Rf1-g1 Qe2-d3 42. Qd8-h4 Ne8-f6 43. Qh4-f2 Bc2-d1 44. Rg1-f1 Bd1-g4 45. Rf1-c1 Nf6-e4 46. Rc1-c8+ Kf8-f7 47. Qf2-a7+ Kf7-g6 48. Rc8-c1 Bg4-d1 49. Rc1-c6+ Ne4-f6 50. Rc6-c7 Qd3-f1+ 51.Qa7-g1 Qf1xg1+ 52. Kh1xg1 Nf6-d5 53. Rc7-d7 Nd5-e3 54. Kg1-f2 f5-f4 55. g2-g3 Ne3-g4+ 56. Kf2-g1 f4xg3 57. h2xg3 Bd1-c2 58. Rd7-d2 Bc2-b1 59. a2-a4 Ng4-e5 60. Rd2-d6+ Kg6-f5 61. a4-a5 Kf5-g4 62. Kg1-f2 Ne5-d3+ 63. Kf2-g2 Nd3-c1 64. Rd6-d4+ Kg4-f5 65. a5-a6 Nc1-e2 66. Rd4-b4 Ne2-c3 67. a6-a7 Bb1-a2 68. Rb4-d4 Nc3-b5 69. a7-a8=Q Nb5xd4

70. Qa8xa2 Kf5-e5 71. Qa2-g8 Nd4-e6 72. Qg8xh7 g7-g5 73. Qh7-d3 Ke5-f6
74. Kg2-f3 Kf6-e5 75. Kf3-g4 Ne6-c5 76. Qd3-f5+ Ke5-d4 77. Kg4-f3 Kd4-c4
78. Kf3-e3 Nc5-b3 79. Qf5xg5 Kc4-b4 80. g3-g4 Nb3-c5 81. Qg5-d5 Nc5-a6
82. Ke3-d4 Resigns

An overview

The general impressions are as follows:

The effectiveness of the psychological start is increased by the number of "almost free moves" given to Black. This is natural since the basic idea is to start the development of White using the closeness of Black, and in order to be really close, the black figures need a sufficient number of moves. However, with the increase in the number of "almost free moves" it becomes easier for Black to start an attack and thus to force White to stop being generous. Thus, the tactic of White is to carefully watch the threats of Black while still making it possible to "invite" Black to be closer.

For this Program, this tactic cannot continue for more then 10 moves, and not only because there are more and more possibilities for Black to start an attack. The point is also that after so many moves, the closely approaching Black already succeeds in coordinating its figures.

Discussion and conclusions

On the concept of the "best move"

Though the Reader can assume that the following argument is "put forward" by the very unusual game situation in focus, the point raised is rarely discussed, and it is indeed worth stressing that the concept of "best move" lacks many aspects that are just needed in order to see the game in a wide context.

In his commentaries on the games of grandmasters [5], Anatoly Karpov says several times: *"The game enters the stage of unobservable complications"*, and it seems to be important here also to consider the problem of the use of the concept of the "best move", because apart from the rare cases when the Program obviously waits for (anticipates) a typical elementary mistake, it should be seeking the "best move".

My general old observation (impression) on chess, further supported by the present investigation, is that most chess positions have no "best move". The logical problem is that we can point at the "best move" in an *understood* position, but this understanding will be never complete until we see/find

this "best move". Though the concept "best move" is applicable to many positions, this quite objective "faulty logical circle" makes, in general, chess strategy not quite deterministic; the chess position usually is some poorly defined situation, not adjusted to any standard optimisation in terms of unique functions. The decision that a move is good (signed as "!" or "!!") is sometimes justified by the final victory, but the decisions are sometimes changed by later analysis. (Some such examples are found even in classical games.)

Of course, the development of the art of chess is naturally done via well-analysed positions with best moves found *post factum*. However, the "number" of the chess positions having the "best move", compared to the positions not having it, seems to be something like the power of a countable set compared to that of a continuum. That is, we can have as much as needed of positions with a best move, helpful for any didactic chess-learning, but these positions are extremely rare among all the possible positions.

I think that clear understanding that there is no any "best move" in many positions belongs to Lasker. That is, his so-called "psychological" approach was, first of all, based on this correct *scientific observation*.

Summary and questions

1. We have generalised Alyochin's defence to an *Alyochin-type start*, giving in it initiative to the unusually playing White. Based on our experiment, we see such a strategy as a disarming the opponent (the Program), in the sense that it can take the program out from the "library", and make it confused for a long time because of having the wrong impression about your real strength, and because of difficulty in returning to the library sufficiently quickly. Most paradoxically, such a passive defence of White often does not seem to be *objectively* weak, because the undeveloped position of White *finally* aids (via simplicity of the targets, and the confusion of Black) further development. The sixth game demonstrates that the taking Black out of the library does not necessarily cause unjustified attacks, just a very indecisive play. During the easy development (advance) Black does not take care about good coordination between all of its figures. This is contrary to the case of usual play when good coordination is dictated by the understood continuous pressure (or resistance) of White.

Of course, these observations might be incorrect for a stronger program, but the fact is that a programmed *machine can* show clear signs of nervousness, i.e. unjustified early attacks, and also depression, i.e. unusually weak play *for many moves* after it is taken out from its library, and the fact is

that my scores against the program were strongly improved.

2. How stable is the use of the (serious) internal library by the program, and how to check this stability most simply? In which cases can we check the stability by asking the program to play, starting from a particular moment, for both sides?

3. The conclusion that machine is stronger than human player has to be reconsidered, since the psychology can "improve" the human player. Since inclusion of the "psychology" into a program is, in principle, also possible, the conclusions re relative strengths of different programs should be then also reconsidered.

4. Is the assumption that a Program can be troubled by symmetry of the opponent's constructions correct?

5. Considering that for a larger board there would be more place for initial confusing tracks of white Knights, we suggest 10x10 board chess game, the "Chess Corrida Bullfight", with 4 knights instead of 2 for each side (or 8x10 with the same figures as now), in which White is *obliged* to at least once reconstruct its initial position, and, optionally, perform at least one loop with at least one of the knights.

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Présentation d'informations décisionnelles à partir de jeux de plateau: illustration du potentiel du jeu de Dames chinoises

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Résumé: *La visualisation d'informations est un champ de recherches qui prend de plus en plus d'importance. L'un de ses objectifs est de contribuer au processus décisionnel que cela soit pour une aide à l'identification, au tri, à la communication ou la mémorisation d'informations. Nous abordons ici l'apport potentiel d'un type particulier de visualisations d'informations: la présentation d'informations à partir de jeux de plateau. Après en avoir présenté globalement les caractéristiques et intérêts, nous prenons comme exemple le jeu des Dames chinoises pour figurer l'exploitation de ce type de visualisations. Dans ce cadre, nous comparons une présentation d'informations issue des Dames chinoises à trois techniques de présentations d'informations: les diagrammes en barres, les graphes en radars et les visages de Chernoff.*

Mots-Clés: Visualisation d'information, Jeu de plateau, Jeu de stratégie, Diagramme, Analogie, Analyse multivariée

Introduction

La visualisation d'informations est un domaine à la fois ancien et en plein essor [9, 13]. Elle joue depuis très longtemps un rôle important dans l'aide à la décision [11]. De nombreuses techniques ont déjà été développées pour aider à identifier, trier et analyser des informations dans un but décisionnel [22]. Cependant, il semble que la visualisation d'informations à partir de

jeux de plateau ait été assez négligée. Il existe, certes, quelques prises en compte de sa dimension ludico-géographique [7, 4], mais l'utilisation de son potentiel informationnel est presque oublié. En effet, si le potentiel des jeux pour des activités non ludiques est désormais admis grâce au développement des *serious games* [1], il semble que la dimension vidéo ludique des jeux desquels ils s'inspirent réduise considérablement l'intérêt porté aux jeux sur plateau. Pourtant, ces jeux sont aussi nombreux et ont un potentiel aussi intéressant que leurs cousins numériques. Le plateau qui leur sert de support se réduit souvent à un espace à deux dimensions. Les pions qui y prennent place peuvent être regardés, soit en trois dimensions comme dans le jeu réel, soit sous la forme de projections sur un espace à deux dimensions. Nous sommes donc en présence de supports visuels qui peuvent facilement être transposés sur des écrans d'ordinateurs. De plus, ils peuvent retrouver leur positionnement originel, c'est-à-dire à plat sur une table, avec les tablettes informatiques et les smartphones qui sont maintenant largement disponibles. Ainsi, si nous restons uniquement dans le domaine ludique, nous pouvons lister, un certain nombre de jeux de plateau qui ont déjà leur équivalent sous la forme de jeux vidéo. Parmi ceux-ci, nous pouvons relever tous les jeux anciens encore joués: *Backgammon*, *Dames*, *échecs*, *Go*, *Solitaire*, ... De même, des jeux de plateau plus récents devenus des classiques ont aussi été transposés sur informatique: *Monopoly*, *Othello*, *Risk*, *Scrabble*, *Stratego*, *Trivial pursuit*, ... Ce phénomène touche aussi des jeux très récents: *Blokus*, *Les colons de Catane*, *Les aventuriers du rail*, *Mémoire 44* ...

Nous souhaitons donc aborder l'intérêt de ce type de jeu pour aider à la visualisation d'informations. Pour ce faire, nous commencerons par présenter les jeux de plateau et certains classements qui leurs ont été consacrés. Puis, nous ferons un parallèle entre la visualisation d'informations et les jeux de plateau pour mieux mettre en évidence leur potentiel. Ensuite, nous aborderons quelques travaux qui ont précédemment été réalisés dans cette optique. Enfin, nous prendrons comme exemple le jeu des *Dames chinoises* pour figurer l'exploitation du potentiel d'un jeu de plateau pour visualiser de l'information. Dans ce cas, nous comparerons les *Dames chinoises* à trois techniques de présentations d'informations multivariées: les diagrammes en barres, les graphes en radars et les visages de Chernoff.

Présentation des jeux de plateau

Il existe un très grand nombre de jeux. De manière simple, nous pouvons les considérer comme des passe-temps qui peuvent selon le cas, se jouer ou

non autour d'une table. Parmi les jeux qui nécessitent habituellement une table, nous pouvons retrouver les jeux de plateau, les jeux de cartes, les jeux de dés, les jeux de mots, les jeux de dextérité, les jeux de tuiles (*Dominos*) et les jeux de mémoire (Whitehill, 2009). Les jeux de plateau ont été étudiés à de nombreuses reprises. Parmi les classements réalisés, celui de Murray [18] est l'un des plus référencés. Cette classification tient compte des jeux d'alignement (*Marelle, Morpion*), de configuration (*Dames chinoises* et jeu de *Halma*), de guerre (*échecs*, *Go*), de chasse (*Le renard et les poules*, *Solitaire*), de course (*Jeu de l'oie*, *Backgammon*, *Petits chevaux*) et enfin les jeux de la famille des *Mancala*. Solomon (1973) a proposé une autre classification qui distingue les jeux de plateaux en quatre catégories. Boutin [8] la présente comme suit: jeux purement abstraits (*Blokus*, *Dames chinoises*, *Mancalla*, *Othello*) qui ne font pas référence à des situations réelles, les jeux abstraits thématiques (*Backgammon*, *Le renard et les poules*) oùle lien entre le plateau de jeu et ses pions avec le thème abordé n'est pas évident, les jeux thématiques abstraits (*échecs*, *Go*, *Les aventuriers du rail*, *Les colons de Catane*, *Monopoly*) qui par le biais de certains éléments de jeux font penser à la thématique, mais n'en sont pas des simulations et, les jeux purement thématiques qui sont plus ou moins des représentations et simulations d'une situation réelle (*Cluedo*, *Mémoire 44*, *The Great Battles of Alexander*). Whitehill (2009) a repris en partie la classification de Murray [18] pour proposer une catégorisation en jeux: d'alignement, de courses, de capture oùle principe du jeu est prendre les pièces de l'adversaire (*Dames*, *Echecs*, *Mancala*, *Othello*, *Risk*), de construction (*Carcassonne*, *Les aventuriers du rail*, *Les colons de Catane*), de marchandage et de négociation (*Cluedo*, *Diplomacy*, *Les colons de Catane*) et de survie (*Survive: Escape from Atlantis*, *Vineta*) oùles joueurs doivent faire durer le plus longtemps leurs pions alors que le plateau se désagrège à chaque tour de jeu. L'intervention du hasard durant la partie ainsi que le nombre de joueurs [8] ou encore le nombre d'informations représentées sur les pions et le type de cartes peuvent aussi permettre de classer les jeux [15]. Mais, nous pouvons encore aller au-delà. à partir de l'un ou l'autre des classements ci-dessus, nous pouvons encore trouver d'autres critères. Certains jeux peuvent être qualifiés de stratégiques par rapport à ceux fondés surtout sur l'adresse d'un joueur ou le hasard, d'autres de coopératifs (*Bioviva*, *Horreur à Arkham*) vis-à-vis de la majorité des jeux compétitifs (*Cluedo*, *Dames*, *Petits chevaux*). Quoi qu'il en soit, les jeux de plateau se distinguent avant tout des autres jeux de société du fait qu'ils font appel à des représentations spatiales qui tiennent lieu de support au déroulement de la partie.

Potentiel des jeux de plateau pour présenter de l'information

Selon Card et al [9], la visualisation d'information permet, notamment, d'améliorer la mémorisation des informations présentées, de faciliter la reconnaissance de structures cohérentes, de schémas et de relations entre éléments représentés. Elle permet ainsi de contribuer au processus décisionnel et cela reste valable même si les éléments affichés n'entretiennent au départ aucune relation de nature spatiale [5]. Afin de guider le processus de conception d'une "bonne" représentation visuelle d'informations, Chabris et Kosslyn [10] ont établi le principe de correspondances représentationnelles. Ce dernier stipule que pour qu'un diagramme soit effectif, il doit dépeindre l'information qu'il présente de la même manière que nos représentations internes le font [10]. En d'autres termes, une présentation visuelle d'informations est plus performante si elle fait appel à des éléments auxquels nous nous sommes déjà référés pour réfléchir. Nous nous fondons sur ce principe pour supposer que si une personne est déjà sensibilisée à un jeu de plateau, si nous développons une représentation visuelle d'informations à partir de ce dernier sans trop nous éloigner de ses fondamentaux, alors l'efficacité de cette présentation sera plus performante qu'une autre. En effet, les jeux de plateau lorsqu'ils sont connus des personnes qui y jouent aident à faire le lien entre des représentations cognitives internes et externes (Zhang, 2000). Lorsque nous considérons les jeux de plateau à partir de leur support, au moins le temps d'une partie, ce support est figé. Nous sommes en présence d'une cartographie d'informations. Celle-ci, une fois regardée par deux personnes ou plus peut servir de représentation partagée pour discuter de choix stratégiques ou tenter de résoudre certains problèmes [16]. Le plateau permet de percevoir directement une configuration nouvelle, une divergence d'opinions. En tant que système de schématisation visuelle, ce type de représentation d'informations contribue autant chez le public expert que chez les novices à augmenter significativement les capacités de résolution de problèmes (Casakin et al, 1999). En référence au jeu d'échecs, Libaert [17] a souligné que l'un des grands intérêts de la compréhension d'informations à partir d'un jeu de stratégie reposait sur l'idée de plan qu'il suscite. Il ne s'agit pas seulement d'envisager un seul coup, mais de prendre en compte si possible les suivants ainsi que ceux de vos adversaires. Une présentation d'informations par analogie à un jeu de plateau crée donc une sorte de dynamique d'anticipation et de réflexion.

Autres travaux sur les jeux de plateau et la présentation d'informations

Nous pouvons faire référence à quelques travaux qui ont montré le potentiel de certains jeux pour aider à communiquer ou raisonner. Utilisé tel que, Yosuda (2003) présente le *Go* comme un outil de communication. Par-delà le jeu lui-même, cet auteur montre le plaisir que prennent les enfants à participer à une partie de *Go*, à encourager leurs camarades ainsi qu'à développer des stratégies efficaces. Une fois les règles assimilées et la partie entamée, le fait de poser des pierres (les pions du jeu de *Go*) suscite l'enthousiasme et surtout l'envie de jouer le prochain coup au mieux. Concernant ce même jeu qui a semble-t-il fait l'objet du plus grand nombre d'études, Boorman [6] s'en sert pour expliciter les campagnes militaires et insurrections des troupes communistes chinoises entre 1937 et 1948. Au cas par cas, il réalise une correspondance analogique entre une carte géographique et le plateau de jeu qui transforme les voies de communication en lignes, les villes en intersections et les frontières de la Chine en limites du plateau de *Go*. Les pions joués correspondent alors aux villes contrôlés par tel ou tel camp. Saucin [20] a développé un autre système de représentation à partir du *Go*. Il s'y intéresse pour expliquer le développement économique du Japon entre la fin du XIXe siècle et la Deuxième Guerre mondiale. Dans ce cadre, le plateau de *Go* correspond à un ensemble de secteurs d'activités ou de marchés. Les intersections du jeu correspondent à des marchés ou des parts de marchés selon l'échelle de correspondance choisie. Les pierres, au cas par cas, sont associées à des produits, des services ou à des entités juridiques. Pour réaliser sa transposition, il utilise quelques principes simples. Puisque le plateau de *Go* est constitué de plusieurs secteurs quadrillés d'inégales importances, il propose de faire correspondre l'importance de ces zones avec l'importance relative de tel ou tel secteur d'activités. Comme le plateau se présente sous la forme d'une matrice, chacune des zones est en contact avec plusieurs autres. Ces zones sont liées en fonction des moyens technologiques ou intellectuels qu'elles nécessitent en partant des coins du plateau qui symbolisent les secteurs les plus basiques (Alimentation, Textile, . . .). Enfin, Goria [14] a utilisé un système similaire pour mettre en évidence des distinctions dans les choix de programmation des chaînes de télévisions M6 et TF1. Il fonde sa représentation sur une matrice dont les colonnes correspondent à des créneaux horaires conjugués à un groupe de jours de la semaine et les lignes à des catégories de programmes télévisés proposés. Les colonnes d'une part et les lignes d'autre part sont réparties de manière à ce

que les résultats des meilleurs audimats qui leurs correspondent forment une courbe en cloche (c'est-à-dire que la répartition de leurs valeurs ressemble à une distribution gaussienne). Les pions du jeu sont ensuite posés selon un code de trois couleurs: occupés seulement par TF1, occupés seulement par M6, occupés par les deux chaînes. L'intérêt de ce type d'analogie est de voir si une logique d'ensemble peut être déduite chez l'un ou l'autre camp.

Concernant le jeu d'*échecs*, Young [24] a développé un système pour représenter et raconter le déroulement d'une bataille historique du type des guerres napoléoniennes. La bataille de *Waterloo* est ainsi racontée. Pour cet auteur, il existe un lien qui peut être établi entre l'importance de certains lieux topographiques liés à la bataille concernée et les cases de l'échiquier, celles du centre étant les plus importantes. Chacun des *Rois* est associé à un chef d'armée et les *Reines* à un corps d'élite. L'ensemble des autres pièces correspond à différents corps d'armée. De plus, une analogie est faite entre la capacité de mouvement des pièces et leurs capacités de protection (par exemple, un *Cavalier* peut, par sa capacité de déplacement, protéger un *Pion* en menaçant une pièce qui si elle prenait ce pion serait prise au tour suivant) avec les lignes de communication qui existent entre corps d'armée. Si ces lignes sont coupées par l'ennemie, cela représente toujours un danger. Palhares [19] signale que quelques années plus tard, Ansur [3] a adapté ce système pour représenter le déroulement d'une bataille du Moyen-âge. Pour cela, il fait le rapport entre pièces à déplacement important dans le jeu (*Cavalier*, *Tour*, *Fou*, ...) avec la cavalerie dans la bataille de référence, les *Pions* avec l'infanterie et le *Roi* avec le chef de l'armée. Au niveau des mécanismes du jeu, la correspondance est établie si la bataille choisie est gagnée par la prise du chef adverse.

Illustration avec les *Dames chinoises*

Pour démontrer l'intérêt de l'utilisation de jeux de plateau pour présenter de l'information, nous prenons l'exemple d'un autre classique des jeux de plateau: les *Dames chinoises*.

Historique et règles

D'après Boutin [8], les *Dames chinoises* apparaissent en 1892 sous le nom de *Stern-Halma*. Ce jeu est donc une variante du jeu de l'*Halma*, ce qui se retrouve dans leurs mécanismes qui sont quasi identiques. L'*Halma* est un jeu pour 4 joueurs maximum, tandis que les *Dames Chinoises* permettent de jouer jusqu'à 6 joueurs. Les cases sur lesquelles sont posés les pions forment

dans le cas de l'*Halma* un carré et une étoile pour les *Dames chinoises*. A l'*Halma*, à 4 joueurs, 4 séries de 13 pions de couleurs différentes sont utilisées. Aux *Dames chinoises*, chaque joueur dispose de 10 pions de sa couleur. Les pions sont en général des billes toutes identiques couleurs exceptées.

Au début de la partie, les pions d'un joueur sont rangés dans un même coin de manière à ce qu'ils le remplissent (figure 1). Le but du jeu est d'amener en premier tous ses pions dans le coin opposé. Chaque joueur, à son tour, peut déplacer un pion dans n'importe quelle direction par glissement sur une case adjacente libre ou par saut au-dessus d'un autre pion si la case sur laquelle il doit atterrir est libre. Un saut ne permet d'enjamber qu'un seul et unique pion à la fois, mais une série de sauts est possible en un seul coup si les places libres et les pions sont alternés. Les cases localisées dans les coins des autres joueurs peuvent servir pour faire passer des pions, mais ils ne peuvent si arrêter sauf s'il s'agit de leur objectif. Un joueur qui laisse l'un de ses pions se faire bloquer sur sa case de départ perd directement la partie et ses pions sont retirés su plateau.

FIGURE 1 – Configuration de départ aux Dames chinoises

Mécanismes de transposition

Le plateau de *Dames chinoises* possède une configuration abstraite de 121 cases (ou intersections selon le point de vue). Il s'agit d'un jeu compétitif où 6 joueurs s'affrontent. Les *Dames chinoises* ont donc un potentiel pour présenter une comparaison abstraite entre 6 groupes de variables dont on cherche à estimer la valeur relativement aux autres. Comme chaque joueur

dispose de 10 pions, nous pouvons supposer qu'une présentation d'informations à partir de ce jeu peut compter jusqu'à 10 variables (13 pour l'Halma).

Selon nos hypothèses, la représentation d'informations par analogie aux *Dames chinoises* est a priori un outil destiné à présenter de l'information issue de multiples variables, c'est-à-dire que cette représentation possède des qualités pour réaliser des analyses multivariées. C'est donc vers ce type d'outils que nous allons nous tourner pour estimer le potentiel propre aux *Dames chinoises*. Pour y parvenir, il nous faut identifier le genre de transposition d'informations réalisable sous la forme d'une partie de ce jeu.

La première idée que nous pouvons émettre consiste à utiliser les 13 cases que doit emprunter tout pion pour rejoindre sa position optimale. Nous pouvons ainsi évaluer de 0 à 13 les valeurs des 10 variables associées à chaque pion d'un joueur ; ce dernier figurant, par exemple, un objet ou un produit analysé. Si, le nombre d'emplacements disponibles au centre pose problème pour des scores identiques, la règle du positionnement relatif peut être utilisée: en cas de conflit de places, le pion avec la valeur la plus forte est placé sur la trajectoire la plus courte de son objectif.

La même idée peut être perfectionnée. Nous divisons le plateau en secteurs pouvant accueillir au moins le nombre de pions de chaque joueur. Nous pouvons alors exploiter une échelle de valeurs de 5 à 8 positions dont certaines correspondent à une, deux ou trois rangées. De plus, dans les règles des *Dames chinoises*, si un pion est bloqué sur sa position initiale, il met en péril l'ensemble du groupe auquel il appartient. Cette référence peut nous aider à repérer des risques associés à une variable n'ayant pas atteint une certaine valeur minimale. Ainsi, nous disposons d'une méthode pour présenter jusqu'à 6 groupes de 10 variables ayant des valeurs entre 0 à 5. Si avec 10 variables les conflits au centre risquent d'être trop importants, le plateau peut être agrandi en ajoutant une rangée supplémentaire de cases.

Nous pouvons aller plus loin dans la présentation d'information via les *Dames chinoises*. En effet, nous pouvons faire correspondre le cheminent des pions avec une représentation par chacun des pions du jeu d'un groupe de variables à la place d'une seule. Toutefois, dans ce cas chacune des variables ne pourra prendre que 2 valeurs. Ainsi, les combinaisons relatives à 6 variables qui peuvent prendre 2 valeurs sont les suivantes: (1) 1 –(2) 6 –(3) 15 –(4) 20 –(5) 15 –(6) 6 –(7) 1. Il existe, de la sorte, pour 6 variables: 1 seule possibilité pour que les 6 variables aient la valeur maximale et 1 seule pour qu'elles aient la valeur minimale, 2 possibilités pour que 5 des 6 variables aient la valeur maximale et 2 possibilités pour que 5 des 6 variables aient la valeur minimale, etc. Si nous divisons chacun des axes de déplacements du damier en 7 zones de positionnement (nombre entre parenthèses ci-dessus),

alors sur le même principe que précédemment nous pourrons obtenir une représentation d'informations comparant 6 objets différents à l'aide de 10 (nombre de pions)*6 variables les représentant. Ceci permet d'estimer à partir d'un seuil établi pour chaque variable si une valeur d'intérêt minimum est atteinte ou pas. De la sorte, en exploitant 8 positions sur le jeu, nous pouvons comparer jusqu'à 6 ensembles de 10 groupes de 7 variables dont les valeurs se ramènent à 0 ou 1 (dont la répartition des combinaisons est la suivante: 1, 7, 21, 35, 35, 21, 7, 1). Toutefois, plus le nombre de variables va être important et plus les conflits au centre du plateau vont être nombreux et plus l'incertitude sur les variables impliquées va augmenter.

Comparaison du système de présentation des Dames chinoises avec trois autres techniques d'analyse multivariée

Afin d'estimer le potentiel des *Dames chinoises* pour visualiser de l'information, nous comparons sa présentation avec celles sous la forme de diagrammes en barres, d'un graphique en radars et de visages de Chernoff. Pour cet exemple, nous utiliserons la seconde méthode de transposition citée ci-dessus ; nous partirons d'un exemple de 6 groupes de 8 variables. En fait, chacune de ces variables est pondérée sur une échelle de 0 à 4. Ceci correspond, notamment, à un groupe de réponses estimées via une échelle de Likert. Pour l'exemple choisi, nous pouvons supposer qu'il s'agit de l'estimation de 6 différents produits par un groupe de consommateurs. Nous allons donc considérer le tableau 1 reprenant une estimation sur 8 critères (A, B, C, D, E, F, G, H) de 6 produits différents. L'objectif de la présentation est de savoir quel est le meilleur produit, quel est celui le mieux positionné, quels sont les moins bons. En référence aux couleurs des pions du jeu, les produits sont nommés pour simplifier: Rose, Jaune, Orange, Violet, Vert et Bleu.

Tableau 1 – Estimation de 6 produits Rose, Jaune ...) en fonction de 8 critères (A, B, C ...) sur une échelle de 0 à 4.

	A	B	C	D	E	F	G	H
Rose	1	2	2	3	1	2	3	2
Jaune	2	3	4	4	2	4	2	2
Orange	0	2	1	4	1	4	3	4
Violet	1	3	2	4	2	4	1	3
Vert	1	2	2	3	2	3	4	1
Bleu	1	4	3	0	1	4	3	3

Nous commençons par utiliser un diagramme en barres pour présenter ce type d'information (figure 2). Si nous ne faisons pas d'effort pour ordonner les critères A, B, C, D, E, F, G, H ; il n'est pas évident de savoir quel est le produit le meilleur, même si Rose semble être le moins bon.
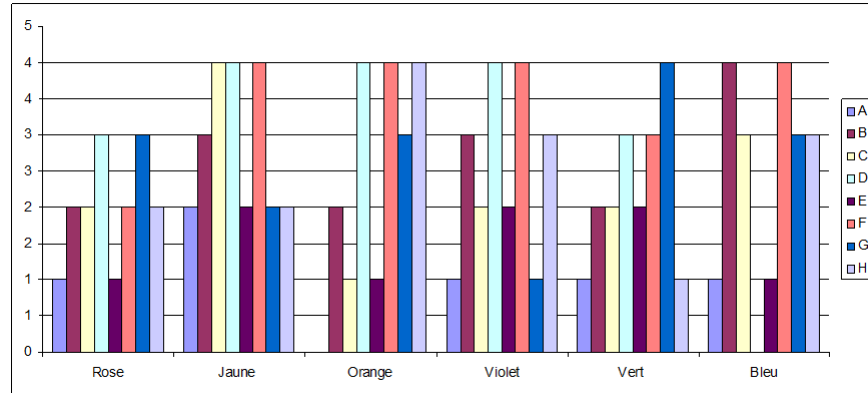

FIGURE 2 – Présentation des informations contenues dans le tableau 1 (les lettres indiquent les variables et les noms de couleurs les produits)

En fait, nous pouvons à l'aide ce diagramme repérer rapidement pour chaque produit combien de fois la valeur de satisfaction maximale est atteinte.
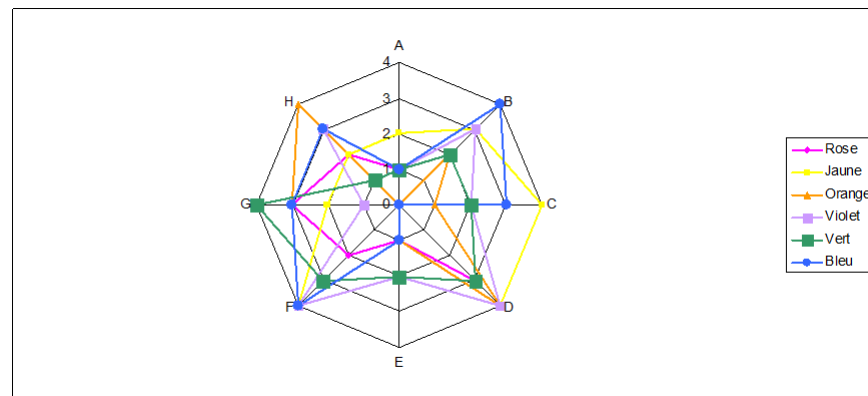

FIGURE 3 – Présentation des mêmes informations que la figure 1 à l'aide d'un graphique en radars (A, B, . . . , F indiquent le nom des variables considérées)

En élaborant un graphique en radars à partir du tableau, nous obtenons la figure 3. Pour 6 produits différents, la présentation semble est un peu confuse. De plus, les formes présentées sont dépendantes du choix de l'ordre des variables. Au moins avec ce type de graphique, nous sommes en mesure de reconnaitre quel produit à au moins une variable avec une valeur de 0 et comme précédemment lesquels ont des valeurs maximales. Le fait que Rose soit le produit le moins performant se lit moins bien sur ce graphique. Si nous considérons chacun des produits séparément pour lui associer un seul graphe radar distinct des autres, nous obtenons une série de glyphes en étoiles, ce qui revient à une technique similaire à celle des visages de Chernoff [13].

Les visages de Chernoff forment un système de représentation d'objets multivarié sous la forme de visages. A chaque variable est associé un élément du visage qui va grossir, s'agrandir, rapetisser ou se réduire en fonction de la valeur que l'on va lui faire correspondre.

La figure 4 illustre une représentation possible sous la forme de visages de Chernoff des informations du tableau 1. Dans ce cas, pour chacun des visages: le volume de la Barbe est associé à la variable A, celui des Yeux à la B, celui du Nez à la C, celui de la Bouche à la D, celui des Sourcils à la E, celui de la Tête à la F, celui du Chapeau à la G et celui des Oreilles à la H. Cette technique peut être pratique pour réaliser des rapprochements et des distinctions entre les produits considérés, mais il est difficile d'estimer la valeur associée à un critère.
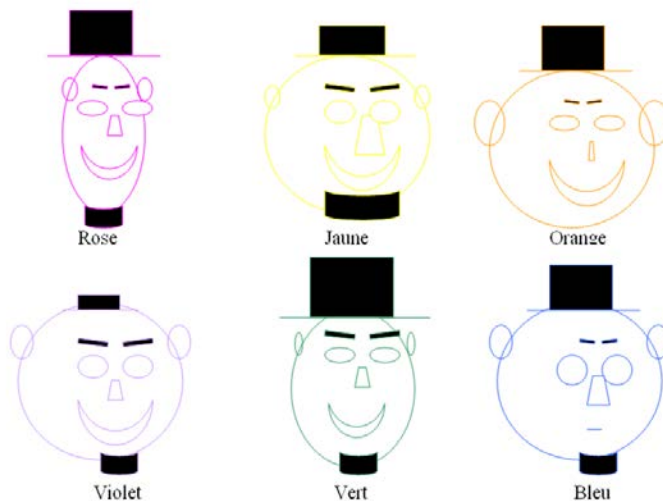

Figure 4 – Informations du tableau 1 via des visages de Chernoff

En outre, il n'est pas certain que du premier coup d'œil nous arrivions à repérer que Bleu et Orange ont une variable avec une valeur minimale. Le choix de certains éléments du visage peut perturber la perception des autres variables [12]. Dans notre cas, il semble que le volume de la tête, par le positionnement des autres éléments du visage qu'elle implique rend le critère F a priori plus discriminant que les autres. Enfin, sous la forme d'une représentation d'informations à partie du jeu de *Dames chinoises*, nous obtenons la figure 5. En utilisant la règle de positionnement suivant laquelle les valeurs les plus fortes ont la priorité sur les plus faibles, les variables ayant une valeur de 4 sont positionnées à la pointe du camp adverse. Cette zone est donc en priorité dégagée par le mouvement des pions. Ainsi, les variables avec des valeurs de 0 sont positionnées sur les lignes les plus avancées par rapport à leurs positions de départ.
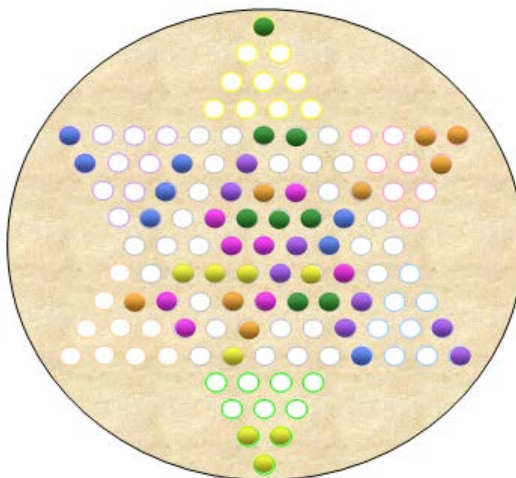

FIGURE 5 – Présentation du tableau 1 avec les Dames chinoises

Ainsi, dès que nous pouvons reconnaître les couleurs, nous pouvons à la fois avoir une idée générale de l'ensemble des positions et voir si tel ou tel ensemble n'a pas un gros point faible (Bleu, Orange) ou bien qui occupe déjà des positions optimales (Bleu, Orange, Violet, Vert, Jaune). Nous pouvons aussi nous apercevoir avec ce système de visualisation de la répartition plus homogène des valeurs associées aux produits Rose, Jaune et Violet.

Conclusion

Nous avons constaté l'intérêt que peut revêtir une présentation d'informations par l'intermédiaire d'un jeu de plateau. Le cas des *Dames chinoises* a été exploré pour illustrer les possibilités de ce classique des jeux de société. Avec ce genre de présentations, nous disposons d'une structure pratique pour considérer des informations de manières nouvelles. Bien évidemment sans accès à une image couleur, ce type de représentation est inutile. Comparativement aux visages de Chernoff, graphes en radars et diagrammes en barres, la visualisation d'informations à partir des *Dames chinoises*, possède quelques avantages et inconvénients. Notamment, nous ne savons pas directement quel critère est représenté par tel ou tel pion. Cependant, pour compenser ce désavantage, il est toujours possible d'intégrer une fonction sur une interface graphique permettant d'afficher le nom de la variable correspondante à un pion. Le nombre d'objets (ou d'avis sur un même objet) comparés est de 6 pour une présentation, alors qu'il est bien plus grand pour les autres techniques d'analyse multivariée. Toutefois, pour des usages du type évaluation d'un produit d'une entreprise vis-à-vis d'autres, ce système semble très pratique. Si le nombre de produits à comparer est supérieur à 5, il suffit de dessiner une deuxième partie de *Dames* pour pouvoir en visualiser 10, etc. Le nombre de variables utilisables varie avec le degré de précision des valeurs représentées. Pour 5 seuils de distinction, 10 variables peuvent être employées, voire 13 si l'on réduit le nombre de joueurs à 4. Si l'on peut se contenter d'une information binaire, pour 6 objets, on peut atteindre raisonnablement 48 voire 60 variables. Si les glyphes radars ou visages de Chernoff peuvent servir pour identifier des valeurs aberrantes et d'autres techniques plus complexes comme les coordonnées parallèles permettant de reconnaître celles qui n'en ont pas [22, p. 391], il semble que dans le cadre d'un *benchmarking*, par exemple, les *Dames chinoises* puissent réaliser ces deux fonctions. Ainsi, même si la représentation d'informations à partir de jeu de plateau n'est pas parfaite comme d'autres systèmes d'ailleurs, elle peut être utile pour trier, identifier et analyser des informations.

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The loop within circular three mens morris

Florian Ulrich Maximilian Heimann
introduction by *Ulrich Schädler*

Abstract *The circular version of "three men's morris" — a simple kind of nine men's morris— is considered as one of the board games of ancient Rome. Its rules have been reconstructed from different sources, such as game boards carved into stone floors and two short passages in Ovidius. The game includes a cycle consisting of only eight situations, which appears already in everyday playing and which is proved in this article. Since the reconstructed rules lead to a game which only works when one of the two players makes a big mistake, doubts can be raised as to the existence of such a game in Roman times.*

Zusammenfassung *Die Rundmühle — eine einfache Mühleform — gilt als eines der Brettspiele des antiken Rom. Seine Regeln wurden aus verschiedenen Quellen, wie etwa in Fußböden eingeritzten Spielbrettern und zwei das Spiel beschreibenden, kurzen Textstellen Ovids, rekonstruiert. Die Rundmühle enthält einen Kreislauf aus nur acht Situationen, der schon im alltäglichen Spiel zum Tragen kommt und der in diesem Artikel nachgewiesen wird. Da also die rekonstruierten Regeln ein Spiel vorschlagen, das nur dann funktioniert, wenn einem der beiden Spieler ein grober Fehler unterläuft, mögen Zweifel gerechtfertigt sein, dass ein solches Spiel in römischer Zeit überhaupt existiert hat.*

Introduction

Since, in the wake of a growing interest in Roman daily life, in the 1970s, educators working in archaeological museums have discovered Roman games, the so-called "circular merels" or "wheel-type mill" holds an unmitigated triumph. Given the number of "wheel patterns" carved into the floors of

Roman streets and squares, the game is considered to be one of the most popular board games of the "Romans", if not the only board game of which the rules have come down to us. Various commercial versions of the game can be bought in museum shops.

In his "A History of Chess" published in 1913, Murray illustrated — in a somewhat contradictory form — such a circular game board "for the Smaller Merels" next to the square one, although he had to admit that its "purpose is unknown" (Murray 1913: 614). It was Carl Blümlein who in 1918 proposed detailed rules of the game of the "wheel-type mill" ("Rundmühle" or "Radmühle" in German), along with a sample game in his "Bilder aus dem römisch-germanischen Kulturleben". In order to explain a figure showing a game board in the form of a circle crossed by four intersecting lines, Blümlein wrote (Blümlein 1918: 101-102): "3 counters belong to each game that have to be brought into a straight line; e.g. Black begins and then the players take turns placing the counters on AA', BB', CC'. After they have to move; after 6 moves Black will, according to Fig. a, have won with his 7th move" ("Zu jedem Spiele gehören 3 Steine, die man in eine gerade Linie zu setzen sich bemühen muss, z.B. Schwarz beginnt, und nun setzen die Spieler abwechselnd AA', BB', CC'. Nun muss gerückt werden; nach 6 Zügen wird bei Fig. a z.B. Schwarz mit dem 7. Zuge gewonnen haben").

Patterns in the form of a wheel with 8 spokes, i.e. circles crossed by four intersecting lines or just eight points on the circle, are often found carved into the marble floors of Roman buildings and squares. The best-known example is the Basilica Iulia at the Forum in Rome. But they can also be identified in Ephesus or Aphrodisias, for example, in large numbers. But what had not been done before Blümlein to my knowledge, was to interpret these patterns as a circular variant of the square "three men's morris" and to connect them to two verses of the Roman poet Ovidius (43 BC – 18 AD) reading:

> *"Parva sit ut ternis instructa tabella lapillis*
> *in qua vicisse est continuasse suos"* (Tristia II, 481-2)
> how a small board is provided with three counters a side,
> and winning lies in keeping them together

and

> "parva tabella capit ternos utrimque lapillos
> in qua vicisse est continuasse suos" (Ars Amatoria III, 365-66)
> a small board presents three stones each on either side
> where the winner will have made his line up together.

By interpreting Ovidius's lines, which until then philologists had hardly understood (cf. Marquardt-Mau 1886: 859 with note 2; Becker-Rein 1863: 340) as a description of the mechanism of capture of a morris game and transferring it to the circular "boards", the Roman circular merels were born.

Though the "circular merels" are not, the square shape of the "smaller merels" is, described in the "Book of Games" by the Spanish King Alfonso X from 1284 (Schädler-Calvo 2009: 295-96, 306). While Ovidius unfortunately failed to give the name of the game, Alfonso calls it "Alquerque de tres", which means "Alquerque with three counters". The game board is a square crossed by lines vertically, horizontally and diagonally. The two players have three counters, which they place alternately on one of the nine points of the intersection of the lines, before moving them from one point to a directly adjacent point. The first player to bring three stones in a line, so making a "mill", wins the game. Alfonso also gives a winning strategy for the starting player, a finding that has led to the game being regarded as a children's game, which his illustration emphasizes. Game boards of this shape as well as a simpler version without diagonal lines can be seen in large numbers in Roman cities, so we can assume that Ovid actually had these "smaller merels" in mind.

Blümlein's interpretation prevailed rapidly. Even a critical mind such as Hans Lamer considered "kreisrunde l(usoriae) t(abulae) mit acht Radien für Mühle" as "the only ancient board game from which one can say for sure that it survived". In his eyes only the question whether the circular or the square shape was the original form remained open (Lamer 1927 col. 1987, 2006). Today, Blümlein's and Lamer's views still apply and the existence of "circular merels" in Roman times is taken for granted (Väterlein 1976: 59; 1981 Montesano 2241; Rieche 1984: 20-21). Murray also shared this view, although he preferred not to mention the circular merels in the section about merels games of his "History of Board Games other than Chess" (Murray 1952: 38-40, but 18 Note 3 with Figure 7B).

Nevertheless, the circular form is not attested a morris game - anywhere in the world. As a matter of fact, Murray in the section devoted to the smaller merels in his "History of Chess", was unable to specify any one country where the circular version of the game was ever attested, unlike the case of the square smaller merels (Murray 1913: 614). Moreover, several of those wheel patterns have diameters of more than a metre or depressions at the points, which alone makes it unlikely that such a "wheel" would have served for a small merels game. It is only recently that doubts have been raised by various authors about the use and function of those wheel pat-

terns namely by Charlotte Roueché (2007), who interpreted at least some of the circles as place marks, Ulrich Schädler (paper read at the BGS colloquium 2007 at Sankt Pölten entitled "*Ashtapada* and round smaller merels: two newly invented "ancient" board games?"; see also Schädler-Calvo 2009: 299), and most recently Claudia-Maria Behling (2013) with her suggestion of a tossing game played on those circles.

Is it therefore only a witty invention by Blümlein? Amazingly, no one has yet attempted to analyse the "circular merels" according to Blümlein's rules, as has been done for the "smaller merels" in the Middle Ages and described more completely by Wilhelm Ahrens (Ahrens 1901: 85-89). It is Florian Heimann who discovered and closed this gap. He undertook this analysis as a school project in 2004 and presented it to the Board Games Studies Journal in 2006. We are happy to finally be able to publish this piece of research. He comes to the conclusion that the circular merels as described actually do not work because neither a winning strategy exists nor does the game ever come to an end, unless a player makes a big mistake. In Blümlein's example White commits this error in his 4th move: White should have foreseen that Black with his 5th move would force White to leave the centre, resulting in the immediate victory of Black. A player who moves a piece to the centre point and is therefore left with two instead of three counters on the circle, will find himself in this uncomfortable position. As long as the players avoid this situation, the game will continue without ever coming to an end, as Heimann's analysis demonstrates. It raises the questions: Can a game have existed and enjoyed great popularity even though it does not work? Were other kinds of games played on these wheel patterns? Did the wheel patterns serve completely different purposes, as several authors suggest?

Ulrich Schädler

The basis for circular three men's morris

From ancient times no explicit records of the rules of a game are preserved. The first known collection of rules dates back to the 13th century and has been commissioned by Alfonso X. King of Castilia (Schädler-Calvo 2009). Even though two authors in ancient Rome have written each an essay on games, unfortunately neither the "On the games of the Greek" of Sueton nor the "The art of the dice game" of emperor Claudius are preserved (Rieche 1984: 8). Therefore, the reconstruction of ancient games is complicated and based on findings and assumptions. In the case of the circular three men's

morris, the rules, which are commonly accepted as reconstruction, are based on two assumptions and one follow up assumption.

The first assumption says that the two mentioned passages from Ovidius (Ars amatoria III 365 – 366; Tristitia II, 481-2) refer to the carved circular patterns, which are thus interpreted as game boards in this assumption. However, apart from the not very significant attribute "parva" i.e. "small", the board of the game, which is described in the passages, is not further characterised at all. Thus, the base for this assumption is relatively small.

The second assumption refers to the aim of the game, which Ovidius describes with the word "continuare". It is assumed that the term can be perceived as "to arrange in a line" (Holzberg 1985: 139), which corresponds to the pounding mechanism of nine men's morris. However, this is just one of several possible interpretations of the term. For example, the also possible perception as "not to separate" of different other translators (W. Hertzberg at Hojer 1996: 20; Rieche 1984: 28; Rieche 1986: 45) does not make up any connection to the nine men's morris. If this assumption is correct, the game described by Ovidius and the "little merels" in the form, in which it is described for example at Alfonso X (Schädler-Calvo 2009: 295-96, 306), share the aim as well as the number of counters. Both games use three counters from two players each. Based on these agreements, which are proofed in the case of the number of counters and which are possible in the case of the aim, the follow up assumption claims the two games to share also their other mechanisms. Thus, the follow up assumption claims that the counters in the game described by Ovidius are in turns placed on the board and then moved.

To sum it up, the assumption that the passages from Ovidius refer to some kind or modification of the playing mechanisms of the "little merels" is clearly better supported than the assumption that the known circular patterns are related to these passages. Even though there is nothing to contradict this relation, there is hardly anything to support it. Based on the described assumptions, different authors have designed the rules of the circular three men's morris in the following form and accepted it as reconstruction.

Rules of the game

The board of this simpler variation of today's nine men's morris is a wheel with eight spokes (Fig. 1). The hub of the wheel i.e. the centre of the circle and the eight points, at which the spokes hit the circle, are the nine fields,

at which counters can be placed. Both parties have three counters each. In turns, the counters are first placed on the board and then moved to adjacent fields. Counters can only be placed on or moved to vacant fields. Flying or hopping is not allowed. The party, which first can arrange its counters in a line across the centre, wins the game (Blümlein 1918: 101-102; Rieche 1994: 20; Hojer 1996: 22).
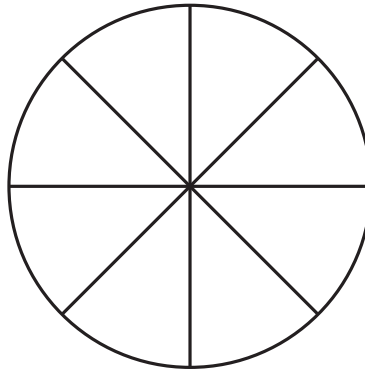

Figure 1: The board of the circular three men's morris.

Proof of a loop

During the first rounds, one can be fascinated by the apparent diversity, which the simple rules can generate on the small board. However soon, one may get the feeling that there are some main situations (e.g. Fig. 3a) which appear more frequently than others or even that the game at flawless play may loop around without ever getting to an end. This guess can be checked by the following analysis:

Given a labelling with clockwise (or counter clockwise) numbers 1 to 8 and 9 in the centre (Fig. 2), it shall be played according to the rules of the circular three men's morris starting from the situation white 1;4;6 and black 2;5;8. White plays. Moves are only allowed if they will neither lead to the loss of the game nor to situations, which have already appeared. That means the new situation may not be transformed to a previous one by any combination of rotation, mirroring or consequent (counters and play) switch of colours. {A possible transformation to a previous situation will be given in curly braces.}
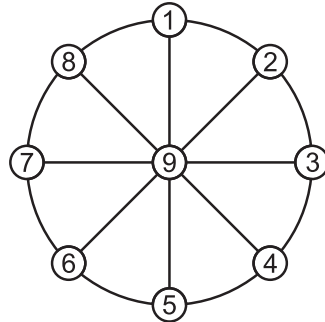
Figure 2: Circular three men's morris board labelling used in this study.

White (w): 1;4;6 black (b): 2;5;8 play(p):w is called situation a) (Fig. 3a). Now, white moves for example w 4 –9.

The new situation w: 1;6;9 b: 2;5;8 p:b is called situation b) (Fig. 3b). The move b 2 –3 would result by w 1 –2 in a loss. However, the move b 5 –4 would result by w 6 –5 in a loss as well. The only move left is b 8 –7.

The arisen situation w: 1;6;9 b: 2;5;7 p:w is called c) (Fig. 3c). It is similar to situation b) {Mirror situation c) along the 3-7-axis and rotate clockwise by 45°}, but now the party plays, which has a counter in the centre i.e. on the 9. If white moves w 9 –3, situation a) would appear again {For (w:1;3;6 b:2;5;7 p:b) consequently switch colours and rotate counter clockwise by 45°.}. The move w 1 –8, would result by s 2 –1; w 9 –2/3/4 and s 7 –9 in a loss. Finally, the move w 9 –8, would result by b 5 –9; w 6 –5 and b 2 –3 in a loss as well. The only move left is w 9 –4.

This situation (w: 1;4;6 b: 2;5;7 p:b) is called situation d) (Fig. 3d). By the move b 7 –8, situation a) would appear again. The move b 2 –9 would result by w 1 –8; b 9 –1/2/3 and w 6 –9 in a loss. The move s 7 –9 lets situation b) arise {For (w: 1;4;6 b: 2;9,5 p:w) consequently switch colours and rotate by 180°}. If black moves b 5 –9, white has to move w 4 –3, as all other moves w 4 –5; w 6 –5 and w 1 –8 would result by b 2 –3 in a loss for white. However, by the moves b 5 –9 and w 4 –3 situation c) would appear again {For (w: 1;3;6 b: 2;7;9 p:b) consequently switch colours and mirror along the 4-8-axis}. Thus b 5 –9 is not allowed either. Black has to move b 2 –3.

The new situation w: 1;4;6 b: 3;5;7 p:w is called situation e) (Fig. 3e). The moves w 1 –2 and w 1 –8 would result by b 5 –9 in a loss. If white moves w 4 –9, black has to move b 3 –2, as all other moves b 3 –4; b 5 –4

and b 7 –8 would result by w 1 –2 in a loss for black. Therefore w 4 –9 is not allowed, as by w 4 –9 and b 3 –2 situation e) would transform back again to situation c). Due to the symmetry of the situation w 6 –9 is not allowed either. (The move w 6 –9 causes b 7 –8, as b 7 –6; b 5 –6 and b 3 –2 result by w 1 –8 in a loss for black. By w 6 –9 and b 7 –8 situation c) appears {Mirror (w: 1;4;9 b: 3;5;8 p:w) along the 1-5-axis}). The only move left is w 1 –9.

By this situation f) (Fig. 3f) appears with w: 4;6;9 , b: 3;5;7 and p:b. Now the two moves b 3 –2 and b 7 –8 are available, which both result neither in a previous situation nor in a loss. For the sake of simplicity, b 3 –2 is analysed first and b 7 –8 will be returned to later on.

Situation g) (Fig. 3g) arises in the form w: 4;6;9 b: 2;5;7 p:w and appears to be the end of a rather short dead end street. The move w 4 –3 would result in situation b) {Rotate (w: 3;6;9 b: 2;5;7 p:b) clockwise by 135°}. The move w 9 –1 would result in situation d). The move w 9 –8 would result in situation e) {For (w: 4;6;8 b: 2;5;7 p:b) consequently switch colours and rotate counter clockwise by 45°}. Finally, the move w 9 –3, would result by b 7 –9; w 6 –7 and b 2 –1 in a loss for white. At this point, the match cannot be continued in compliance with the requirements stated at the beginning.

Even if one would go one step back and return to situation f) (Fig. 3f), the previously possible move b 7 –8 is now not allowed anymore, as it would result in Situation g) {Mirror (w: 4;6;9 b: 3;5;8 p:w) along the 1-5-axis}. The last possibility is to return back to the start and to analyse situation a).

So the starting point is once again w: 1;4;6 and s: 2;5;8 with white at play (Fig. 3a). The move w 4 –9 would result in situation b). Due to the symmetry, the move w 6 –9 is not allowed either, as it would result in situation b) as well {Mirror (w: 1;4;9 b: 2;5;8 p:b) along the 1-5-axis}. If white moves w 4 –3, situation d) would appear again {Mirror {(w: 1;3;6 b: 2;5;8 p:b) along the 4-8-axis and rotate counter clockwise by 45°}. The symmetry clearly shows that w 6 –7 is not allowed either, as it would result in situation d) as well {Rotate (w: 1;4;7 b: 2;5;8 p:b) counter clockwise by 135°}. Thus, w 1 –9 is left as the only possible move.

Situation h) (Fig. 3h) with w: 4;6;9 b: 2;5;8 and p:b appears on the board and represents the eighth and last situation of this study. The move b 8 –7 would result in situation g). Due to the symmetry, the move b 2 –3 would result in situation g) as well {Mirror (w: 4;6;9 b: 3;5,7 p:w) along the 1-5-axis}. The move b 2 – 1 would result in a loss for black by w 6 –7; [b 1 –2 or b 5 –6] and w 4 –3. Due to the symmetry this is also valid for b 8 – 1 (for the sake of completeness: b 8 –1; w 4 –3; [b 1 –8 or b 5 –4]; w 6 –7 loss
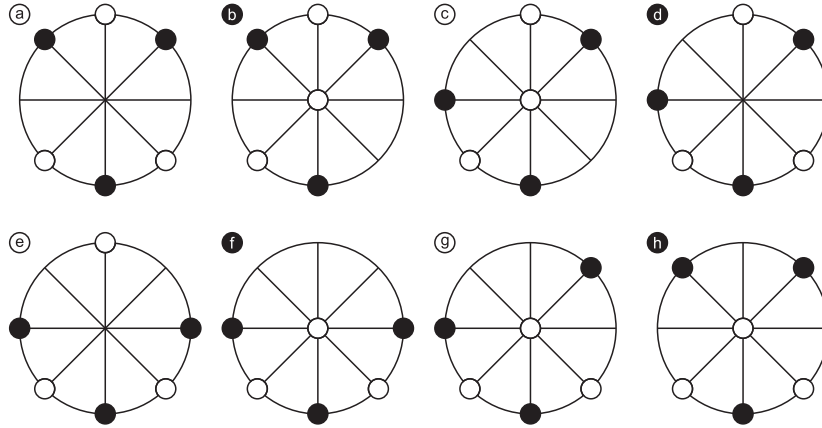
for black).

Figure 3: Eight situations (a-h) of the loop within the circular three men's morris described in this study. The label backgrounds indicate the play.

By this, the initial guess is proved to be correct. Within the circular three men's morris in the form, in which it is described in the archaeological literature, exists a loop of the following eight situations (Tab. 1). This loop takes effect also in everyday playing, as it was everyday playing, in which it has been discovered.

Table 1: Eight situations (a-h) of the loop within the circular three men's morris described in this study.

Situation	White	Black	Play
a	1 4 6	2 5 8	White
b	1 6 9	2 5 8	Black
c	1 6 9	2 5 7	White
d	1 4 6	2 5 7	Black
e	1 4 6	3 5 7	White
f	4 6 9	3 5 7	Black
g	4 6 9	2 5 7	White
h	4 6 9	2 5 8	Black

Using the results of this study to draw conclusions e.g. that the circular three men's morris has been reconstructed in a wrong way and never existed

in the presented form or that the Roman art of playing allowed for a game, which at flawless play does not reach any end, goes beyond the scope of this article and is left for future research.

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A pictish origin for HnefatafL?

David Lawrence

Abstract: *A unique example of Pictish anthropomorphic art was recently discovered in Orkney, incised on the surface of a cattle bone. The find is described and compared with related objects. The carved bone is interpreted as a gaming piece and may, together with other finds from Orkney, hold implications for the origins of hnefatafl.*

'Did these bones cost no more the breeding but to play at loggats with 'em?'
Hamlet, Act V, Scene 1

Introduction

From 1987 to 1996, archaeological finds were collected from sand dunes on the island of Burray, Orkney (figure 1, location 1). These finds had been exposed by sand extraction, motorbike scrambling and blow-out eroding the dunes and damaging previously unknown archaeological sites. No controlled excavation of the site has been undertaken but examination of aerial photographs, taken by the RAF in 1946 has indicated the existence of a number of circular features in the finds area, suggesting an extensive Pictish settlement. A large rectilinear ditched feature was also observed to the south that is likely to have been the original Norse 'Bu' but this area has since been destroyed by sand extraction (W. Budge pers comm). The finds recovered are predominantly animal bones but include Iron Age pottery, stone tools and iron-smelting debris and such notable artefacts as a polished stone axe-head fragment and a discoid stone counter. Because the finds cannot be related to any specific archaeological features, their precise dating and interpretation is unknown but the frequency of Iron Age pottery suggests that most are

likely to have been Pictish. These finds are curated by the Orkney Museum, Kirkwall and it was intended that they should be organised into a teaching and handling collection within the Museum. At the beginning of 2004, the author was commissioned to undertake an assessment of the collection and perform the cataloguing and reorganisation necessary, funded through the Community Environmental Renewal Scheme. For the assessment phase of the project, all items were examined and identified and one bone was observed to have a distinctive design incised into its surface.
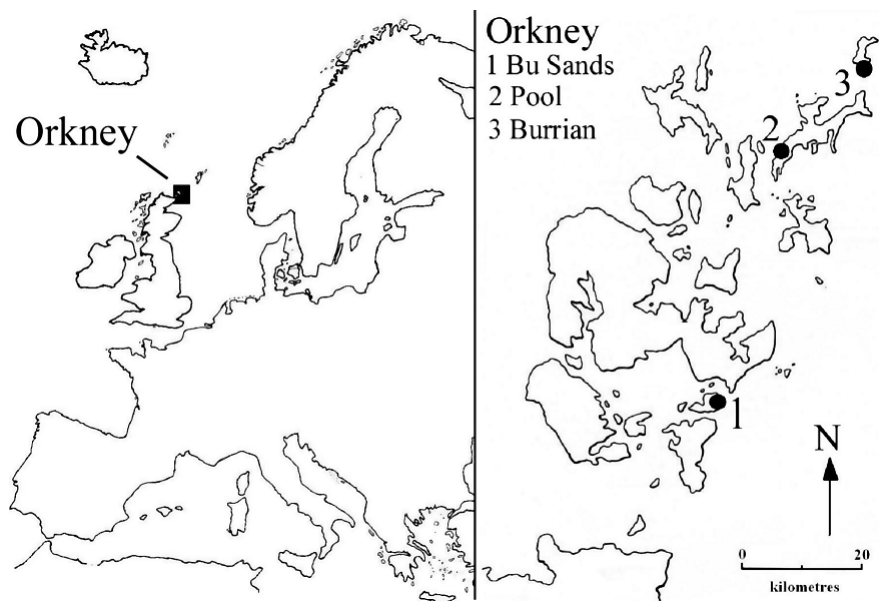

Figure 1: Site Location

The carved bone is the proximal left phalanx (phalanx 1) from the forelimb of an ox over 18 months old at death. It is 53mm in height and 30mm in diameter and was recovered as two large fragments. There is a splinter missing from the front of the carving, possibly from gnawing by a dog in antiquity, and an area of the volar surface has been lost, probably due to modern machining. There are fine cuts present from cleaning the bone whilst fresh but apart from the surface carving, there is no evidence of the bone having received any working. A small area at one corner of the proximal epiphyseal surface is slightly abraded.

The design lies on the sides and back of the bone and demonstrates a high degree of confidence in execution. The main motif is a standing human figure 22mm in height that appears upright when the bone is placed on its
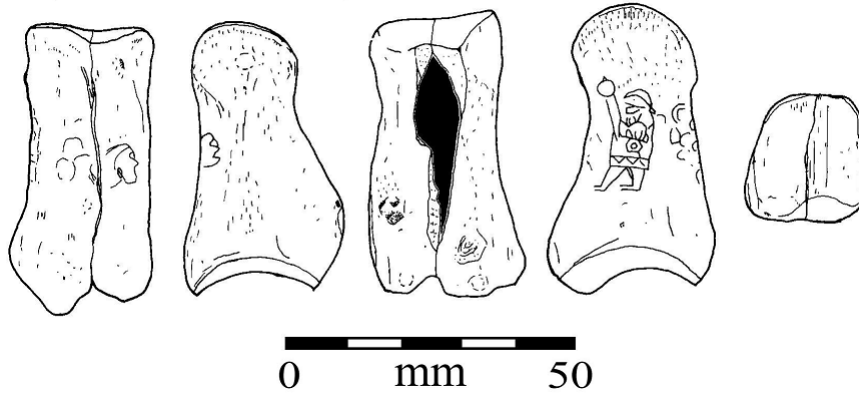
Figure 2: The Bone Artefact

proximal epiphysis. The figure wears a thigh-length tunic showing details such as cloth-folds around the arm and decoration around the hem. The figure clearly represents a warrior wearing a helmet and carrying a shield, with a scabbard at his side, and carrying an unidentifiable weapon, possibly a spear or sword; he also has a ponytail protruding behind and below the helmet. The find has become known locally as the 'Peedie Pict' ('peedie' is a commonly used Orkney word meaning small).
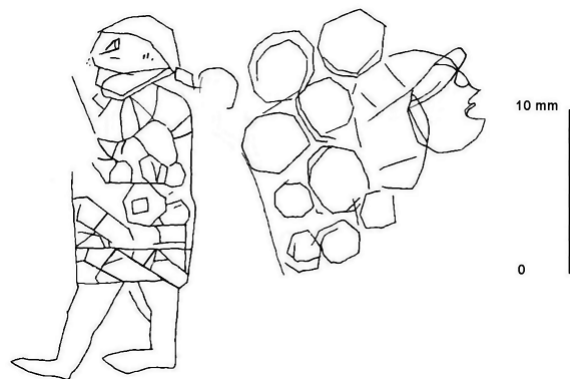

Figure 3: The Design on the Bone

Behind the main figure appears a design of repeated circles that seems largely to be a circular pattern to fill the dorsal surface. This leads to a further human face on the opposite side and has been interpreted as a

helmet crest. The second face is also in profile and also faces toward the volar surface, back to back with the Peedie Pict. This face is executed in a more nave style and has a cartoonish appearance although clearly wearing a helmet; the supposed crest may have been intended to represent hair or even a mere circular pattern.

The three major decorative elements have been shown to result from distinct episodes of carving [25]. This demonstrates a continuity of purpose being maintained over time, as well as the intent to produce a specific object implied by the initial preparation

There is no sign that any further working of the bone was intended: the motifs are completely drawn and fitted within the object's sides without any markings for further cuts. It is likely that this bone represents a finished item, whether as a simple piece of graffiti or as a functional object.

That both figures face the palmar aspect of the bone may suggest that the artefact was intended to have a distinct front and back. The whole arrangement of the carving shows that the bone was oriented with its proximal epiphysis as the base so that both the Peedie Pict and his companion are upright and the 'front' is therefore the palmar aspect. The slight area of abrasion on the epiphysis may demonstrate that the bone stood upright. It is just possible that there was a small carving on the 'front' face of the bone that has been destroyed by the machine damage but no trace remains.

Comparable Finds

Three other cattle phalanges with incised surface designs are known from Orkney: one from the Pool excavations, Sanday [21] and two from the Broch of Burrian in North Ronaldsay [47, pp. 345 and 360-361] [26, pp. 88-89], the sites shown as locations 2 and 3 respectively in figure 1. Of these three, two bear the well-known Pictish 'crescent and V-rod' design, one with the 'mirror case' on the reverse side; the third has an unclear design but may be the terminal of a 'Z-rod.' All are carved so that the design is upright when the bone is on its proximal epiphysis.

Addyman and Hill [1, plate VIIIc] describe a cattle phalanx 'trial piece' from Saxon Southampton (Southampton Museum finds reference A 1993 .19.71) inscribed with runes of 'Frisian type' [1, RI Page; 86-88]. These runes read 'catÆ' (ibid) and it may not be coincidental that the term 'catt' is associated with the Pictish inhabitants of both Caithness and Shetland, possibly as a tribal motif [48, p. 15] [33, p. 139].

A number of similar finds have been reported from terp mounds in the

Netherlands. Munro [30, p. 104] notes "bones of the foot of an ox are covered with concentric circles, apparently for ornamentation" and this suggests a similarity with the rear part of the carving from Bu Sands and also with finds of horse phalanges noted by Roes [40, pp. 54-57], although such circular marks are a common form of decoration.

One other find type is of cattle phalanges smoothed across the proximal epiphysis and whittled around the margins, notably from Pool, Sanday [21]. This formed a shape similar to that of bone and antler pieces from the Broch of Burrian [26, p. 89] and a stone piece found at the early Christian period site of Kiondroghad on the Isle of Man [15, p. 76], all interpreted as gaming pieces.

Still other examples of the working of cattle phalanges are a perforated type found widely in excavations, including one from Bu Sands. These each have a single small circular hole drilled through the centre of the proximal epiphysis either for use of the phalanx as a handle or to take a peg, permitting the securing of the bone in place on another object.

Interpretation

The Peedie Pict is clearly Pictish, both from the style of depiction and by association with Late Iron Age pottery as well as by analogy with similar finds from Orkney. At Pool, it was found that altered cattle phalanges only occurred in the Pictish deposits and not in the Norse layers (A. Smith pers comm).

It seems that these decorated cattle phalanges in general did not require significant further shaping to achieve their intended function, although this function may also have been achieved by whittling at the sides in other examples. Their shape is not itself modified in any way although the decoration clearly shows that they are intended to be seen from all sides: they may constitute a class of artefact in themselves. The Peedie Pict is therefore either a piece of repeated casual carving, an attempt at a design in a trial piece, decoration to identify the bone as a particular object, or a figure that has intrinsic meaning. The confidence of execution, initial preparation, repeated episodes of carving and the use of similar bones elsewhere suggest greater intent than might be the case for 'doodling' but such activity cannot be satisfactorily ruled out. Use as a trial piece seems unlikely because better bone surfaces would have been more readily available with the results being more easily transferable. There must be an inherent aspect of the cattle phalanx that makes it particularly well suited to some function that can be

improved by decorative or symbolic carving. Most significant is that the shape of cattle phalanges permits them to stand upright on the proximal epiphysis and the carvings on all the known decorated examples are clearly carved for this orientation.

Ethnographic parallels for uses of whole cattle phalanges are few. The use of cattle phalanges as 'buzz' toys is known among the North American tribes [11, pp. 751-757]. This though requires that cords be attached mid-shaft, which would obscure the carvings and is therefore unlikely as an explanation of the Pictish examples. Another possible use is as the object in a game such as 'handy dandy' or 'neiveie-nick-nack' [16, pp. 189-190 and 410-411] [28, 169 records an Orkney version] 'hide the button' or the American 'hand game' in which an identifiable object hidden in the palm of one hand or the other must be located by an opponent. These finds would probably be too large for such a function, although the possibility of a similar game has been proposed for parallelopiped dice from the Late Iron Age [9, p. 223]. Cattle bones would also probably be too cumbersome for any game similar to *Inukat* or *Inugaktuuk* played by the Inuit using seal phalanges and metapodials [17, p. 163].

The ability of cattle phalanges to stand upright suggests the possibility that the Peedie Pict was used as a piece in a boardgame. Our understanding of this aspect of past societies is particularly limited because much of the archaeological evidence identified so far - the pieces and the boards - is not securely stratified and there are few contemporary records: we must rely largely on anachronistic material and traditions from diverse cultures.

As well as the decorated and perforated examples from Iron Age Orkney, we should consider the finds of cattle phalanges that have been simply altered by having their sides whittled away, for example at Scalloway, Shetland [41, pp. 172-176] and Pool, Sanday [21]. The shape that this produces has a marked similarity to the pawns of the Lewis chessmen and to other supposed gaming pieces made from other materials. Conversely, some stone and glass pieces seem almost to be in imitation of phalanges, such as those illustrated by Murray [32, p. 58] [31, pp. 763-767], which appear intermediate in form between a phalanx and the conical stone gaming pieces discovered at Scalloway [41, pp. 173-175].

Iron Age gaming boards are known from several excavations [37, pp. 60-62] [44, pp. 188-9] and appear to follow a similar design throughout northern Europe and Scandinavia, probably for a game known in the Germanic areas as *tafl*. The main features of the game are particularly well illustrated by two famous finds: the 10th Century game board found in a crannog at Ballinderry, Ireland and the set of 9th Century playing pieces found at Birka,

Sweden [32, pp. 57-60].

The Ballinderry board is made of wood and has a square grid of seven holes by seven, with the central point and the four corners marked out specially. Other boards are known in which the grid is larger but the board is always a square orthogonal grid with an odd number of lines in each direction, often with the centre and corners specially marked. Stone boards such as those from the Buckquoy excavations [36, 7], now in Orkney Museum, are typically marked by such a grid of lines so that the playing positions are defined by the crossing points and movement is along the lines. Helmfrid [18] has made the suggestion that the term *halatafl* used in the Norse sagas specifically refers to a perforated playing board for the game of *hnefatafl*. The occurrence both of perforated gaming boards such as those from Ballinderry, Ireland and Brough of Birsay, Orkney [13, find 274] and of perforated phalanges may be important in this respect.
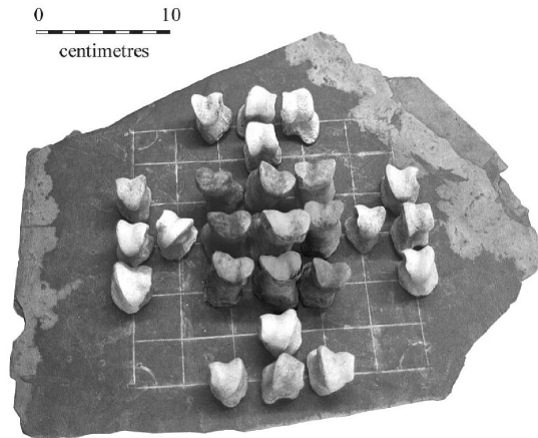
Figure 4: The Replica Gameboard Set for Play

The playing pieces from grave 750 at Birka [4, p. 147] [5, p. 271] are made of glass in two colours: seventeen pieces are light green and nine are dark green. All the pieces have the same plain globular shape about 25mm in diameter except for a single additional dark piece which is tall, decorated and anthropomorphic, wearing a circlet or crown. A similar set made of bone was recovered from grave 624 that showed traces of having had iron pegs in the bases. Other partial sets have been found in graves, all of similar dimensions: the Scar burial on Sanday [34] produced 23 globular playing

pieces of bone for example (now on display in Orkney Museum).

We cannot know whether the rules adopted for play on these boards were consistent within any area or culture but all the available information suggests that the principles were similar [35, p. 197]. The clearest evidence for play is the board design, which is that used in the game of *tablut* recorded in Sweden by Linnaeus in the eighteenth century. Further information can be derived from the Norse sagas and from medieval Welsh and English manuscripts: these have been summarised by Murray [32, pp. 55-64], Bell [6, part I; 75-81, part II; 43-46] and Helmfrid [18]. Two much quoted Norse riddles, from the Herverar Saga, recorded in the 14th Century, are particularly enlightening and bear repetition:

"Who are the maids that fight weaponless around their lord, the brown ever sheltering and the fair ever attacking him?' (Answer: the pieces in *hnefatafl*), and

'What is the beast all girdled with iron which kills the flocks? It has eight horns but no head' (Answer: the *hnefi* or head-piece in *hnefatafl*)." [32, p. 61]

This shows, despite variations between the surviving Old Norse texts and the inherent awkwardness of translations, that the game must have been sufficiently uniform for the answers to be widely recognisable. Parlett [35, p. 201] suggests that the second answer relates to the manner in which the king-piece was carved but it seems more likely to apply to the number of defending pieces around the king, whose regular arrangement radiating from the king in eight directions at the start of the game could readily be likened to the king's 'horns' (if in four directions like *tablut* then only four horns would be present). The riddles also indicate that by the time of their recording at least, the king need not have been anthropomorphic and that the two sides were distinguishable by colour.

The spacing between playing points on known Iron Age game boards varies from about 10mm upwards. Some of the smaller examples such as those from Buckquoy [36, pp. 187 and 198-199] were undoubtedly produced in a very casual manner that suggests that they were not intended for regular use but rather made for an ad hoc game using improvised pieces. A spacing of 25 - 30 mm seems to have been common among the better produced boards, including those from Ballinderry and Wimose and such a size is required to permit the practical use of cattle phalanges as playing pieces; it is also similar to the diameter of many Iron Age counters, including one from the Bu Sands. (Most authors have followed Murray [32, p. 58] in describing the fragmentary board found at Wimose in Denmark as a square hnefatafl board but there is no evidence to suggest that the board was not rectangular.

It is quite possible, given its supposed date, that the board is in fact an import from the Roman Empire or a copy of a Roman original and we might perhaps consider that it belongs rather to the ludus latrunculorum family of games.)

The use of circular motifs on the phalanx recalls finds from Frisian terp mounds that have been interpreted as skittles pins. Roes [40, pp. 55-57], discussing these Dutch finds, reported the modern use of cattle phalanges for skittles and this use is clearly depicted in the elder Brueghel's 1560 painting of 'Children's Games.' MacGregor [27, p. 134] notes the collection and use of cattle phalanges in 20th century Friesland as skittle-like targets in a throwing game. Interestingly, similarities between other bone artefacts have recently interpreted as evidence for strong Iron Age links between the Northern Isles and Frisia [42, pp. 111-115].

One further plausible alternative interpretation is that the carved bones from Orkney are lots for divination (cleromancy), with a meaning when cast based partly on the incised design, perhaps in a similar manner to that recorded among the Germans of the first millennium AD by Tacitus (Germania, chapter 10). This would permit wide variation in the quality of execution without impairing usefulness. The use of an intact bone may have been required by the lack of wood in Orkney or even have been necessary for ritualistic or functional purposes: the use of unworked astragli as dice is well known for instance. In this context, the use of both abstract Pictish symbols and recognisable figures might be explicable, especially if different surfaces can show different meanings. It is possible that although the Peedie Pict is a robust male warrior figure, the other face (which despite being helmeted is relatively graceful with no obvious beard) is intended to be female and this potentially gives opposite interpretations to the two sides and intermediate meanings for the volar and dorsal surfaces. This would fit the suggestion of a dualistic Pictish philosophy (as perhaps overstated) by Jackson [22]. This interpretation of the artefact need not conflict with its function as a boardgame piece, indeed such a dual function would resolve the apparent confusion relating to translations of the Hervera Saga riddles discussed by Helmfrid [18] that appear to describe 'throwing' of the king-piece; a game board could readily act as the field for the casting of lots.

The use of astragli and bone artefacts in this divinatory manner is well known, as for example among the Tswapong of southern Africa [49, especially figure 2]. In this context, the use of both symbols and recognisable figures might be explicable, especially if different surfaces can show different meanings. The simultaneous use of disparate objects as practised by the Tswapong may also suggest a function for the decorated discs recovered from

Pictish contexts such as those from Shetland and Caithness summarised by [46, pp. 45-47]. Culin notably suggested [10, pp. xvii-xxxvi] that a magical or divinatory origin might be a common, even universal attribute of games and although this was not a view held by Murray [32, p. 235], the Inuit seal bone game provides an apposite example [17, p. 163] and the topic remains worthy of discussion (for example [23]). Biblical references (including Proverbs 33, 16) demonstrate that Christian beliefs among the Picts need not have prevented such activities.

Experimental Archaeology

At a 'Family Fun Day' in Burray, a stone board that had a 7x7 grid of incised lines was used to play *tafl*. The lines were spaced at 25mm and the playing pieces were cattle phalanges from the Bu Sands collection, now used as a handling set. The king's pieces were all phalanx 1 and the other side used phalanx 2, which permitted easy distinction between the sides (phalanx 2 also stands upright on its proximal epiphysis, giving a pleasing shape for a gaming piece but is significantly shorter than the first phalanx). The king itself was a particularly large phalanx 1, which made the piece sufficiently distinct for ready recognition

The experimental games brought home two points that suggest that the carving of the Peedie Pict was not necessary to indicate a *tafl* king. It was noted that on a board of this size, the pieces were so close together that although they could be readily identified by size, any surface marking would probably not have been easily visible. If the Peedie Pict was carved to be a *tafl* king then the other pieces must have been substantially smaller – perhaps phalanx 2 sized, similar in fact to the men from Birka – and the king would then have been recognisable purely by height. It is also clear that the movement of the pieces in tafl does not require the designation of direction on the pieces, which may move in any direction: there is no 'front.' It follows then that the anthropomorphic design of the Peedie Pict carving is unlikely itself to be directly related to tafl play but may indicate a cultural tradition and the (probably male/warrior) anthropomorphism of both the Birka 'kings' and the conical pieces from Scalloway and Mail must be noted in this respect. If the king were usually the only piece from a set of 25 or more to be large and anthropomorphic, then that would also explain the rarity of such finds. If this cultural symbolism was as important to the Picts as to the Norsemen - as the Peedie Pict suggests - and we extend this interpretation to the carved phalanx finds from Burrian and Pool, then to

retain symbolism, the meaning of the well-known Pictish crescent and v-rod symbol might be 'king,' 'warrior' or 'battle-leader.' By the time that the Hervera Saga riddles (above) were recorded, this tradition may have been lost or become purely symbolic, permitting the description of the hnefi as having no head.
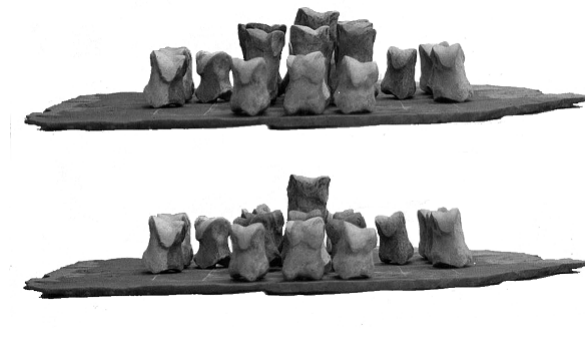

Figure 5: Side View of Board set up for *Tafl* Play with Cattle Phalanx Pieces. Above: the king side all phalanx 1, obscuring the king; Below: the king only phalanx 1, others phalanx 2

The experiments in Burray also used wooden facsimiles of the bone as ninepins. The play was quite satisfactory and suggested that cattle phalanges performed well in this role. Skittles games have a variety of rules, usually permitting two or three throws of a ball, stick or wooden disc (known as a 'cheese') with the pins arranged in different patterns. Some score knocking down a kingpin more highly and others require that the kingpin be knocked over in order to score at all. If the purpose of the bone was to serve as a skittles pin, then the surface carving may be intended to indicate that the Peedie Pict was a 'kingpin.' Skittles lends itself well to social activity with possibilities for team play and drinking games, which we can expect to have been as popular in the past as they are today.

Conclusion

We do not have any specific evidence to suggest whether the Peedie Pict was intended to represent a particular Biblical or Pictish character, an archetype or an abstract 'warrior.' Although Pictish use of human images as religious idols has been suggested [38, p. 3], an interpretation of the Peedie Pict as a gaming piece or cleromantic lot (or both) seems most likely to be correct.

The degree of finishing that such an article would require may depend on the nature of the game to be played: a set of skittles casually used by children might require less elegance in form than pieces for a frequently played adult boardgame for example. MacGregor's [27] observation of the collection and use of cattle phalanges in 20th century Friesland as skittle-like targets in a throwing game ('*loggats*') is very clearly supported by a detail shown in the elder Breughel's 1560 painting 'Children at Play.' Smith's [42] suggestion that other bone artefacts indicate contact between Frisia and Orkney in the Iron Age may be important because the distribution of carved cattle phalanges seems localised to these areas so far and it would seem probable that such pleasant activities as games should also have become common to neighbouring groups.

The tradition of boardgame playing in Pictish Orkney is attested by the existence of a number of boards made with varying degrees of formality, notably the rough stone examples from Buckquoy, Red Craig [37, pp. 60-62], Ritchie 1977; 187, Brundle 2004) and Howe [44, pp. 188-9]. The *tafl* type of game seems later to have existed in a similar form throughout northern Europe, though almost certainly with numerous minor variations, possibly evolving into *tablut* [32, pp. 55-64] [6, I; 75-81 and II; 43-46]. A distinguishing feature of this family of games though is that just one counter needs to be distinguished from all the others as a 'king,' a role for which the Peedie Pict would be well qualified. The Pictish attribution of the Orkney finds suggests a date of around 500-700AD: earlier, possibly by several centuries, than any of the supposed *hnefatafl* artefacts previously identified (except possibly the Wimose board, which must probably be reconsidered as mentioned above).

Accepting the interpretation of finds of worked cattle phalanges as gaming pieces, if they are all 'kings' from a game such as *hnefatafl*, then the apparent absence of ordinary pieces seems strange. In *tablut* for example there are 24 such pieces to 1 king, as found in grave 750 at Birka. The most likely explanation for this is that the pieces are found but that their appearance is not diagnostic of function. Obvious possibilities include shells, stones and the second phalanx of cattle, which could be used unworked – quite a likely occurrence if so little apparent effort went into producing the king. The most likely explanation for the apparent absence of ordinary pieces is that the pieces are found but that they are casually used items and their unworked appearance is not diagnostic of function.

Both boards and pieces are known from many Norse sites, particularly important examples being the Ballinderry board, the Birka games sets and the Baldursheimur pieces. Their association with *hnefatafl* is extremely plausible and fits with every mention of the game in the Norse sagas. These

Norse examples are typically high status objects, craftsman made and precious to the owner; the Pictish examples in contrast show relatively minor modification of raw materials and are more casual, homely pieces. Apart from the bone pieces, the crudely made stone gameboards recovered from archaeological sites in Orkney, especially the examples from Buckquoy and Howe, are likely to be Pictish yet bear the design of the basic *tablut* board that has been identified with *hnefatafl*. Unfortunately, most early gameboards and pieces potentially attributable to the Iron Age are poorly stratified and, furthermore, many major Pictish sites appear to demonstrate continuity of occupation into the Norse period, probably including Bu Sands [24]. We may however, tentatively conclude that this game was well known to the Picts of Orkney and not a later Norse introduction. If we consider that the Wimose board – probably the earliest known game board from Iron Age northern Europe - may be from a Roman game such as *ludus latrunculorum*, then the possibility exists that the Orkney finds are the earliest evidence of *tafl* so far. The *tafl* games may then be Pictish in origin and later became widely known through trade across the North Sea to Scandinavia and northern Europe.

Acknowledgments

'The lot is cast into the lap; but the whole disposing thereof is of the Lord.'
Proverbs 16, 33

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The Development and Regional Variations of Liubo

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Abstract: *This paper clarified the transition of liubo game boards with respect to both chronological order and genealogical relationships based on recent evidence. In spite of the limited direct access to many of the relics due to the organic material used in most of the liubo items, I believe that an overall understanding of liubo was achieved. Each type of liubo board was used concurrently over a long period of time. Despite limited evidence, regional variation in the game boards was identified. However, more new evidence may yield different interpretations and require reexamination in the future.*

The results indicate that typical board design could be traced back to ancient liubo and the T motif of the TLV pattern could be a relatively newer innovation. Interpreting the typical TLV pattern based on the "circular sky and square earth" cosmology was deemed as inappropriate for this research.

This study was conducted mainly based on liubo artifacts, and graphic documents, such as illustrated stones, were taken only into secondary consideration. I hope to conduct further examination and exploration of liubo based on graphic materials in the near future.

Keywords: Liubo, TLV pattern, divination, bronze mirror, sundials

Introduction

As has been theorized for other ancient board games [23], the origin of the Chinese ancient board game *liubo* (六博) is believed to be related to divination and oracle reading. In fact, archeological evidence and historical documents support liubo's strong relationship with divination. For example, in Qin's *Zhanguoce* (Art of War战国策), there is a story about one boy who plays liubo by throwing dice in place of the gods. This story indicates that the origin of liubo is strongly associated with divination [35]. Furthermore,

"Hermit's Liubo," *Xianrenliubo* (仙人六博) drawn on illustrated stones from the Han Dynasty show its relationship with mountain wizards. The main design of the bronze mirrors during the Han Dynasty (TLV patterns and four sacred animals) is the same as that of the *boju* (博局) game board, and these symbols are also representative of mountain gods. In addition, the *bojuzhanmudu* (博局占木牘) (a wooden board used for divination) excavated from a Han tomb at Yinwan in Lianyungang City, Jiangsu Province (江蘇省連雲港市尹湾漢墓) [19, 20], shows an identical pattern to the *boju* and also reveals its close relationship with divination.

Implementation of *boju* game board designs into Chinese sundials and bronze mirrors with TLV patterns and four sacred animals is believed to represent the ancient philosophy of cosmology; therefore, the designs are often compared with other designs appearing on the back of mirrors (besides those with TLV patterns and four sacred animals). In a recent study, based on historical documents and excavated evidence, Suzuki (2004) concludes that *boju* designs indicate Buddhist emblems (吉祥紋) connected to divination [31, 32].

The purpose of this paper is to categorize and delineate the development of *boju* game boards that have been studied in the past. It is not, however, to analyze the historical idea of cosmology in liubo design because this study would require an extensive amount of historical documentation and evidence. With limited artifacts, this paper will present the geographic distribution of liubo based on game board types and investigate possible regional differences in its spread and development.

Methods

Komai (1943) initiated a study of liubo based on historical evidence rather than existing literature for the first time [18]. Later, new archeological reports on liubo figurines and game boards deepened archeologists' understanding. Several researchers studied liubo based on these findings, including Watabe (1982), who reconstructed an outline of liubo and its rules based on archeological research and findings up to 1980 [1]. His investigation on rules of liubo includes everything that the literature could reveal, and no study superior to his work has been made to date. However, the fact that a wooden board for divination (博局占木牘) with the same pattern as a game board was excavated from a Han tomb at Yinwan in Lianyungang City, Jiangsu Province (江蘇省連雲港市尹湾漢墓) may lead a new interpretation

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[1]See [35] for the reference. Extensive research review is recorded in [35] and [17]

of the rules of liubo in the future. Koizumi (1991) furthered Watabe's study by reexamining game boards and classifying them into a few patterns and hypothesizing their development [17].

Based on these past studies and newly excavated evidence, this study looks into variations in game board patterns to understand their time frames, and find out if there is any regional variation in their distribution.

Recent excavations have yielded many new pieces of archeological evidence, which urge us to reevaluate past studies. However, these archeological artifacts include not only actual liubo equipment, but also illustrated stones and clay figurines showing liubo boards, which must be analyzed in a different matter. The next section will explain how the evidence was handled in this study.

- Excavated evidence

  Liubo equipment including sticks and dice buried with corpses were excavated from a Han tomb at Yanggao, Shanxi Province (山西省陽高漢墓) [2] and a   Han tomb at Wanan, Hebei Province (河北省萬安漢墓) [3] in the early 20th century, but it was Komai's 1943 research that first verified these as items of liubo.

  Such actual artifacts truly help develop the study of liubo, but as most were made of organic materials such as timber or bone, they are unfortunately not well preserved.

- Other liubo-related relics

  Burial goods (明器) and figurines (俑) made as substitutions for actual articles were often buried with corpses. A game board made of bronze unearthed at Tonggu Graves at Putuo, Xilin County, Guangxi Province (広西壮族自治区西林県普馱銅鼓墓) [8] may have been designed as a burial good but it might have been actually used as well. A ceramic figure and a wooden figurine were excavated from the Han tombs at Zhangwan, Lingbao County, Henan Province (河南省霊宝県張湾漢墓) [11] and Mojuzi, Wuwei County, Gansu Province (甘粛省武威県磨咀子漢墓) [4] respectively. However as they are not for actual use, they may not necessarily reveal details about liubo precisely.

- Illustrated artifacts

  Similarly, it is difficult to grasp the whole picture of liubo from illustrations on materials such as stones or bricks. These tend to be exaggerated or simplified and need to be interpreted carefully.

- Inscriptions

  Currently, a wooden board for divination from a Han tomb at Yinwan (尹湾漢墓) is an important piece of evidence to understand liubo. It includes zodiac inscriptions as well as a design of a liubo game board.

  For the present analysis, actual liubo paraphernalia were considered primary sources and other liubo-related relics secondary sources, with careful attention paid not to place too much importance on the latter. More specifically, for the main purpose of this research (to analyze the development of liubo) actual game boards were mainly used, and illustrations and non-actual materials were only used supplementarily.

Developmental Change of Game Board Types

Explanation of liubo equipment

Before examining the development of liubo, liubo playing items are identified borrowing the nomenclature used by Watabe [35] based on past studies and relics from a Han tomb at Mawangdui (馬王堆漢墓). Referring to his study, this section introduces liubo game equipment.

Even though the details about rules of Liubo are unknown, they are broadly understood as follows. Two players place 6 game pieces on the L pattern in front of the opponent. They move the pieces to a place called 'Zhang' (張) and then back to the original place, using six stick dices or an eighteen-sided dice. It is believed that a player could take the opponent's pieces or immobilize them.

First, half-arc-shaped bamboo sticks, *bo*（博）, from which *liubo* gets its name, are known to have been lined with metal on the inside [38] (Figure 1.3). It is believed that an 18-sided die was used instead of the sticks in some versions of the game, although the fact that no dice （骰子）were found in tomb No. 3 at Mawangdui (馬王堆３号墓) casts some slight doubts on this [36] (Figure 1. 1).

The game is played by 2 players. Each player usually uses 6 game pieces, called *qi* (棊), for a total of 12 pieces in the game. Several *qi* were excavated from Han tombs at Dabaotai, Beijing City,(北京市大葆台漢墓) [41] as well as at Yanggao (陽高漢墓) and elsewhere (Figure 1.2). They are rectangular-shaped, and bear illustrations of birds at one end. It is a assumed that when a piece advanced to a "water"*shui* (水) position, it was turned upright to promote it into a stronger piece called an owl *jiao* (梟) [35].

Next, there is a wooden strip called *chou* (算) for tallying scores. The

2. Game pieces, *qi* (Han tomb at Yanggao)

1. Dice (Tomb No.3 at Mawangdui)

3. Sticks, *bo* (Qin tomb at Shuihudi)

Figure 1 Dice ; Game pieces, *qi* ; Sticks, *bo*
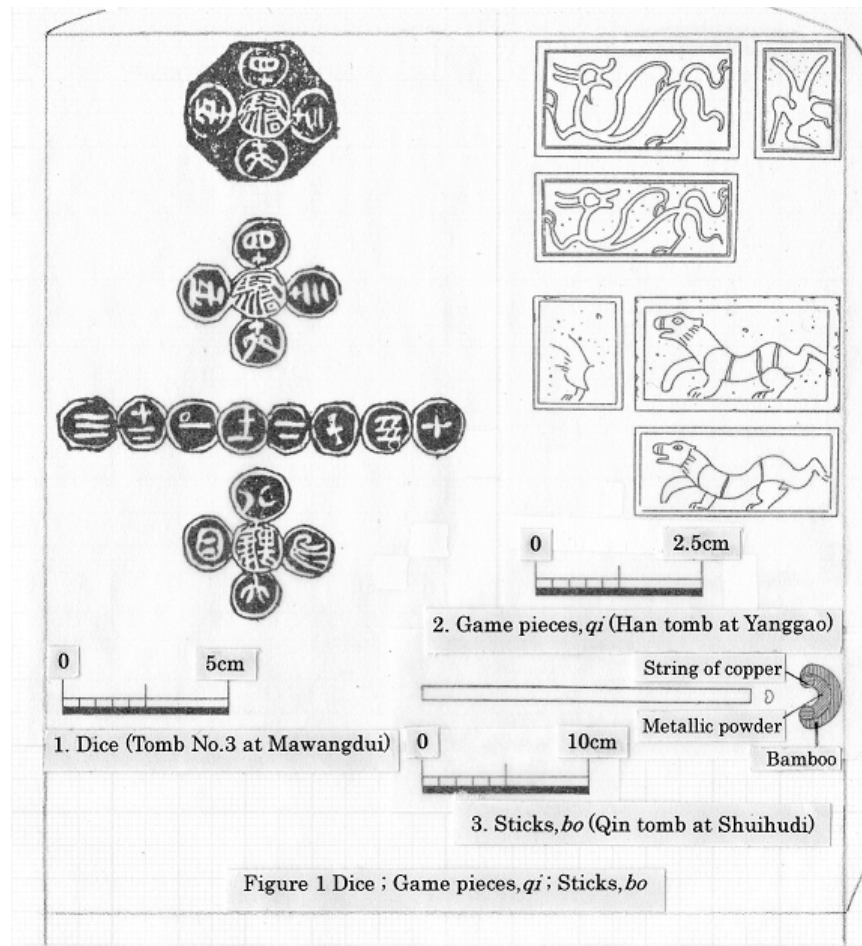
one excavated from a Han tomb at Mawangdui (馬王堆漢墓) is famous, but another was also unearthed at a Han tomb at Yanggao (陽高漢墓).

Although a special piece called *yu* (魚fish) relating to tallies is thought to have existed, none have actually been discovered yet. However, two round objects on a board shown in a clay figurine from a Han tomb at Zhangwan (張湾漢墓) are considered to be possible fish (魚) [9] (Figure 2), and it is assumed that the capture of this piece by the opponent affected the score of the game.

There is also a weight, *zhen* (鎮), that is placed on the mat on which the dice are thrown [24, 30]. Many weights made of bronze have been excavated.

Finally, the game board, *boju* (博局), is clearly distinguishable from other game boards, but ironically, it is impossible to find any clear differences
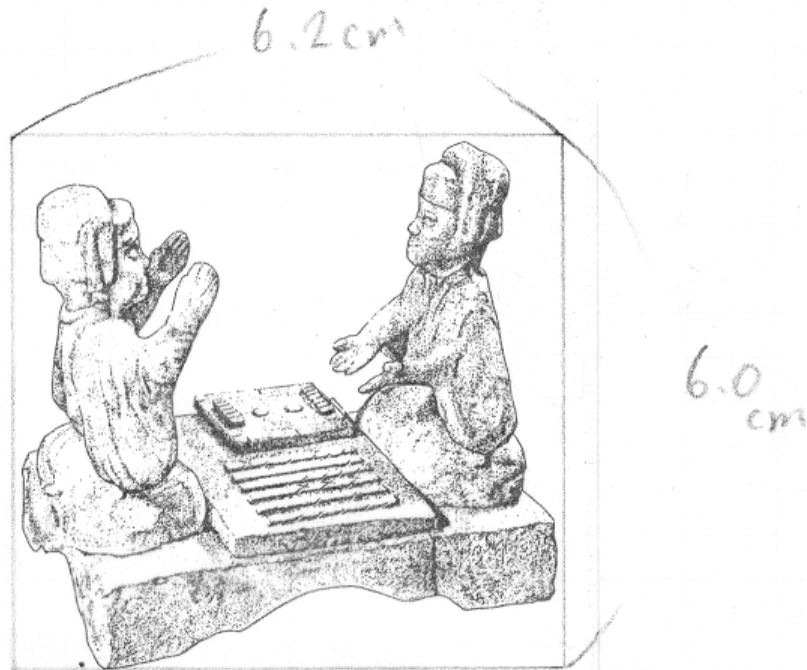
Figure 2 Clay figurines from a Han tomb at Zhangwan

between them and wooden divination boards like the one excavated from the Han tomb at Yinwan (尹湾漢墓). Next, names of each part of the *boju* are identified for convenience of explaining details. Figure 3 shows the names of parts of two types of game boards.

Types of Game Boards

Game boards with a variety of features and styles that have apparently changed over time are used in this categorization.

- Jicheng Type (Figure 4.1)

  The Jicheng board type is unique in that it is rectangular, unlike most of the standard *boju* that are square-shape. Also, the TLV pattern is irregular and the design is identical with that on the opposite side but differs from the adjacent side, while other types of *boju* have identical
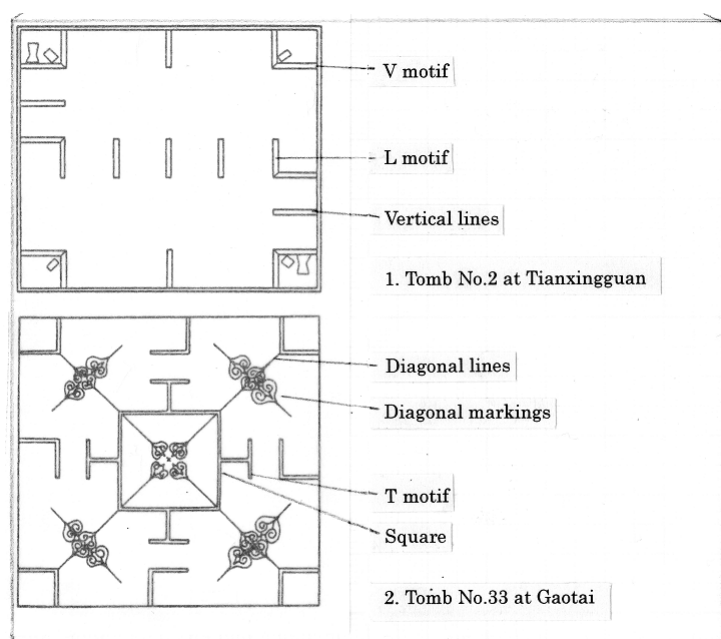
Figure 3 Names of each part of the *boju*

designs on all four sides. Three straight lines are found in the center instead of a square. This type of board has either 3 or 4 legs, which are comparatively long.

Although this type had been found at tomb No. 314 at Yutaishan, Hubei Province (湖北省雨台山314号墓) [40] prior to Watabe and Koizumi's studies, it was not included in their analyses.

Other examples have been excavated from tomb No. 1 at Jicheng (紀城１号墓博局) [16], tomb No. 2 at Tianxingguan (天星観２号墓博局) [14] and tomb No. 9 at Jiudian (九店９号墓博局) [15] in Jingsha City, Hubei Province (湖北省荊沙市).

- ZhongshanType (Figure 4.2) The Zhongshantype provides an important key to drawing a connection between the Jicheng type and game boards with complete TLV patterns. Although both Watabe and Koizumi point out that the game played on this board may differ from liubo, we may assume from comparison with the Jicheng type and the Zhongshan II type that it actually was used with liubo. The Zhongshan I type, in contrast to the Jicheng type, is characterized by a square board, but it has the same design as the Jicheng type. A small difference is that the vertical line on each side in the Jicheng

type is horizontal in the Zhongshan I type, which can be considered a developmental change towards the Zhongshan II type. A single game board (stone surface) [10] of this type was discovered at the national tomb M3 at Zhongshan of Pingshan County, Hebei Province (河北省 平山県).

- Zhongshan II Type (Figure 4.3)

  The shape of the Zhongshan II type is square. Even though the horizontal and vertical lines of the T motif are separated, the TLV pattern and square drawn in the middle of the board completes the standard liubo board. The designs on each side are identical and have horizontal side-lines instead of diagonal markings. The diagonal lines inside the square were not considered a determining feature of this type.

  Like the Zhongshan I type, only a single stone board has been excavated from the national tomb M3 at Zhongshan. It is classified by Watabe as type D and Koizumi as type 1 in terms of liubo design (Figure 10).

- Mawangdui Type (Figure 4.4)

  This board is square-shaped and shows a TLV pattern and a square. However, the horizontal and vertical lines of the T motif are separated, similar to the Zhongshan II type. There are markings on the diagonal instead of horizontal side-lines.

  Examples of this type were unearthed at tomb No. 3 at Mawangdui, Changsha City, Hunan Province (湖南省長沙市馬王堆 3 号墓出土博 局) [?], Qin tomb at Shuihudi, Yunmeng County, Hubei Province (湖北 省雲夢県睡虎地秦墓出土博局) [38], and tomb No. 31 at Jinqueshan in Linyi City, Shandong Province (山東省臨沂市金雀山31号墓出土博局) [22]. Koizumi has categorized this board as type 2. Some Yaozhuang type boards (see below) with square-shaped diagonal markings are sometimes included in the Mawangdui type.

- Dafentou Type (Figure 4.5)

  This board is square-shaped with a complete TLV pattern. In contrast to the Mawangdui type, there is no separation between the horizontal and vertical lines of the T motif. The diagonal lines are represented as circles.

  The Dafentou type has a complete TLV patterns similar to mirror designs showing TLV patterns and four sacred animals. An exam-

ple has been unearthed from tomb No. 1 at Dafentou, Yunmeng County, Hubei Province (湖北省雲夢県大墳頭１号墓出土博局) [12]. Although they cannot be identified as boards for actual use, other examples etched on brick *zhuan* (磚) and unglazed ash ceramics (灰陶), have been discovered in the Jingdi empress tombs at Xianyang City, Shanxi Province (陝西省咸陽市景帝皇后陵陵園出土博局) [29] and in Changan Castle Yao No. 37 at Xian City, Shanxi Province (陝西省西安市長安城37号窯出土博局) [27]. Watabe categorizes this liubo design as type C and Koizumi as type 3.

- Gaotai Type (Figure 4.6)

  This board is square-shaped, and shows the same basic design as the Dafentou type, but the existence of markings superimposed on diagonal lines is unique to this type. The markings in the square are not used to determine this type.

  Only one example of this type was excavated from tomb No. 33 at Gaotai, Jingzhou City, Hubei Province (湖北省荊州市高台33号墓出土博局) [13].

- Mojuzi Type (Figure 4.7)

  This board is square-shaped. There are no diagonal markings but the rest of the design is the same as the Gaotai type. Although no actual Mojuzi type boards have been found, a famous wooden figurine showing this type was excavated from tomb No. 48 at Mojuzi, Wuwei County, Gansu Province (甘粛省武威県磨咀子48号墓). A similar game board made of clay was excavated at Xiangwu Village, Ku District, Song County, Henan Province (河南省嵩県庫区郷呉村)[2]. Several illustrated stones showing this type have also been discovered. The design of a wooden board for divination unearthed from the Han tomb at Yinwan in Lianyungang City, Jiangsu Province (江蘇省連雲港市尹湾漢墓) has been identified as the Mojuzi type. Watabe classifies this liubo design as type F and Koizumi as type 5.

- Putuo Type (Figure 5.8)

  The square and TLV pattern are present, and it is differentiated from the Dafentou type in that there are no diagonal lines or markings. The L motif on a prototypical Putuo type game board unearthed from a Tonggu Graves at Putuo, Xilin County, Guangxi Province (広西壮族

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[2]From an exhibit at Rakuyo Museum in 1998. Each side measures approximately 27 cm

1. Jicheng Type
(Tomb No.1 at Jicheng)

2. Zhongshan I Type
(National tomb M3 at Zhongshan)

3. Zhongshan II Type
(National tomb M3 at Zhongshan)

4. Mawangdui Type
(Tomb No.3 at Mawangdui)

5. Dafentou Type
(Tomb No.1 at Dafentou)

6. Gaotai Type
(Tomb No.33 at Gaotai)

7. Mojuzi Type
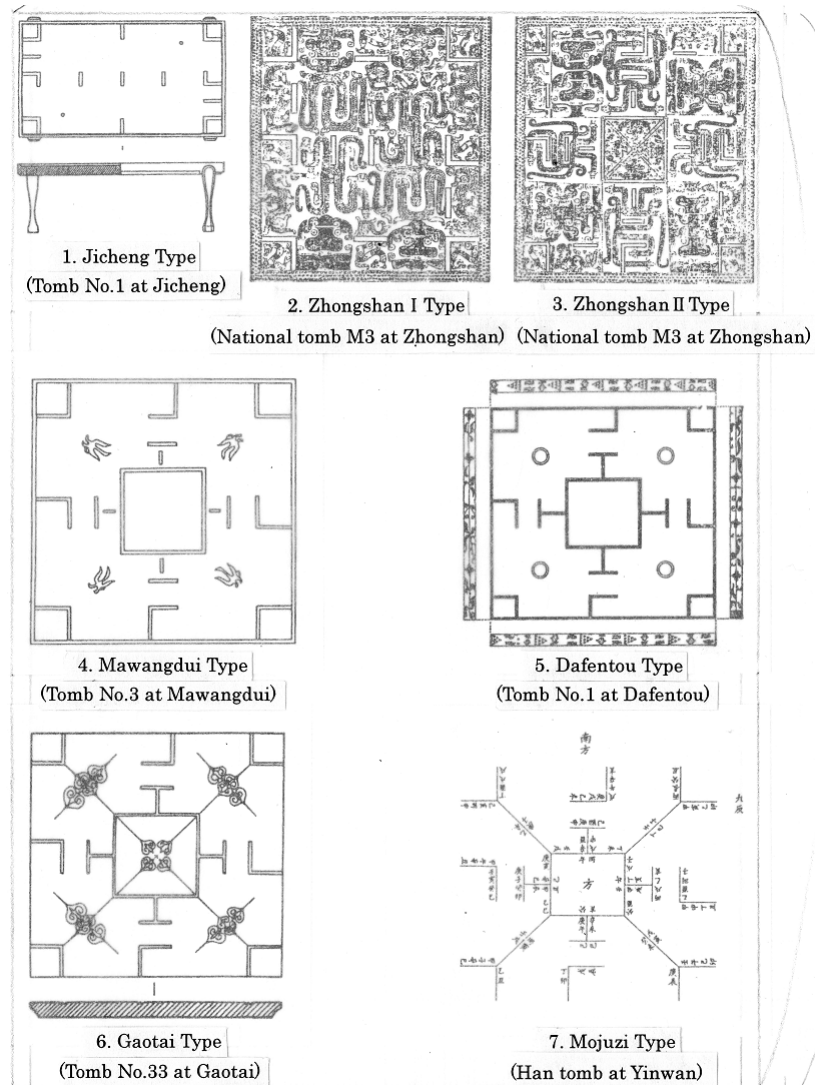(Han tomb at Yinwan)

Figure 4 Types of Game Boards (Size=1/10)

自治区西林県普馱銅鼓墓出土博局) [8] faces the opposite direction of the L on a typical game board. As the board is made of bronze, not wood, this may indicate a possible mistake in the process of carving the mold.

Long legs may be another characteristic feature of this type, but game boards without legs have been excavated from tomb No. 2 at Gaotai,

Jingzhou City, Hubei Province (湖北省荊州市高台 2 号墓) [13] and tomb No. 1 at Tuanshan, Jiangsu Province (江蘇省団山 1 号墓) [26]. A game board unearthed from tomb No. 1 at Luobowan, Gui County, Guangxi Province (広西壮族自治区貴県羅泊湾 1 号墓) [7] also belongs to this type, but its possession of legs is not clear due to damage.

Koizumi classifies this board as type 4 in his categorization of liubo design.
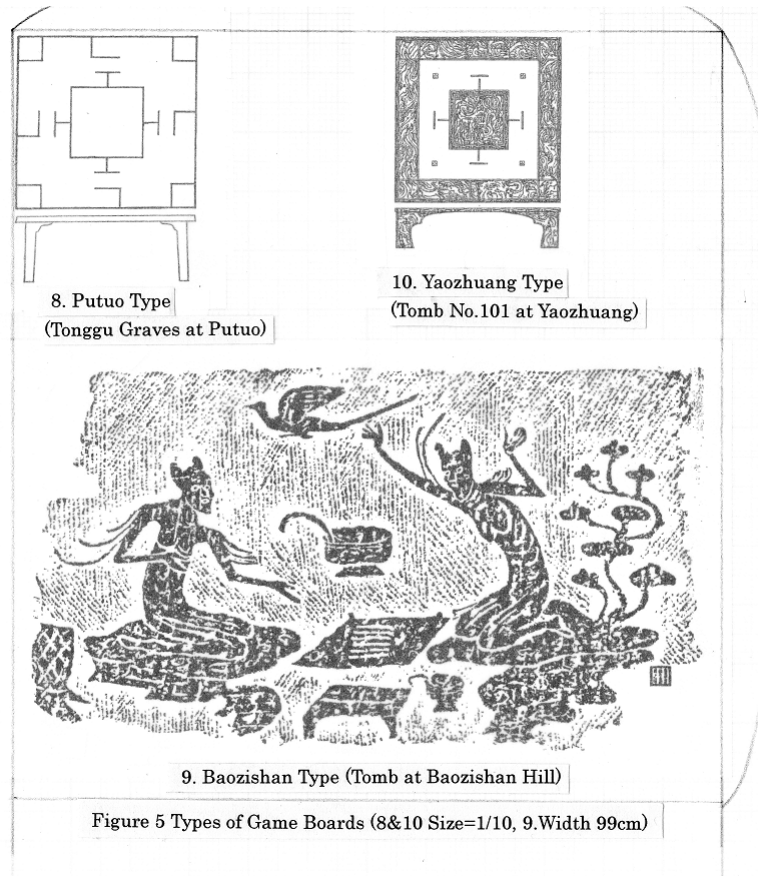
- Baozishan Type (Figure 5.9)

No square or TLV patterns are found, and the surface of the board is partitioned crosswise. A well-known illustration of the Baozishan type board is found in the collection of illustrated stone coffins from a tomb at Baozishan Hill, Xinjin County, Sichuan Province (四川省新津県宝子山崖墓) [39]. Other boards are seen in the collection of unearthed illustrated stone coffins at Xinjin County (新津県) [39] and illustrated stones excavated at Deyang City, Sichuan Province (四川省徳陽市) [6]. Short legs are attached to the Baozishan board, but the Deyang board is only seen in illustrations from above so it is unclear whether it has legs or not. Since the designs in the corners of the Baozishan and the Deyang boards are different from each other, it is possible to make further subclassifications. However, since the evidence is only available in illustrations, actual artifacts are needed for further examination.

Watabe classifies this as type A.

- Yaozhuang Type (Figure 5.10)

This board type is square-shaped with a center square and TLV pattern. The horizontal and vertical lines of the T motif are separated. Square-shaped diagonal markings distinguish the Yaozhuang type from the Mawangdui type. Square or other shaped dots are sometimes added in the center square. Short legs also characterize the Yaozhuang type. Examples of this type have been excavated from tomb No. 101 at Yaozhuang, Yangzhou City, Jiangsu Province (江蘇省揚州市姚荘101号墓出土博局) [37], tomb No. 19 at Sanjiaoxu, Tianchang County, Anhui Province (安徽省天長県三角圩19号墓出土博局) [1], and a tomb in Fei County, Shandong Province (山東省費県出土博局) [28, 9]. Diagonal markings of the board from tomb No. 7 at Dongyang, Yixu County, Jiangsu Province (江蘇省盱眙県東陽 7 号墓出土博局) [25] have a four-leaf design and are small and square-shaped. This

board has short legs, and is classified as the Yaozhuang type in this paper.

8. Putuo Type
(Tonggu Graves at Putuo)

10. Yaozhuang Type
(Tomb No.101 at Yaozhuang)

9. Baozishan Type (Tomb at Baozishan Hill)

Figure 5 Types of Game Boards (8&10 Size=1/10, 9.Width 99cm)

Developmental Changes in Game Board Attributes

This section identifies game board attributes that have undergone modifications over time and facilitate understanding of the geneological order of the categorized types.

- Plane shape of the game board
  → From rectangular to square

- Shape of legs
  → From long legs to short or no legs

- Square in the board center
  → From absence to presence

- T motif
  → From separation of T motif to no separation

- Diagonal markings
  → From horizontal lines on sides to diagonal markings

- Diagonal lines
  → From no lines to diagonal lines

These attributes are assumed to represent chronological changes in the game boards. Next I will explain the general pattern of change in game boards.

Transition of Game Boards

Here, first the aforementioned types are sorted out developmentally, and then a mainstream game board genealogy is proposed.

The Jicheng type can be considered the oldest. Since the Jicheng type board is rectangular without a square in the center, some might regard it as a different board game from liubo. However, it is possible for the Jicheng type to have been modified successively into the Zhongshan I and II Types, thus it is regarded here as an ancient liubo board. The sides of the Jicheng type are not identical and the same designs appear only on the sides facing each other. However, the Jicheng type, which may be considered the prototype of liubo, was unearthed only in Jingzhou City, Hubei Province (湖北省荆州市), and its long legs do not indicate a succession to the Zhongshan I type. Based on these facts, it might suggest a possibility of regional variation in the future. If so, the Jicheng game board may differ only in the possession of long legs and a rectangular-shaped board while otherwise demonstrating common design features.

The Zhongshan I type board is square-shaped, and like the Jicheng type, the four sides are not identical. However, the vertical lines are now horizontal lines, showing a modification in the direction of the Zhongshan II type.

The "standard" liubo game board as acknowledged by Watabe and Koizumi is seen in the Zhongshan II type. The designs on the four sides are identical to the Mawangdui type except for the lack of horizontal lines in the former and addition of diagonal markings in the latter.

Thus the horizontal lines in the Zhongshan II type are expressed as diagonal markings in the Mawangdui type. The distances between the horizontal

and vertical lines of the T motif and between the square and T motif are much shorter on the Mawangdui type compared to the Zhongshan II type. The Mawangdui type is followed by the Dafentou type in which no separation between the horizontal and vertical lines of the T motif and between the square and T motif is found. The following form is the Gaotai type which shows additional diagonal lines compared to the Dafentou type. The final transformation can be seen in the Mojuzi type that has lost the diagonal markings of the Gaotai type and kept only the diagonal lines themselves.

This speculated genealogy can be derived logically and without contradictions from the aforementioned changes in game board attributes, thus the development of boju in this manner can be acknowledged as correct.
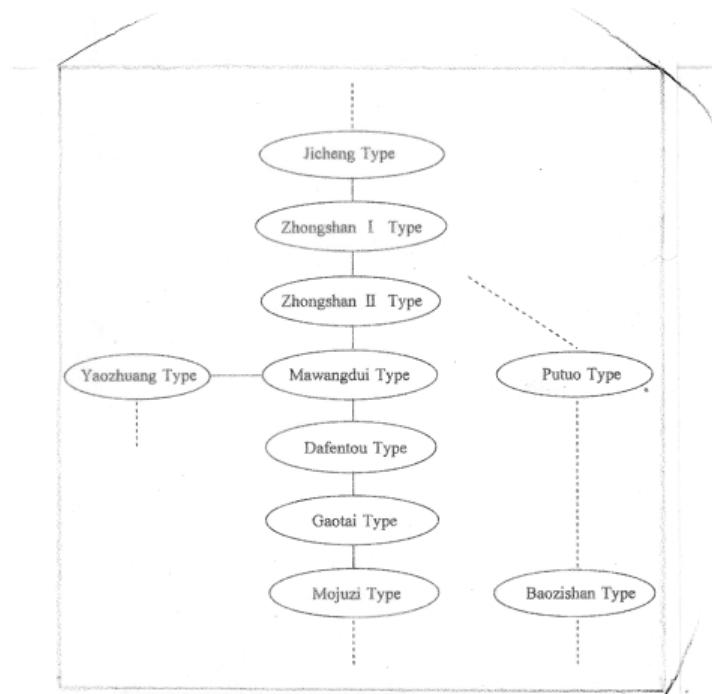

Figure 6 Transition of Game Boards

Distribution and Regional Variation of Game Boards

The previous section discussed the main liubo board development. In this section, other board types that are excluded from the mainstream–the Putuo, the Baozishan, and the Yaozhuang types–are examined.

The Putuo type could not be analyzed as chronologically arriving after the Mawangdui type due to its lack of possession of diagonal markings. However, the game board unearthed from Tonggu Graves at Putuo was made of copper, which indicates that it was probably a burial good. Diagonal markings on an actual game board could easily have been omitted on grave replica. Since no long legs were found in any other boards except in the Jicheng type, I would like to propose a meaningful relationship between the Jicheng type and the Putuo type, which also has long legs. Nonetheless, it is difficult to establish this relationship because boards from tomb No. 2 at Gaotai (高台２号墓博局) and tomb No. 1 at Tuanshan (団山１号墓) have no legs. It is unclear if the board from tomb No. 1 at Luobowan (羅泊湾１号墓) has legs, but the fact that it was excavated from Guangxi implies a spread of distribution and a possibility of regional variation apart from the mainstream board development. Game pieces might have moved diagonally since the Gaotai and Mojuzi types, and the Putuo type can be considered as a variation of liubo in which the pieces do not move on diagonal lines. The features of the Putuo board with long legs and supposedly lack of diagonal movement of the pieces are speculated to be related to the Jicheng type which also has no diagonal movement, and may have branched off from the mainstream board development before the Zhongshan II type appeared.

The Baozishan type becomes the next candidate to continue the genealogy of the Putuo type. Illustrated artifacts enable the Baozishan type to be clarified to some extent, but classification is not attempted in this paper since no relics have been discovered yet. The crosswise-partitioned Baozishan type board does not fit into the mainstream board development, and its pictorial evidence has been excavated only in Sichuan Province. Discovery of relics is expected in the future. Illustrations indicate that the Baozishan type possesses short legs and its crosswise partition on the board possibly reveals no diagonal movement, implying a relationship with the Putuo type. However, considering the geographical distance between these two types, it is difficult to postulate a family relationship between them. It is possible that the board found in tomb No. 2 at Gaotai ties the two types geographically, but I refrain from making a definite judgment here because the excavated artifact shows no legs.

Next, the Yaozhuang type belongs to the Mawangdui type in a broad sense. They have the same T motif and they are identical except that the Yaozhuang type has square-shaped diagonal markings and markings in the square. This type of game board was unearthed in areas adjacent to Jiangsu, Anhui, and Shandong Provinces. Therefore, although the rules may have been no different from the mainstream board game, the distribution of this

board type is probably limited mainly to these three provinces.

To sum up what we have discussed so far, the *boju* design before the Jicheng type is currently unknown and more evidence is needed for analysis. Seven types from the Jicheng type to the Mojuzi type represent the main development of liubo and transitions of the types can be recognized without contradiction. On the other hand, the Putuo type is likely to have developed mainly in the area south of the Changjiang Basin. Judging from the board design, the Putuo type is postulated to branch off from the mainstream before the Zhongshan II type. It is also possible that the diagonal markings were simply omitted from the Dafentou type. Thus, the chronological and genealogical issues need to be reexamined when new evidence is found.

Even though a genealogical relationship between the Putuo and the Baozishan types is suggested in this paper, more examination will be required for verification in the future. Clear characteristics are seen for the Yaozhuang type and although evidence is scant, the distribution of this type seems to be regionally concentrated.
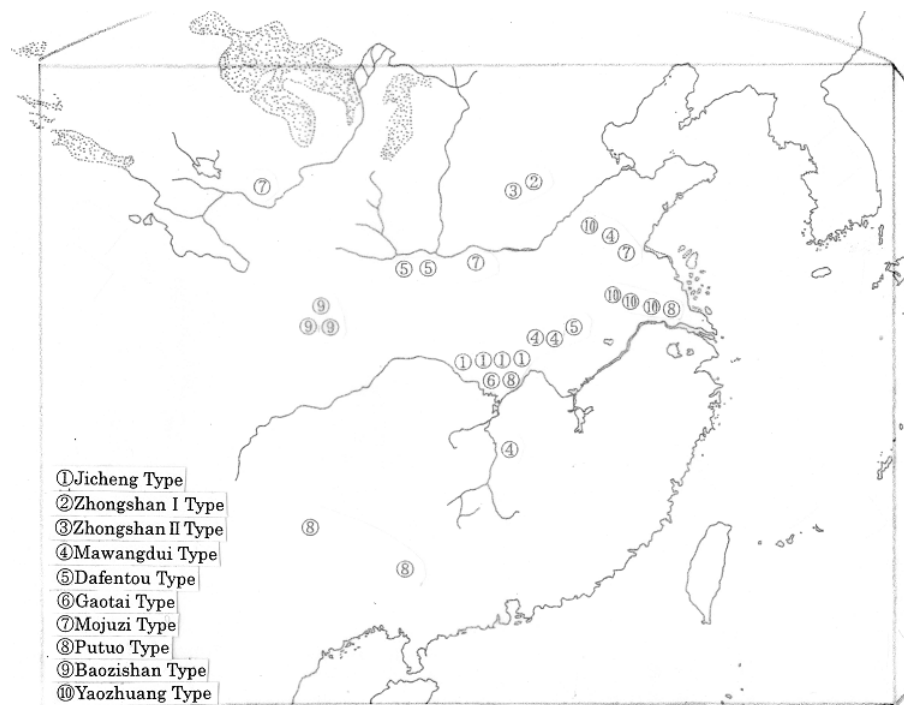

①Jicheng Type
②Zhongshan I Type
③Zhongshan II Type
④Mawangdui Type
⑤Dafentou Type
⑥Gaotai Type
⑦Mojuzi Type
⑧Putuo Type
⑨Baozishan Type
⑩Yaozhuang Type

Figure 7 Distribution of Each Game Board

Chronology of Game Boards

This section outlines the estimated time periods for each type of game board.

The board in tomb No. 1 at Jicheng is dated to the early stage of the middle Warring States Period (B.C.403–B.C.221) and it is considered the oldest example of the Jicheng type. The newer Jicheng board found in tomb No. 2 at Tianxingguan dates to the late period of the middle Warring States Period. The Zhongshan I and II types boards unearthed in the national tomb M3 at Zhongshan both date to the early period of the Later Warring States Era. No evidence of *boju* has been found between the Later Warring States Period and the Qin Dynasty (B.C.221–B.C.207). The Mawangdui type game boards from tombs No. 11 and 13 at Shuihudi date to the Qin Dynasty. As the game board from tomb No. 3 at Mawangdui indicates, the Mawangdui type was in use in the early stage of the Former Han Dynasty (B.C.206–A.D.23). The Yaozhuang type, sometimes included in the Mawangdui type, existed in the latter stage of the Former Han Dynasty. The Dafentou and Gaotai types were seen in evidence from the early Former Han Dynasty, demonstrating fast-changing board game styles in this period. An illustration of a liubo board on a wood block unearthed from tomb No. 14 at Fangmatan (放馬灘) [5] shows no separation between the horizontal and vertical lines of the T motif. Chronologically, the Dafentou and Gaotai types existed during the late Warring States Period, before the unification of China by the Qin Dynasty (B.C.221), preceding the Mawangdui type. Illustrated evidence may not reveal everything, but a few artifacts in the Later Warring States Period and the arrival of all types up to the Mojuzi by this time imply that the Mawangdui type must have developed before the Later Warring States period at the latest.

Even though no actual relics have been found for the Mojuzi type, a stone coffin board excavated from tomb No. 2 at Qingyunshan, Linyi City, Shandong Province (山東省臨沂市慶雲山２号墓出土石棺博局) [21] is dated to the middle period of the Former Han, so the time interval between it and the Gaotai type is fairly consistent.

The Putuo type boards found in a Tonggu Graves at Putuo (普駄銅鼓墓博局), tomb No. 1 at Luobowan (羅泊湾１号墓博局), and tomb No. 2 at Gaotai (高台２号墓博局) are estimated to be from the first half of the Former Han Dynasty. This suggests that the Putuo type did not branch off from the Mawangdui and the Dafentou types, but that it had a different genealogy apart from the mainstream since long before.

Although artifacts have not been found for the Baozishan type, multiple illustrative materials indicate its existence. The type belongs to the Latter

Han era (A.D.25A.D.220), but details about the dates are unknown. Since there is a long interval between the Putuo type and the Baozishan type, further examination is required when new evidence is discovered.

Judging from the chronology of unearthed relics, different liubo board types have overlapped for relatively long periods of time. This implies that older and newer game boards were in use at the same time.

Miscellaneous Issues about Liubo

This section discusses some issues about liubo genealogy and regional variation as identified above based on changes in the game board types.

In the past, only the Zhongshan II type was considered as the origin of the ancient liubo. Usually, the Jicheng and Zhongshan I types were either ignored or understood as boards for a different kind of game. However, this study shows that the Jicheng and Zhongshan I types are clearly related to liubo and they should not be excluded but rather recognized as important material about its origin. If ancient cosmology is reflected in the TLV pattern, we need to examine whether it is present in the Jicheng type liubo design as liubo game boards without TLV patterning have now been clarified. However, a different conclusion can be drawn if we consider that the typical TLV pattern was established as a reflection of the old Chinese cosmological idea of "circular sky and square earth" (天円地方) at the time of transition from the Zhongshan I type to the Zhongshan II type. Therefore, we speculate that there was no influence of Chinese cosmology the design until to the Zhongshan I type.

However, it is unclear if this cosmological thinking influenced the transition from the Zhongshan I to II types and TLV patterning was created as a result. Considering the sequential change from the Jicheng to Zhongshan II types, we should rather presume that the typical TLV pattern developed from the liubo transition. The fact that the spheral pattern is used only in bronze mirrors and sundials means that the "circular sky and square earth" cosmology in which the sphere is regarded as heaven had not yet been adopted. Next, I will examine another possibility besides the "circular sky and square earth" cosmology on the development of the T motif in the TLV pattern.

The LV motif of TLV pattern was already established with the Jicheng type, but the origin of its design has not been established yet. The meaning of these motifs could have differed considering the time gap between the LV and T motif development.

Suzuki maintains that as the board design is used in mirrors with the four sacred animals, it is related to the Xi-wang-mu religion (西王母信仰) and divination [31]. If there is a close relationship between the game board design and divination, may we not assume that the development of the T motif was derived from the letter ( ) indicating a shaman which, as Terasawa [33, 34] maintains, crossed over to Japan as well.
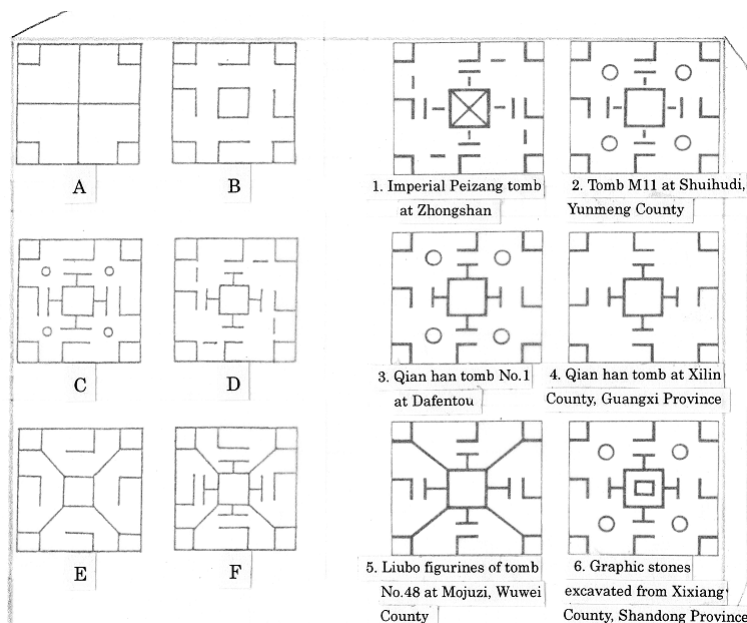
Figure 8 Classifications by Watabe(left)and Koizumi(right) (See Note 2&7 for reference)

Summary

This paper clarified the transition of liubo game boards with respect to both chronological order and genealogical relationships based on recent evidence. In spite of the limited direct access to many of the relics due to the organic material used in most of the liubo items, I believe that an overall understanding of liubo was achieved. Each type of liubo board was used concurrently over a long period of time. Despite limited evidence, regional variation in the game boards was identified. However, more new evidence may yield different interpretations and require reexamination in the future.

The results indicate that typical board design could be traced back to ancient liubo and the T motif of the TLV pattern could be a relatively newer

1. Tomb No.314 at Yutaishan

2. Tomb No.9 at Jiudian

Figure 9 Types of Game Boards (Size=1/10)

innovation. Interpreting the typical TLV pattern based on the "circular sky and square earth" cosmology was deemed as inappropriate for this research.

This study was conducted mainly based on liubo artifacts, and graphic documents, such as illustrated stones, were taken only into secondary consideration. I hope to conduct further examination and exploration of liubo based on graphic materials in the near future.

Acknowledgements

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Figure 2 is from Hayashi (cited in [9]) and others are cited from the reports of the excavations.

A Chess Legend

Arie van der Stoep
Independent board game researcher

Introduction

In 1913, the chess and board game researcher Harold Murray claimed: "especially from the thirteenth to the fifteenth century, chess attained to a popularity in Western Europe which has never been excelled and probably never equaled at any later date" [5, p. 428]. In the 16th c. chess sharply lost its position, Murray remarked elsewhere [5, p. 442]. The cause of the decline could be the changes in the circumstances of life, especially the greater popularity of playing cards, that should satisfy the needs of the time better than board games. Cf. Eales 1985:79-80. This interpretation does not tally with the facts: for example in France the board gamFe draught was in the 16th c. very popular [15, pp. 90-91].

A rather sudden decline presupposes rapid cultural changes in the culture of Western Europe. Such a rapid change never took place. It is true, peerage had lost the dominant medieval position. But the fall of nobility as a factor of power in favour of the rich citizens was already keeping on for some centuries. And it is also true that the scientists of the 16th and 17th c. showed a great interest in the lost culture of the Greek and Romans. But this interest had never been totally absent, it trickled through in the medieval literature of Western Europe.

It is possible to dissolve the antinomy, I believe, by exposing some results from an investigation that ranges over almost forty years.

But let me first explain why the author of this article occupies himself with the past of chess. For I am a Dutchman who seldom plays chess but who is addicted to draughts (checkers), during close on sixty years!

My grandfather was a keen chess player, member of a club. When I had reached the age of six he taught me the rules of continental draughts, the variety played in The Netherlands. In his eyes, draughts was a simple kind

of chess – a sad misconception; David Parlett [7, p. 242] opens his chapter on draughts with the words: "Draughts would be universally recognized as one of the world's great games were it not eclipsed by the social hegemony of Chess". For my grandfather draughts was a leg up to the real game: chess. "When you are eight I'll teach you the wonderful of the kings", he promised me. How much I disappointed him! This wonderful game of the kings turned out to be boring, whereas draughts was fascinating. And chess compositions were as boring as the game itself; how spectacular were the draughts compositions in the paper, with their complicated captures. I started to compose draughts compositions myself. But to do him a favour I occasionally dropped in on my grandfather's for a game of chess.

For my study I read Dutch medieval romances of chivalry, for the greater part translations from French. The knights played tables and chess, not draughts. Why not? Was it not yet invented? Who had studied the history of the game? I biked to the library in Rotterdam and found a history written by H.J.R. Murray [6]. On pages 72-83 he unfolded his ideas about the genesis of draughts. Was his hypothesis plausible? It was needed to put it under the microscope, but that was not so easy, for to manage it I had to study the history of chess. And soon I found myself occupied with a game I had not bothered about since grandfather's death. If only he had known!

To the source

Where does the notion come from that in Western Europe between 1200 and 1500 chess has been an immensely beloved game? From the first generation of chess historians. To get to grips with their way of reasoning we should imagine ourselves back in the second half of the 19th c.

About 150 years ago, a quest to the origin of chess started. The 19th c. is the age of the rediscovery of the Middle Ages. In the 16h and 17th c. the medieval culture had fallen into discredit. The medieval culture was barbarian, uncivilized, uninteresting, unimportant, declared scientists; the classical times had been far more valuable. In the 19th c., this image turned. Literary men studied medieval literature, linguists medieval languages, archeologists remains from the Middle Ages, historians tried to reconstruct the ages that had gone. Together with kindred souls, Antonius van der Linde found that many a medieval author had written a work mentioning chess. How beloved that game had been! Eagerly successors as Murray shared his enthusiasm. And with the same enthusiasm generations after Murray adopted his view: in medieval Western Europe chess had been unprecedentedly popular. How-

ever, the two mentioned giants focused on chess; too little did they realize that chess was played together with and beside other board games, too little were they attentive to possible mutual influence. Younger generations of chess historians built on Murray's monumental, imposing work, as much as possible treading in his footsteps. But they adopted his main shortcoming too: the lack of attention to other board games. Moreover, they were not attentive enough to the newly developed scientific methods they could apply to get to better grips with the past than was granted to Murray in his time.

Exactly one century after the publication of Murray's impressive "A history of chess" (1913) I put remarks on this outlook. Showing respect for an outlook is not parroting it, showing respect is investing time, is scrupulous study. And a critical approach is necessary, for from three nonliterary sources we must conclude that in the Middle Ages chess has definitely not been the most popular board game. I discuss successively the medieval composition of the population, the medieval puzzles and the medieval gaming board.

Medieval composition of the population

There is no indication that in the Middle Ages chess was played outside the nobility and higher clergy, said Richard Eales. In numerical terms the last mentioned classes represented only a very small section of society. Nobility represented in numerical terms only a very small section of society. Eales [2, p. 57] states: "Aristocracy and gentry families amounted to much less than one per cent of the population, even with a generous allowance for their domestic households and retainers. The game may have spread more widely among the clergy, but it is unlikely it reached the mass of parish priests (...) The active clergy did not make up more than two per cent of medieval populations." On the same page Eales warned: "The social appeal of chess should not be exaggerated". Exaggerated? I do not understand why Eales did not add the sentence: 'These figures make clear that in the Middle Ages chess was far from a beloved and frequently played game'.

Eales' opinion is not generally shared. Parlett [7, p. 301] quoted the researcher Antje Kluge-Pinksker, who suggested (in 1994) by recent archaeological finds that in the 11th and 12th c. chess (and tables) played an important role in the daily lives of many people also outside the stratum of society indicated by Eales.

Medieval puzzles

Two Italian puzzle men recorded chess, tables and morris puzzles, namely Nicholas de Nicholea, working under the pen-name Bonus Socius, and a citizen of Bologna [7, p. 301][Murray 1913:618-620]. The presentation of the puzzles do not give us leave to suppose that the collectors preferred chess above the two other games.

In three chapters Murray [5, pp. 564-735] dealt exhaustively with the chess sections, trying to find answers to questions such as 'What is their origin?' and 'What is their value?' Eales [2, p. 69] was far from excited about the level of the chess problems: "The problem collections themselves were based on Muslim models, and though they evolved with changes in taste and fashion, they rarely showed any signs of technical advance on their eastern prototypes".

Murray [5, pp. 702-703] devoted some words, hidden in an Appendix, to the tables and morris problems. They were not based on earlier examples, as the chess problems, but were of European origin. "At first sight, a dice-game does not appear very suitable for the composition of problems", Murray opined. He liked the morris problems better: "Some of the problems are very ingenious, and I think that they leave a more favourable impression of the ingenuity of the medieval composer than is the case with the problems of chess or tables".

It is not a careless assertion, I think, to propose that medieval residences were not exactly crowded with young men assiduously composing chess problems.

The medieval gaming board

A lot of bills, inventories and last wills drew up in France until c. 1525 mentioned a gaming board. Seven citations.

(1) ii tabliers de fust garniz de leurs tables et d'eschez, achatz en la rue Neuve-Nostre-Dame et dlivrz en la garderobe du Roy [1352, purchased for king John II the Good]

(2) Deux tabletes de ciprs, ouvrz et garniz de tables et eschaiz from Pierre Cardeau [1382, purchased for king Charles VI the Well-beloved]

(3) Un tablier d'argent dor, ployant par moyti, fait par dedans de pices de nacle (= nacre, mother-of-pearl) et garny de tables et d'eschaz [1416, property of the Duke of Berry, son of Charles V]

The common gaming board was flat, made up of two hinged panels, on one side inlaid or painted with a tables pattern and on the other side with a chequered 64 squares pattern. See Stoep 1984:34-36 for more medieval descriptions of this kind.

The name TABLIER was also used for boards from a different kind. Three descriptions, taken from Stoep 1984:34-36.

In 1502, Anne of Brittany married king Louis XII of France, and clerks registered her possessions. She was the owner of a box covered with green leather, embellished with leaf silver. In this box crystal chess pieces were kept. The chess board was described as follows:

(4) Ung tablier de crystal garny d'argent dor, pour servir auxd. eschs, estant en ung estuy couvert de vert
(A crystal gaming board decorated with leaf silver to serve for the aforementioned chess pieces, housed in a green case)

Inventory Baux castle 1426:

(5) Grand tablier double, marquet par dedens, pour jouer aux tables et cheacs
(Big folding gaming board (box?), the inside inlaid, to play tables and chess)

In 1524, Margaret of Austria possessed

(6) Ung tablier garny d'ivoire, eschequet d'un cost blanc et noir, et de l'autre cost, pour jou au plus de poins, et il y a une petite quehue de serpent de mesme, pour jou aus-dit poins.

One side of the board had a chequered pattern, the other one a game "au plus de poins", i.e. a game where the players tried to make as many points as possible. To play this game a serpent tail was needed.

Margaret also owned

(7) Ung tablier de bois carr, garny d'ivoire, l'eschequier de mesme au prc-dent (...) et de l'autre cost pour jou au marrelier
(a square wooden board, the chessboard the same as the aforementioned board (...) and the other side designed for the playing of morris)

Applying the figure of speech we call *pars pro toto* I can say more about the quotes (1)-(7).

In The Netherlands chess as well as draughts enjoys some popularity. Chess players and draughts players use the same flat board. On one side this board has 64 squares to play chess and on the other side 100 squares to play draughts. The board has two names: chess players call it chess board, draughts players call it draughts board. Both groups avail themselves of the pars pro toto, i.e. they use the name of the part of the board that is important for them.

We can use the pars pro toto when interpreting the descriptions (1)-(7). If these boards served exclusively for chess, we might expect the pars pro toto CHIQUIER. In (4)-(7) the name TABLIER is used in its neutral meaning of 'gaming board', I think. In the Middle Ages TABLIER meant both 'gaming board' and 'board for tables'. We can (1)-(3) read as 'board for tables', but given the interpretation of (4)-(7) 'gaming board' is more obvious.

A second contradiction

In the Introduction I indicated an antinomy in Murray's work. I point to a second contradiction: nonliterary medieval sources tell us that in this time chess was certainly not the most popular board game, but in literary medieval sources chess has a dominant position. This induces me to the question to what extent it is permitted to pronounce upon reality on the basis of literature.

It might be useful to reveal my background. In the 1960s and 1970s I studied Dutch literature and Dutch linguistics. The teacher historical literature brought her students in touch with the past, starting with the 11th c. And immediately with France, for the greater part of the medieval Dutch literature are translations from French works. As the French culture also radiated to great cultures as Spain, Italy, England and Germany, medieval Dutch literature was in fact European literature.

Literary theory

The teacher general literature brought up the problem how the world of literature relates to the real world. Murray and his predecessors were unaware there was a problem. The contradiction I made mention of demands us to solve the problem.

A general answer on the question whether literature is a mirror of reality cannot be given: the reliability of literature as a reflection of reality differs per genre, per author and per book. The work of Emile Zola and of Charles Dickens for instance tells us more about the social reality than the western, the doctor novel and the fancy novel from our time. But... In the hands of a novelist a doctor novel can outgrow into a work of art. He could show in a probing way how the relation of a doctor and a nurse leads to difficulties because on the shop floor of a hospital they have a different status.

Chess plays a role in two important medieval genres: the didactic poem and the roman of chivalry. To what extent can we consider them as a mirror of medieval life?

The medieval didactic poem

The poet of today who often dares to incorporate images borrowed from colleagues asks for scathing criticism: that is theft, he is expected to devise original images.

In the Middle Ages the poet's task was less demanding: poet's task was less demanding: a poet frequently borrowed images. An often borrowed image was a game of chess.

In the medieval world life on earth was not more than a preparation to the hereafter, the eternal life under God's protection. It was hard working, for the devil and his henchmen always lay in ambush to tug the human into hell. God was just, did not distinguish between poor or rich, slave or ruler: the social differences that existed on earth fell away in heaven. The poem with this message is called *didactic poem*. During a game of chess, i.e. during life on earth, there is inequality, a king rules over all the other pieces on the board. But Gods promises consolation to the poor soldier who is put in for a whim of his sovereign: after the game a hand sweeps the pieces in one bag, in death every distinction falls away. See for extensive quotes [5, pp. 496-563].

The first example he mentioned dates back to the 11th c., South Germany. Eagerly other authors of a didactic poem adopted the allegory of the chess game, varying and elaborating it.

The question is, of course, if we may adduce these poems as a proof for the popularity of chess, like Murray did, although he admitted [5, p. 529]: "the writer's interests were always engaged more with the allegory than with the game", but he added: 'Still, the [chess moralities] are not without importance in the development of chess in Europe". Not without importance.

Easily said, difficult defended. Murray did not try to find a strong argument but made some propositions, cautiously writing: "(the moralities) may have..."

There is reason for caution, I believe, because the genre demanded only a little knowledge of chess. For the writer, who repeated images of his predecessors. And for the reader, for whom the message is clear without knowing anything about chess.

The medieval romances of chivalry

In my youth I read with red ears about the adventures of the white cowboy Old Shatterhand and his Indian blood brother Winnetou, made up by the German Karl May. And later in the cinema I enjoyed the western. At least four times I saw the epic Once upon a time in the West. This masterpiece –as it is in my eyes– shows with some realism the struggle to open up the American West for the white man by building a railway. The average western has the standard scheme of the good cowboy putting up a fight against the bad guy.

The western did already exist in the Middle Ages: the romance of chivalry. The Old Shatterhands of that time fought against Saracens, or against a firedrake, or against a bad magician. Just like the cowboy the knight is a flat character, with standard qualities: he lives in a castle, wages war and matches himself against other knights in a tournament, to relax he hunts for deer and birds. And every author lets him play tables and chess. Such repetitions contribute to the understanding of the listeners –the texts were meant to be recited–: an experienced audience was expecting knights to play "eschecs et tables". There is a relation with the concept of *local colour*. A writer colours the places he evokes in with particular properties; every child knows from fairy tales that a king lives in a castle.

In the literary analysis, a commonplace, a fixed expression, is called a *topos*. The word *topos* was taken from the ancient Greek, who discerned the topos already in the literature of their time. A commonplace from a funeral oration is "We are ashes and dust".

In the didactic literature the image of chess was repeated, varied and extended, and the same happened in the romance of chivalry. When the woman was introduced –for some ages the romance was only populated by men–, the knight got a new task: to do deeds by order of a noblewoman, as frighten an unwelcome young man. In dozens of variations lovers seized any pretext to meet each other, and chess could be an alibi. A condition

was, of course, that the two knew the rules, and the authors solved this problem introducing chess as a part of the upbringing. A similar process of development is found in the romance of chivalry of our days.

The literary theory says that we may not see a topos as a representation of reality. Compare the function of chess in the narrative arts of our time. If next year ten filmmakers shoot their principal characters playing a game of chess, they have absolutely not the intention to tell their audience about chess as a pastime, the number of players, its position amidst other board games. One movie director for instance suggests his characters are intelligent thinkers, another will use pretty designed chess pieces because of their elegance, and a third emphasizes the luxury of an interior by means of a valuable chess set on a decoration coffee table.

The sixteenth century

In the early 16th c. the didactic poem and the romance of chivalry disappeared. Van der Linde, Murray and their successors understood the content of these genres as a faithful representation of reality. As a consequence they found a serious regression of chess in the 16th c. This is unjust: chess only appeared in the literature, it does not prove anything. In the 16th c. chess was a minor board game, Murray observed. He is right, but I add; in the 16th c. chess was as unpopular as in the Middle Ages. I shall found this claim by means of linguistic tools.

Linguistics

My study of my mother tongue comprehended in addition to literature two other main subjects: reading and writing (structure of texts, style, argumentation) and linguistics. To acquire a picture of medieval draughts –and at the same time of chess, see the Introduction– I used both the tools developed by the literary theory and the tools developed by linguists.

Etymology is a branch of the linguistic tree. In the years I discovered Murray's work linguists initiated me in the principles of etymology. Each teacher warned his students for the many pitfalls. It is a tricky subject, many a linguist slipped up by explaining the origin of a word too easily. It is definitely necessary to study a word thoroughly in its linguistic and historical context. Sniggering they gave us examples of blundering colleagues who had insufficiently studied one or even both contexts.

To my surprise, the strongest pillar under Murrays proposition about the birth of draughts was his explanation of the French game name (JEU DE) DAMES. In other words: he used etymology to pronounce upon a board game in the past. Murrays approach, however, was an example of the way one should not do an etymological investigation. Therefore is idea of the genesis of draughts was by definition unreliable. There was no alternative but starting an own inquiry into the origin of the French game name (JEU DE) DAMES, in the hope I could use it as a starting point for further research.

Three days off

During the summer holidays of 1975 I withdraw for three days in the library of Rotterdam, consulting all available dictionaries from the 16th, 17th and 18th c. The result? Except for a sole 18th c. lexicographer, no one supposed that the French game name JEU DE DAMES literally meant "game of the chess queens". The French game name JEU DE DAMES was almost unanimously translated by Latin LUDUS DUODECIM SCRUPUS, literally "game with twelve pieces", a proof that it is not right to take it for granted chess played any part in the genesis of draughts.

Bilingual dictionaries of the modern languages gave me headache. Three examples. The Dutch word DAMBORD, nowadays meaning 'draughts board', was translated by English CHESS BOARD. The French game name JOUER AUX CHECS, nowadays meaning 'to play chess', was between 1550 and 1700 defined by lexicographers as 'to play tables'. And the Italian game name MARELLA was connected with 'draughts' and with 'morris'. Therefore an inquiry into the history of draughts was impossible without studying, besides chess, tables and morris too.

Linguistics and the history of chess

Murray published his wrong explanation of the French game name DAMES in 1952. He summarized a longer reasoning in his unpublished manuscript "Preliminary investigations into the history of draughts" (1916). By the way, he also blundered with his etymology of the Spanish game name ALQUERQUE [5, p. 613]. See for my proposal Stoep 1997:158-159, Stoep 2007:174-175.

In Murray's defense we can put forward that etymology was in 1916 still in its exploratory stage. In three publications from much later time, however, chess historians allowed themselves to make an etymological proposition within five minutes, their legs on the table and a pint in their hand. In the late 15th c. the new chess queen made its appearance. In France the piece was called DAME, in Spain DAMA. Obviously, 'chess queen' was a new sense of an existing word. From which word? Pretty guesses replaced profound study. Jacob Silbermann en Wolfgang Unzicker [7, p. 301][1977 I:40-42] supposed that the French name DAME for the chess queen was a homage to Joan of Arc. Ricardo Calvo [1, pp. 82-89] and Govert Westerveld [17, p. 217] took their chance on queen Isabella of Castile. Joachim Petzold [8, p. 153] [9, pp. 4-9], embroidering on an 18th c. proposal [Golombek 1976:79], opted for Mary, the mother of God, as the paragon; a well-nigh blasphemous proposition. On psychoanalytic grounds and investigator conducted to Catharine Sforza as a model [2, p. 77].

Except for the chess grandmasters Silbermann and Unzicker these men moved in an academic setting; why such an amateurishly approach if they could easily ask a linguist for advice?

My research took me nearly forty years. They led up to a dissertation in 1997; in Dutch, with summaries in English and French. My finding: the French game name (JEU DE) DAMES and the Spanish name DAMA for the chess queen go both back to the medieval French word DAM, meaning 'dam, dike, wall'. This etymology guides the investigator searching the origin of draughts or the origination of the new chess queen into quite another direction than earlier explanations.

In my 1997 thesis the main subject is the linguistic method and result. It stands to reason: I had to prove to the University of Leyden I was capable of an independent investigation. Nevertheless the Subject index fills nearly two pages.

The Word index runs to nearly six pages. It does not only include living or dead words from the jargon of draughts and chess players but also words used by players of tables, morris or alquerque. Like a human being a word is born, changes by the experiences it goes through and dies ultimately. The society where a word lives is called a *word-field*. To thoroughly understand a word we must have a view of the entire word-field. Word-fields in other languages too, for the French game name DAMES was borrowed in other languages. For this reason, the Word index mentions words from fourteen languages.

There could be readers asking for more clarification about the word-field. Well then, a word-field can be compared with a closed family, a family

excluding everyone outdoors. If the manager of a company dies, his successor
will be a member of the family. In case children lose their parents, other
members of the family will take care. Only when it is inevitable there will
be made an appeal to an outsider, for example in case of a heart attack. A
word-field is a closed family too.

By means of a game name belonging to the French word-field *Board
game*, I explain what the study of a field contributes to our knowledge of
board games.

Above I referred to the enigmatic French game name JOUER AUX CHECS.
Between c. 1000 and c. 1500 and from c. 1700 up till now this name meant
'to play chess'. Between c. 1500 and c. 1700 the name meant 'to play
tables'. Why? Well, in the 15th c., the medieval French game name for
'to play tables', JOUER AUX TABLES, died. The death of a human being
induces us to a question: what happened? The death of the name for tables
in France c. 1500 induces us to a question: what happened? Did tables
fell into disuse? Could the medieval variety have been surpassed by a new
variety? No matter what may have happened, it means a signal to the
investigator of board games: he knows he should make inquiries, and where
and when.

At any rate, French players of tables needed a new name. They looked
around inside the board game word-field and encountered the name JOUER
AUX CHECS. The main sense of JOUER AUX CHECS became 'to play tables'.
The name kept its sense 'to play chess', but evidently this sense was seldom
used. Which means we can draw this conclusion: in France between c. 1500
and c. 1700 chess was a seldom played game. Which proves that the study
of a word-field augments our knowledge of tables and chess.

The outcome of this linguistic research correspondents to Murray's ob-
servation that in the 16th c. chess lost or had lost its mighty position.

The full report of the French word-field Board game is to be found in
Stoep 2007:101-116. This book is a continuation of my thesis, but differs
essentially. Just like in 1997 I provide insight into the courses I take to find
out the etymon of a word. But I discuss the consequences of an etymology for
our view on the genesis and/or the evolution of several board games. Surveys
on board games describe chess as a game enjoying a great popularity in the
Middle Ages. I came to an entirely different view: draughts has been much
more popular, chess was not more than a minor game. At least in England
and France, and in Spain in the late Middle Ages. For lack of data I know
little or nothing about other medieval civilizations.

How could it be possible I get to outcomes that are conflicting with everything we believe to know about board games in bygone times? The cause is a painful structural fault made by chess historians. Their aim is one board game: chess. In the past this game has been tremendously popular, they conclude, other board did not come near it. Such a conclusion implies a judgment about these other games, but without having studied them (!). And what's more, as a consequence of this unsatisfactory approach you easily come to false claims. An example. The chess historian Richard Eales draw the conclusion that chess acquired its present status of intellectual game in the 18th c., when chess was a pastime for intellectuals [2, p. 106]. These intellectuals, however, played draughts too [15, pp. 94-96], so that Eales' claim must be wrong.

Medieval chess in England

After what I wrote about the concept *word-field* it may not surprise English board game terms were a subject of my study. Among these terms the word CHECKERS – I ignore variants as (AT THE) ESCHEKKER. Until the 14th c. this game name meant 'chess', literally "game at the chequered board". Anywhere in 14th c. Europe a player of board games transferred the game we know under the name of Alquerque –and that without any doubt was played with promotion [15, pp. 138-140] – to the chess board. English players called this "new" game CHECKERS. It caused a communication problem, for if your neighbor invited you TO PLAY CHECKERS, did he want to play chess or draughts? The language user clears such an ambiguity away by choosing another word for the least used sense and keeping the most frequently used sense. The least used sense must have been 'chess', for chess got a new name, borrowed from French: CHESS.

Conclusion: that in 14th c. England CHECKERS in the sense of 'draughts' was more frequently used than CHECKERS in the sense of 'chess' means that in this age chess was a game of less importance than draughts [16, pp. 27-29].

Medieval chess in France

In medieval France draughts has been a popular game, so much that it became proverbial. I don't base my case on one proverb. No, from the 11th until the 15th c. a complex of expressions was inspired by the wrong or right move of a draughts piece [15, pp. 149-154]. I gathered almost 70 metaphors, spread over 22 different idioms [15, p. 150]. The expressions might have been used earlier, but data before the 11th c. are lacking. The many vari-

ations prove there was a continuous touch with the game itself, they are not fossilized. For comparison: STALE-MATE is an example of a fossilized metaphor. Once, a writer with knowledge of chess wrote: "The votes are equally divided, no decision could be made. There was an impasse, a stale-mate". STALE-MATE is one of the thousands of words an Englishman learns in the course of time; he does not need knowledge of chess to understand it.

Medieval chess in Spain

There can be no doubt chess was a popular board game in the ancient Muslim world. See for instance the attention for chess in the manuscript on board games in 1284 made for king Alfonso x of Castile, a time when the Moors still had a powerful position in Spain. In the German translation by Ulrich Schdler and Ricardo Calvo [11] chess demands 130 pages, the other games 132. In Spain in the late Middle Ages, chess seems surpassed by draughts. Could there be a relation with the decreased influence of the Moors in favour of the European influence?

According to chess historians from our days it was Spain, late 15th c., which welcomed the new chess queen with its greater range [17, p. 219 for example]. I analysed that the name for this piece, DAMA, derives finally from a term used by French draughts players [15, pp. 38-47]. The linguistic approach has spin-off for our understanding of development in the past: it is tempting to argue we should seek the explanation of the extended range of the chess queen in the long range of the king in Spanisch draughts [15, pp. 43-44].

Note

In his review of "The anatomy of chess", 2004:136, Ulrich Schdler asked critical questions about the genesis of chess. Applying linguistic methods, I put the genesis of draughts between 0 and 500 AD, in a civilization in the Roman sphere of influence (By the way, in Stoep 2007:209-215 I placed the genesis of draughts in ancient Greece, but neither the civilization nor the time seems tenable). In the Middle Ages and in later centuries draughts has evidently influenced upon chess, especially related with the promotion. In a culturally leading civilization as France for example the great popularity of draughts continued after the Middle Ages [15, pp. 90-96]. Only after the 18th c. chess succeeded in escaping from this influence. If we assume that chess also before 1000 was influenced by draughts –but is such an anachronistic assumption reasonable?– we might expect chess owes its promotion to draughts.

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New problems on old solitaire boards

George I. Bell and John D. Beasley
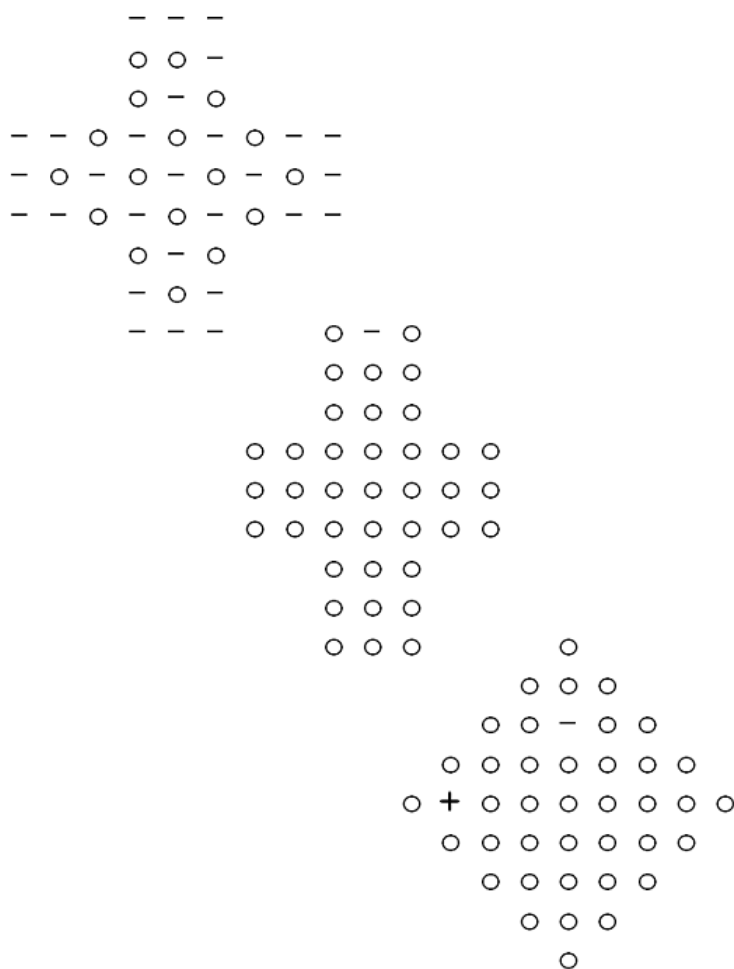
Abstract: *Some old solitaire boards are brought down from the literature, dusted off, and re-examined, and some remarkable problems are displayed on them.*

Background and history

Solitaire ("Peg Solitaire" in America) is a very familiar one-person board game. The board consists of an array of holes or squares; a man (usually a peg or a marble) is placed in each hole; one man is removed; the rule of play is to jump a man over a neighbouring man, removing the man jumped over; the object is either to reduce to a single man or to leave the men in some specified pattern. But these simple rules yield a game of remarkable subtlety, which has spawned a substantial literature both practical and mathematical. In particular, J. H. Conway published an extensive treatment in 1982 which gave the most important discoveries up to that time (in some of which he had played a major part), and one of us devoted a complete book to the subject a few years later (Berlekamp, Conway and Guy 1982/2004, Beasley 1985/1992). Any statement not more specifically referenced in what follows will be found in one of these works.

The game appears to have originated in France in the late seventeenth century, and to have been the "Rubik's Cube" of the court of Louis XIV (Berey 1697, Trouvain 1698). On the evidence of a passing reference in a letter from Horace Walpole, "Has Miss Harriet found out any more ways at *solitaire*?", it was already established in England in 1746; in 1985, one of us took a very cautious view of this, suspecting that the reference might be to a card game, but David Parlett has written that these fears were groundless: "Patience dates from the late eighteenth century, did not reach England until the nineteenth, and was not called Solitaire when it did" (Walpole 1746, Parlett 1999). Sadly, the widely-quoted legend that the game was invented by a prisoner in the Bastille is almost certainly false. In 1985, the earliest reference to this that could be found was in an English book of 1801, more than a century after the alleged event and in a different country to boot, and nobody has yet brought an earlier reference to our attention.

The game was originally played on the 37-hole board shown in Fig. 1, and a selection of problems on this board was published by Berey (Berey undated). However, it is impossible on this board to solve the puzzle "start by vacating the central hole, play to leave a single man in this hole", and the game is now more usually played on the 33-hole board shown in Fig. 2. But boards of many other shapes and sizes have been tried, and in this paper we shall consider three of these: (a) the 45-hole board of Fig. 3, briefly studied by Johann Christoph Wiegleb in 1779 but little used since; (b) the 39-hole board of Fig. 4, which forms a halfway house between Wiegleb's board and the normal 33-hole board and on which there is a simply stated problem of remarkable difficulty; (c) the 41-hole diamond board of Fig. 5,

which received attention in France in the late 19th century (Wiegleb 1779, Lucas 1882/1891). Play from a single initial vacancy to a single survivor is very much harder on these boards than on the 33-hole and 37-hole boards.

```
        o o o
      o o o o o
    o o o o o o o
    o o o o o o o
    o o o o o o o
      o o o o o
        o o o
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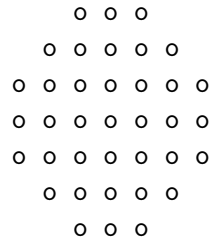
Figure 1: The classical 37-hole board

```
            o o o
            o o o
        o o o o o o o o
        o o o o o o o o
        o o o o o o o o
            o o o
            o o o
```
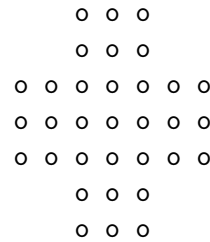
Figure 2: The 33-hole board

```
        o o o
        o o o
        o o o
  o o o o o o o o o
  o o o o o o o o o
  o o o o o o o o o
        o o o
        o o o
        o o o
```
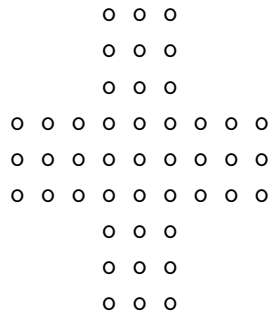
Figure 3: Wiegleb's 45-hole board

```
        o o o
        o o o
        o o o
  o o o o o o o o
  o o o o o o o o
  o o o o o o o o
        o o o
        o o o
        o o o
```
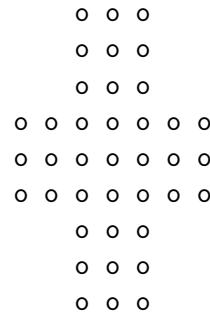
Figure 4: The 39-hole "semi-Wiegleb" board

```
              o
            o o o
          o o o o o
        o o o o o o o
      o o o o o o o o o
        o o o o o o o
          o o o o o
            o o o
              o
```

Figure 5: The 41-hole diamond board

Most of the results that follow owe their discovery to computer search, but those that do not involve counting moves have been verified by mathematical analysis. One of us (GIB) programmed the computer to search for solutions of certain kinds, "failure to find" being treated as a provisional but

strong indication that no such solution existed; the other (JDB) attacked the unsolved problems analytically, and demonstrated that solutions of the kind required were indeed impossible. A specimen demonstration appears in an appendix. Claims that a certain solution is the shortest possible, or that only a certain number of similarly short solutions exist, are completely computer-dependent and have not been independently verified.

The unsolvability of the problem "start by vacating the central hole, play to leave a single man in this hole" on the 37-hole board is a consequence of a property known as "position class": the various positions possible on a Solitaire board can be divided into 16 different classes, and it is impossible to play from a position in one class to a position in another. The earliest demonstration of this known to us was due to Suremain de Missery and was reported as late as 1842 (Vallot 18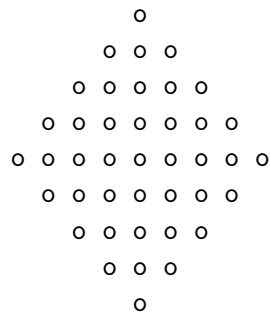42), but the result, once suspected, is not difficult to prove, and we believe that it had in fact been established very early in the history of the game. (It is perhaps proved most simply by marking off the diagonals of the board in threes, mark-mark-clear-mark-mark-clear and so on, and observing that if the total number of pegs in the marked diagonals starts odd it must remain odd throughout the solution and if it starts even it must remain even.) This theory is spelt out in detail in all mathematical treatments of the game, but we shall not go further into it here. All the problems we shall consider will have initial and target positions within the same class, and the reasons for any unsolvability will lie deeper.

Long sweeps on Wiegleb's board 45-hole board

On the 33-hole board, the longest sweep geometrically possible is a 16-sweep (see for example Fig. 6). However, such a board position cannot be reached from a single vacancy start, or in fact from any starting position with fewer than 16 vacancies (the position itself)! From a single-vacancy start, the best that can be achieved is an 11-sweep, but it is not then possible to play on and reduce to a single man. The longest sweep that can occur as the last move in play from a single-vacancy start to a single-survivor finish has length 9.

In these and subsequent figures, "o" denotes a man and "-" an empty hole.

The longest sweep geometrically possible on Wiegleb's board is the same 16-sweep as is available on the 33-hole board. The sweep can begin either from d2 as shown in Fig. 7a or from d4 as in Fig. 7b (or from 10 other

```
          a b c d e f g
       1      o o -
       2      o - o
       3  - o - o - o -
       4  o - o - o - o
       5  - o - o - o -
       6      o - o
       7      - o -
```

Figure 6: A 16-sweep on the 33-hole board

```
   a b c d e f g h i          a b c d e f g h i
 1         - - -            1         - - -
 2         o o -           2         - o -
 3         o - o           3         o - o
 4  - - o - o - o - -       4  - - o o o - o - -
 5  - o - o - o - o -       5  - o - o - o - o -
 6  - - o - o - o - -       6  - - o - o - o - -
 7         o - o           7         o - o
 8         - o -           8         - o -
 9         - - -           9         - - -
```

Figs. 7a and 7b: The 16-sweeps possible on Wiegleb's board

locations symmetrically equivalent). Remarkably, each of these 16-loops can be realized as the final move in single-vacancy to single-survivor play.

The easiest way to solve a long-sweep problem is to set up the reverse of the target position, putting a peg where the target position has a hole and vice versa, and to attempt to reduce this position to a single peg. If we succeed, listing the jumps in reverse order gives a solution to the original problem. For example, Fig. 8a shows the reverse of Fig. 7a, and if we set up this position we find (probably after a certain amount of trial and error) that we can play f1-f3, i4-g4-e4, d4-f4-f2, i6-g6-e6-e8, d9-d7, d6-d8, f9-d9-d7, a6-c6, f8-d8-d6-b6, a4-a6-c6-c4, b4-d4, d1-f1-f3-d3-d5-f5-h5, and i5-g5, reducing to a single man at g5. If we now set up a full board, vacate g5, and play i5-g5, f5-h5, d5-f5, and so on, we eventually find ourselves at Fig. 7a, and we can play the spectacular 16-sweep and finish with a single survivor at d2. The reader may care to set up Fig. 8b, which shows the reverse of Fig. 7b, and play to reduce to a single man at g4, though this is appreciably more difficult.

```
   a b c d e f g h i        a b c d e f g h i
1        o o o           1        o o o
2        - - o           2        o - o
3        - o -           3        - o -
4  o o - o - o - o o      4  o o - - - o - o o
5  o - o - o - o - o      5  o - o - o - o - o
6  o o - o - o - o o      6  o o - o - o - o o
7        - o -           7        - o -
8        o - o           8        o - o
9        o o o           9        o o o
```

Figs. 8a and 8b: The reverses of Figs. 7a and 7b

By this means, it can be shown that Fig. 7a can be reached from a full board with just g5 vacated, and Fig. 7b from a full board with just g4 vacated (or d7, by symmetry). Exhaustive search by computer, subsequently confirmed by mathematical analysis, has shown that no other starting positions are possible. The actual solutions discovered by this means are somewhat untidy, since a 6-sweep such as d1-f1-f3-d3-d5-f5-h5 becomes six separate moves f5-h5, d5-f5, d3-d5, f3-d3, f1-f3, and d1-f1 when the jumps are made in reverse order, but once a solution has been found it can easily be rearranged to reduce the number of separate moves. Solutions optimized in this sense appear in Appendix A.

The 16-loop is the longest sweep ending at d2 or d4, but what about the other locations on this board? Although sweeps as long as 13 are geometrically possible, the longest finishing sweep at any other location only has length 9 (to the problem "vacate d9, finish at d3"). It is however possible to have longer *internal* sweeps, and in particular the penultimate move in a solution to the problems "vacate d6 or g6, finish at d3" can be the same 16-sweep from d2 as we have just seen above.

Optimally short solutions on Wiegleb's board

Having solved a solitaire problem, the natural next step is to try and minimize the number of separate moves (counting a sequence of jumps by the same man as a single move). On the 33-hole board, a remarkable set of optimal solutions was developed by Ernest Bergholt and Harry O. Davis between 1912 and 1967. One of us demonstrated by computer in 1985 that these solutions were indeed optimal, and this has been confirmed by Jean-Charles Meyrignac. On the 37-hole board, the best pre-computer work was

done by Alain Maye, Leonard J. Gordon, and Davis. Computer analysis by Meyrignac subsequently beat four of their solutions by a single move, and demonstrated the remainder to be optimal (Meyrignac 2002).

On Wiegleb's board, the problem does not appear to have received attention until now. It follows from the "position class" theory that on this board, as on the standard 33-hole board, the starting and finishing holes of a single-vacancy single-survivor problem must be a multiple of three rows and columns apart (for example, if we start by vacating d1, we can hope to finish at d1 itself, a4, d4, g4, or d7, but nowhere else). It follows that there are 36 essentially different single-vacancy single-survivor problems; any other such problem can be transformed into one of these 36 by rotation or reflection.

Wiegleb himself only gave a solution to the problem "vacate d1, finish at d4", with a note that the inverse problem "vacate d4, finish at d1" was also solvable. In fact each of the 36 problems is solvable except for "vacate e1, play to finish at e1". One of us established this in 1985 and indicated how the unsolvability of the outstanding case had been proved, but a fully written-out proof would be lengthy and to the best of our knowledge none has been published. Analysis by computer has now confirmed this unsolvability, and has also found the shortest solution to each of the remaining 35 problems. The problem "vacate and finish at e2" requires 23 moves (an interesting parallel with the 33-hole board, where the equivalent problem "vacate and finish at d2" takes at least one move more than any other), and each of the rest can be solved in between 20 and 22 moves. While 16 (nearly half) of the problems can be solved in 20 moves, no 19-move solution has been found.

Table 1 summarizes the results, and specimen solutions are given in Appendix A. Since these results come from lengthy and complex computer runs, they do not constitute a formal proof that the lengths given are the minimum possible. It is possible that some programming bug is present, and as yet the results await independent verification. However, the program has reproduced all the results previously established as shortest possible on the 33-hole board, and we are confident that its results on other boards are similarly correct.

These solutions are very difficult to find by hand, some virtually impossible (though the solutions to "vacate b5 or e5, finish at e2" with their intermediate 12-sweeps were so found by Alain Maye). Peg solitaire problems do not have unique solutions, except in very special cases or on small boards. If two successive moves do not interfere with each other, they can be executed in the opposite order, producing another solution of the same length. Even when one looks at the set of moves in a solution regardless of order, there are usually many different possibilities, all equally valid. How-

ever for two of the problems in Table 1 the set of solution moves is in fact
unique (to within symmetry, of course), and in three other cases there are
only two or three possibilities.

Table 1: Shortest solutions to single-vacancy single-survivor problems on
Wiegleb's board

Vacate	Finish at	Number of moves	Number of different solutions	Vacate	Finish at	Number of moves	Number of different solutions
d1	d1	22	n/c	e1	e1	Unsolvable	
d7	d1	20	1	b4, e4	e1	20	3
d4	d1	20	30	e7	e1	22	39
g4	d1	20	38	e2	e2	23	n/c
a4	d1	21	30	e8	e2	22	1
d2	d2	20	775	b5, e5	e2	22	204
d8	d2	20	208	e3	e3	22	213
d5	d2	20	983	e6	e3	21	220
g5	d2	21	683	b6	e3	21	244
a5	d2	22	341	e9	e3	22	2
d3	d3	20	364	e4, b4	e4	20	191
d9	d3	20	91	e1	e4	22	87
d6	d3	20	3798	e7	e4	22	n/c
g6	d3	20	4845				
a6	d3	21	2943				
				e5, e2	e5	22	3
d4	d4	20	40				
g4	d4	20	63				
d1	d4	21	60				

The numbers of solutions are given to within symmetry and ordering of
moves; "n/c" indicates "not calculated".

Specimen solutions are given in Appendix A, and we draw particular
attention to the 22-move solution to the central game (vacate and finish at
e5). This is the analogue of Bergholt's 18-move solution on the standard
33-hole board.

A difficult problem on the 39-hole "semi-Wiegleb" board

The standard 33-hole board and the 45-hole Wiegleb board are special cases
of "generalized cross" boards in which a central 3x3 square has a 3xn arm
attached to each side. Each arm is two holes deep on the 33-hole board
and three holes deep on Wiegleb's board. The 39-hole board of Fig. 4

offers a halfway house between these boards. A systematic investigation of generalized cross boards by computer has brought to light an unusually difficult single-vacancy single-survivor problem on this board.

Solitaire players have long known that the problem "vacate and finish at d1" (Fig. 9) is the most difficult single-survivor problem on the 33-hole board, and on Wiegleb's board the equivalent problem "vacate and finish at e1" (Fig. 10) is unsolvable. On the 39-hole board of Fig. 4, the problem "vacate and finish at d1" (Fig. 11) is solvable but only just; apart from the left-right reflection made possible by symmetry, the jumps that we must make are completely determined. As always in a Solitaire solution, we have flexibility in the order in which we make them, but the actual jumps must be the same. The solution, which has been published though not in print (Beasley 2003), appears in Appendix A, and a demonstration of its uniqueness is given in Appendix B. This is the only single-vacancy single-survivor problem we know, on a board of natural shape and reasonable size, where the jumps of a solution are completely determined in this way.

```
                                   a b c d e f g h i           a b c d e f g
        a b c d e f g        1           o - o          1       o - o
  1        o - o             2           o o o          2       o o o
  2        o o o             3           o o o          3       o o o
  3    o o o o o o o         4   o o o o o o o o o       4   o o o o o o o o
  4    o o o o o o o         5   o o o o o o o o o       5   o o o o o o o o
  5    o o o o o o o         6   o o o o o o o o o       6   o o o o o o o o
  6        o o o             7           o o o          7       o o o
  7        o o o             8           o o o          8       o o o
                             9           o o o          9       o o o
```

Figure 9: Difficult   Figure 10: Unsolvable   Figure 11:   Uniquely
                                                          solvable

In each case, the task is to leave the final survivor in the hole initially empty.

This is quite a different property from the uniqueness or near uniqueness of some of the solutions in the last section, and is much more fundamental. There, we were talking about uniqueness of *moves*, and they were only unique or nearly unique because we were restricting ourselves to solutions of a certain length. Here, we are talking about the constituent *jumps*, and their uniqueness remains whether we combine them into a 21-move solution as is done in Appendix A, or play them all out separately, or do anything in between. However we solve the problem, if we write out the jumps we have made and tick them off one by one against those in Appendix A, we find we have made either exactly the same jumps or symmetrically equivalent ones.

"La corsaire" on the 41-hole diamond board

One of the solutions given by Berey on the 37-hole board is entitled "Table de la Corsaire". In our notation, he vacates e1, and then plays e3-e1, g3-e3, f5-f3, f2-f4, g5-g3, d3-f3, g3-e3, e4-e2, e1-e3, b3-d3, b5-b3, d5-b5, d7-d5, c1-c3-c5, a3-c3, d3-b3, b2-b4, a4-c4, c5-c3, a5-c5, d5-b5, b6-b4, c7-c5, and f6-d6. This leaves the pattern shown in Fig. 12, after which the man on d1 sweeps off nine other men and e7-c7 finishes the solution. A similar finish is possible to the problem "vacate e7, finish at c7" on the 37-hole board, and also to the problems "vacate c1 or c7, finish at c7" on the 33-hole board.

```
                            a b c d e f g h i        a b c d e f g h i
                          1       -                 1       o
         a b c d e f      2      - o -              2      o o o
       1     - o -        3     - - o - -           3     o o - o o
       2    - - o - -     4    - - o - o - -        4    o o o o o o o
       3  - - o - o - -   5  - - o - o - o - -      5  o + o o o o o o o
       4  - o - o - o -   6    - - o - o - -        6    o o o o o o o
       5  - - o - o - -   7     - - o - -           7     o o o o o
       6    - - o - -     8      - - o              8      o o o
       7     - - o        9       -                 9       o
```

Figure 12: "La Corsaire"

Figure 13: "La Corsaire" on the 41-hole diamond board

Figure 14: A deceptive setting of "La Corsaire"

Play on the 41-hole diamond board is vastly more difficult than on the 37-hole board (the only solvable single-vacancy single-survivor problems are "vacate f8 or c5, play to finish at d8 or g5" and problems equivalent to these), and we were therefore surprised to discover that a "corsaire" finish is possible on this board as well. The natural equivalent of Fig. 12 on the 41-hole diamond board is shown in Fig. 13, and if we start by vacating f8 or c5 we can indeed play to this position.

There is more. If we look at the possible moves of the man at e2 earlier in the play, we find that it can start at c4, g4, c6, g6, or e8, but not at e2 itself. The same is of course true of other orientations of the problem; for example, if we vacate e3 (it's always nice to have the initial vacancy on the vertical axis of symmetry) and play for a corsaire finish h5-...-b5 and b6-b4, we find that the corsaire man can start at f3, f7, d3, d7, or b5, but not at h5 itself. We can therefore pose the problem in the deceptive form shown in Fig. 14: "Vacate e3, mark the man at b5 in some way, and play to reduce to a single survivor, this marked man making a 9-sweep at the penultimate move".

A moderately advanced player, who has read or worked out the "position

class" theory and knows that an initial vacancy at e3 means that any survivor must finish at b4 or h4 (or e7, which is not relevant here), will try to set up a finale b5-...-h5 and h6-h4, and he will not succeed; no such finale is possible. Instead, the marked man must migrate to h5 earlier in the play, and then perform a corsaire sweep back to b5. A solution with this property is given in Appendix A.

Summary

The game of Peg Solitaire may have a history of over three hundred years, but it is very far from exhausted. This paper has presented some of the more interesting problems that have recently come to light. We trust it has given pleasure, and we hope it may prompt others to search for the further delights that are surely still awaiting discovery.

Appendix A: Solutions

Although most of the solutions which follow were originally generated by computer, the moves of some have been reordered to give a more natural progression round the board. A much more extensive set of Solitaire solutions, on these and on other boards, can be found on the web site http://www.geocities.com/gibell.geo/pegsolitaire/.

Long-sweep solutions on Wiegleb's board

Vacate g5, finish at d2 with a 16-sweep, solution derived from Fig. 8a rearranged to minimize the number of separate moves: i5-g5, f5-h5, d5-f5, d3-d5, f3-d3, f1-f3, f4-f2, d1-f1-f3 (8), b4-d4-f4, c6-c4, a6-c6, d6-b6, a4-a6-c6 (13), d8-d6, f8-d8, e6-e8, d9-d7, d6-d8, f9-d9-d7 (19), g6-e6, i6-g6, g4-e4, i4-g4 (23), d2-f2-f4-h4-h6-f6-f8-d8-d6-d4-f4-f6-d6-b6-b4-d4-d2.

Vacate g4, finish at d4 with a 16-sweep. Fig. 8b can be reduced to a single man at g4 by playing a6-c6, d6-b6, a4-a6-c6-c4, b4-d4, f9-f7, f6-f8, d9-f9-f7-d7, d1-d3-d5, d8-d6-d4, i4-g4-e4-e2, f2-d2, f1-d1-d3-d5-f5-h5, h6-h4, i6-i4-g4. The key to this solution lies in the parallel moves g4-e4-e2 and d3-d5-f5-h5, and any solution must contain either these moves or equivalent ones across the SE corner (i4-g4-e4-e6-e8, a6-c6, d6-b6, a4-a6-c6-c4, d1-d3, b4-d4-d2, f1-d1-d3-f3, f9-f7-f5, f2-f4-f6, d8-f8, d9-f9-f7-f5-h5 etc). The jumps can be rearranged to give the following 22-move solution to the original problem: i4-g4, h6-h4, f5-h5, d5-f5, d3-d5, d6-d4, d1-d3-d5, f2-d2, f1-d1-d3 (9), b4-d4,

c6-c4, a6-c6, d8-d6-b6, a4-a6-c6 (14), f7-d7, f9-f7, f6-f8, d9-f9-f7 (18), e4-e2, g4-e4, i6-i4-g4 (21), d4-d2-f2-f4-h4-h6-f6-f8-d8-d6-b6-b4-d4-f4-f6-d6-d4.

These solutions, in 24 and 22 moves respectively, are the shortest possible.

The problem "Vacate d9, finish at d3 with a 9-sweep" can be solved in a simple systematic way by playing f9-d9, e7-e9, e5-e7, g5-e5, f7-f5, e5-g5, h6-f6, h4-h6, i6-g6, f6-h6, f4-h4, i4-i6-g6-g4, f2-f4, d2-f2, f1-f3, f4-f2, d4-d2, d1-d3, h4-f4-d4-d2, b4-d4, c6-c4, d4-b4, a4-c4, d6-d4-b4, a6-a4-c4, b6-b4-d4, d8-d6, d9-f9-f7-d7-d5-d3-d1-f1-f3-d3. A rearrangement saving a move is possible (instead of h4-f4-d4-d2, b4-d4, c6-c4, d4-b4, play b4-d4-d2, c6-c4, h4-f4-d4-b4).

The problem "Vacate d6 or g6, finish at d3 with an internal 16-sweep" can be solved most simply by starting from Fig. 8a and playing a6-c6-e6-e4-e2, f2-d2, d1-d3-d5-b5 (again these parallel moves), b4-b6, f9-f7, f6-f8, d9-f9-f7-d7, d8-d6, i4-g4, f4-h4, i6-i4-g4-g6, h6-f6, and either a4-a6-c6-e6 and f6-d6 or a4-a6-c6-e6-g6. This leaves two pegs untouched at e1 and f1 but otherwise reduces the board to a single peg at d6 or g6. If we now refill the board, vacate g6 or d6, and play these jumps in reverse order, we come down to Fig. 7a with two extra pegs at e1 and f1, and we can complete the solution by playing the 16-sweep and the move f1-d1-d3. A rearrangement in 23 moves is possible.

Optimally short solutions on Wiegleb's board

We arrange the solutions in order of finishing hole, as in Table 1.

Finish at d1

Vacate d1: d3-d1, f2-d2, f4-f2, f1-f3 (4), d4-f4, e6-e4, c6-e6, a6-c6 (8), d8-d6-b6, f6-d6, c4-c6-e6, f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (15), g4-g6, i4-g4, f4-h4, i6-i4-g4 (19), a4-a6-c6, b4-b6-d6-d8-f8-f6-h6-h4-f4-d4-d6-f6-f4-f2, d1-f1-f3-d3-d1 (22).

Vacate d4 or g4: f4-d4 or e4-g4, then c4-e4, a4-c4 (3), f6-f4-d4-b4, d2-d4, f2-d2, h4-f4-f2, f1-f3 (8), g6-g4, i6-g6, f8-f6-h6, i4-i6-g6 (12), d8-f8, f9-f7, d6-f6-f8, d9-f9-f7 (16), a6-a4-c4-e4-e6-e8, c6-c4, b6-b4-d4-d6-d8-f8-f6-h6-h4-f4-f2, d1-f1-f3-d3-d1 (20).

Vacate d7: d9-d7, d6-d8, d4-d6, f4-d4, c4-e4, f2-f4-d4, a4-c4-e4 (7), b6-b4, a6-a4-c4, f9-d9-d7-d5-b5 (10), d2-f2, f1-f3 (12), h4-f4-f2, g6-g4, i6-g6, f6-d6-b6-b4-d4-f4-f6-h6, i4-i6-g6 (17), e8-e6-e4, f8-f6-h6-h4-f4-d4-d2, d1-f1-f3-d3-d1 (20). As a 20-move solution, this is unique to within move ordering.

Vacate a4: c4-a4, b6-b4, a4-c4 (3), d5-b5, d7-d5, d9-d7 (6), d4-d6-d8, d2-d4-b4, a6-a4-c4 (9), f4-d4-b4-b6-d6, f2-d2, h4-f4-f2, f1-f3 (13), h6-h4, i4-

g4, f6-f4-h4, i6-i4-g4 (17), f9-d9-d7-d5-f5-h5, f7-d7, f8-d8-d6-f6-h6-h4-f4-f2, d1-f1-f3-d3-d1 (21).

Finish at d2

Vacate d2 or d5: d4-d2 or d3-d5, then d1-d3 (2), f4-d4-d2, e6-e4, c6-e6, a6-c6, d8-d6-b6, f6-d6, c4-c6-e6, a4-a6-c6 (10), f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (14), g4-g6, i4-g4, f2-f4-h4, i6-i4-g4 (18), f1-d1-d3-f3, b4-b6-d6-d4-f4-f6-d6-d8-f8-f6-h6-h4-f4-f2-d2 (20).

Vacate d8: d6-d8, d9-d7 (2), d4-d6-d8, b4-d4, c6-c4, a6-c6, f6-d6-b6, a4-a6-c6 (8), d3-d5, d1-d3 (10), e8-e6, h6-f6-d6-d4-d2, g4-g6, i4-g4, f4-h4, i6-i4-g4 (16), f2-f4-h4-h6-f6-f4-d4-b4-b6-d6, f9-d9-d7-d5-f5, f1-d1-d3-f3, f8-f6-f4-f2-d2 (20).

Vacate g5: e5-g5, e3-e5, c4-e4, a4-c4 (4), f3-f5, f1-f3, h4-f4-f2, d1-f1-f3 (8), g6-g4, i6-g6, f6-h6, i4-i6-g6 (12), f8-f6-f4-d4-b4, d7-f7, d9-d7, d6-d8, f9-d9-d7 (17), b6-d6-d4, e6-e4-c4-c6, a6-a4-c4 (20), and finish with the 12-loop d2-f2-f4-h4-h6-f6-f8-d8-d6-b6-b4-d4-d2 (21).

Vacate a5: c5-a5, e5-c5, d3-d5, d1-d3, d6-d4-d2, f1-d1-d3 (6), f6-d6, c6-e6, a6-c6 (9), d8-d6-b6, f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (14), g4-g6, i4-g4, f4-h4, i6-i4-g4 (18), f2-d2-d4-f4-f6-d6-d8-f8-f6-h6-h4-f4-f2, b4-d4, a4-a6-c6-c4-e4-e2, f2-d2 (22).

Finish at d3

Vacate d3: d5-d3, d7-d5, d9-d7 (3), b4-d4-d6-d8, c6-c4, a6-c6, f6-d6-b6, a4-a6-c6 (8), f4-d4, e2-e4-e6, h4-f4-f6-d6, g6-g4, i6-g6, f8-f6-h6, i4-i6-g6 (15), d3-d5-d7-f7, d1-d3, f9-d9-d7, f2-f4-h4-h6-f6-f8-d8-d6-b6-b4-d4-d2, f1-d1-d3 (20).

Vacate d9: d7-d9, d5-d7, f8-d8-d6, f6-f8, f9-f7, f4-f6-f8, d9-f9-f7-d7-d5-f5 (7), d3-d5, b4-d4, c6-c4, a6-c6, h6-f6-d6-b6, a4-a6-c6 (13), g4-g6, i4-g4, f2-f4-h4, i6-i4-g4 (17), d1-d3-f3, d4-b4-b6-d6-d4-f4-f6-h6-h4-f4-f2-d2, f1-d1-d3 (20).

Vacate d6 or g6: f6-d6 or e6-g6, then c6-e6, h6-f6-d6, c4-c6-e6, a6-c6, d8-d6-b6, a4-a6-c6 (7), f7-d7, f9-f7, f4-f6-f8, d9-f9-f7 (11), g4-g6, i4-g4, f2-f4-h4, i6-i4-g4 (15), d5-f5, d3-d5, d1-d3-f3 (18), b4-b6-d6-d8-f8-f6-h6-h4-f4-f6-d6-d4-f4-f2-d2, f1-d1-d3 (20). These solutions include an internal 14-sweep.

Vacate a6: c6-a6, e6-c6, d8-d6-b6, d4-d6, f4-d4, a6-c6-e6-e4, b4-b6, a4-a6-c6 (8), f7-d7, f9-f7, f6-f8, d9-f9-f7 (12), h6-f6, g4-g6, i4-g4, f2-f4-h4, i6-i4-g4 (17), d3-d5-b5, d1-d3-f3, f6-h6-h4-f4-f6-f8-d8-d6-b6-b4-d4-f4-f2-d2, f1-d1-d3 (21).

Finish at d4

Vacate d4 or g4: f4-d4 or e4-g4, then c4-e4, a4-c4 (3), h4-f4-d4-b4, d2-d4, f3-d3, f1-f3, f6-f4-f2, d1-f1-f3 (9), g6-g4, i6-g6, f8-f6-h6, i4-i6-g6 (13), d8-f8,

f9-f7, d6-f6-f8, d9-f9-f7 (13), a6-a4-c4-e4-e6-e8, c6-c4, b6-b4-d4-d2-f2-f4-h4-h6-f6-f8-d8-d6-d4 (20).

Vacate d1: d3-d1, f2-d2, d1-d3, d4-d2, f1-d1-d3 (5), e4-e2, g4-e4, i4-g4 (8), b4-d4-d2-f2-f4-h4, d6-d4-f4, c6-c4, a6-c6, d8-d6-b6, a4-a6-c6 (14), f8-d8, d9-d7, f6-d6-d8, f9-d9-d7 (18), i6-i4-g4-e4-e6-e8, g6-g4, h6-h4-f4-f6-f8-d8-d6-b6-b4-d4 (21).

Finish at e1

Vacate b4 or e4: d4-b4 or c4-e4, then d6-d4, d3-d5, d1-d3 (4), b6-d6-d4-d2, a4-c4-c6, d8-d6-b6, f6-d6, a6-c6-e6 (9), f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (13), g4-g6, i4-g4, f4-h4, i6-i4-g4 (17), f2-f4-f6-f8-d8-d6-f6-h6-h4-f4, f1-d1-d3-f3-f5-d5, a5-c5-e5-e3-e1 (20). The only alternatives still allowing a 20-move ordering are to play f6-d6-b6 and d8-d6 at moves 7 and 8, or f7-d7, f9-f7, f6-f8, h6-f6-d6, a6-c6-e6 at moves 8-12.

Vacate e7: e5-e7, c6-e6, a6-c6, e3-e5, c4-e4, a4-c4 (6), d8-d6-d4, d3-d5, d1-d3 (9), f6-d6-d4-d2, f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (14), g4-g6, i4-g4, f4-h4, i6-i4-g4 (18), f2-f4-h4-h6-f6-f8-d8-d6-b6-b4-d4, f5-d5-b5, f1-d1-d3-d5, a5-c5-e5-e3-e1 (22).

Finish at e2

Vacate e2: e4-e2, c4-e4, a4-c4 (3), d2-d4, d5-d3, f2-d2-d4-b4, f4-f2, f1-f3, h4-f4-f2, f6-f4, d1-f1-f3-f5 (11), g6-g4, i6-g6, f8-f6-h6, i4-i6-g6 (15), d7-f7, d9-d7, d6-d8, f9-d9-d7 (19), e5-e3, b5-d5, b6-d6-d8-f8-f6-h6-h4-f4-f6-d6-d4, a6-a4-c4-e4-e2 (23).

Vacate e8: e6-e8, c6-e6, d4-d6, d7-d5, d9-d7, b4-d4-d6-d8, f9-d9-d7 (7), a6-c6-c4 (8), d2-d4-b4, f3-d3, f1-f3, f4-f2, d1-f1-f3 (13), h4-f4-f2-d2-d4, g6-g4, i6-g6, f6-h6, i4-i6-g6 (18), f8-d8-d6-f6-f4-h4-h6-f6, f7-f5-d5, a5-c5-e5-e3, a4-c4-e4-e2 (22). As a 22-move solution, this is unique to within symmetry and move ordering.

Vacate b5 or e5: d5-b5 or c5-e5, then d3-d5, f4-d4, f6-f4, f3-f5, f1-f3, h4-f4-f2, d1-f1-f3 (8), g6-g4, i6-g6, f8-f6-h6, i4-i6-g6 (12), d7-f7, d9-d7, d6-d8, f9-d9-d7 (16), c4-e4, a4-c4, d2-f2-f4-f6-f8-d8-d6-f6-h6-h4-f4-d4-b4, a6-a4-c4 (20), b6-b4-d4-d6, c6-e6-e4-e2 (22). This solution, with its internal 12-sweep, was found by Alain Maye.

Finish at e3

Vacate e3: e5-e3, c4-e4, d6-d4, f6-d6, c6-e6, a6-c6 (6), d3-d5, d8-d6-d4, f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (12), g4-g6, i4-g4, f4-h4, i6-i4-g4 (16), f2-f4-f6-d6-b6, a4-a6-c6 (18), d1-d3-f3, b4-b6-d6-d8-f8-f6-h6-h4-f4-f2-d2, f1-d1-d3-d5, c5-e5-e3 (22).

Vacate b6 or e6: d6-b6 or c6-e6, then f6-d6, a6-c6-e6, c4-c6, e5-c5 (5), then join the previous solution after move 6 (21 moves in all).

Vacate e9: e7-e9, e5-e7, c6-e6, a6-c6 (4), d4-d6, d7-d5, d9-d7, d2-d4-d6-d8, b4-b6-d6, f9-d9-d7-d5-b5 (10), f3-d3, f1-f3, f4-f2, d1-f1-f3 (14), h4-f4-f2-d2-d4-b4-b6, g6-g4, i6-g6, f6-h6, i4-i6-g6 (19), f8-f6-f4-h4-h6-f6-d6, a4-a6-c6-e6, e7-e5-e3 (22). The only alternative still allowing a 22-move ordering is to play b4-b6-d6-d8 and d2-d4-d6 at moves 8 and 9. Finish at e4

Vacate e4 or b4: c4-e4 or d4-b4, then a4-c4 (2), f4-d4-b4, f6-f4, f3-f5, f1-f3 (6), d6-f6-f4-f2, h4-f4, g6-g4, i6-g6, f8-f6-h6, i4-i6-g6 (12), d7-f7, d9-d7, d2-d4-d6-d8, f9-d9-d7 (16), b5-d5-f5-f3-d3, d1-f1-f3, b6-d6-d8-f8-f6-h6-h4-f4-f2-d2-d4, a6-a4-c4-e4 (20).

Vacate e1: e3-e1, e5-e3, c4-e4, d6-d4, d3-d5, d1-d3 (6), f4-d4-d2, f6-d6-d4, h6-f6-f4, h4-h6, f3-f5-h5, f1-d1-d3-f3 (12), i6-g6, f8-f6-h6, i4-i6-g6 (15), d7-f7, d9-d7, b6-d6-d8, f9-d9-d7 (19), a4-c4-c6, f2-f4-h4-h6-f6-f8-d8-d6-b6-b4, a6-a4-c4-e4 (22).

Vacate e7: Follow moves 1-20 of "Vacate g5, finish at d2" above, rotated 90 degrees clockwise, and finish with h4-h6-f6-f8-d8-d6-b6-b4-d4-d2-f2-f4, g4-e4 (22).

Finish at e5

Vacate e5 or e2: e3-e5 or e4-e2, then c4-e4, d6-d4, d3-d5, d1-d3, b6-d6-d4-d2, f1-d1-d3 (7), a4-c4-c6, d8-d6-b6, f6-d6, a6-c6-e6 (11), f7-d7, f9-f7, h6-f6-f8, d9-f9-f7 (15), g4-g6, i4-g4, f4-h4, i6-i4-g4 (19), f2-d2-d4-f4-h4-h6-f6-f8-d8-d6-f6-f4, f3-f5-d5, a5-c5-e5 (22). The only alternatives still allowing a 22-move ordering are to play f6-d6-b6 and d8-d6 at moves 9 and 10, or f7-d7, f9-f7, f6-f8, h6-f6-d6, a6-c6-e6 at moves 10-14. Bergholt's 18-move solution to the equivalent problem "vacate d4 or d1, finish at d4" on the 33-hole board is d2-d4 or d3-d1, f3-d3, e1-e3, e4-e2, e6-e4 (5), g5-e5, d5-f5, g3-g5-e5, c3-e3, a3-c3, b5-d5-f5-f3-d3-b3 (11), c1-e1-e3-e5, c7-c5, c4-c6 (14), e7-c7-c5, a5-a3-c3, c2-c4-c6-e6-e4-c4, b4-d4.

39-hole "semi-Wiegleb" board

Vacate and finish at d1. It is shown in Appendix B that we need the following jumps: d3-d1 twice, d5-d3 twice, d8-d6, d4-d2, a4-a6, a6-c6 twice, d6-b6, b4-d4, g4-g6, g6-e6 twice, d6-f6, f4-d4, c5-e5 (or e5-c5, everything that follows being reflected left to right), b5-d5, f5-d5, c1-e1, e1-e3 twice, e4-e2, e6-e4, c2-c4, c7-c5, e9-c9, c9-c7 twice, c6-c8, c4-c6, c7-c5 again, e3-e5 twice, e6-e4 twice more, e8-e6. An optimal ordering is given by d3-d1, d5-d3, f4-d4-d2, e6-e4, e3-e5, e1-e3, g6-e6 (7), b5-d5, c7-c5, c9-c7, a6-c6 (11), b4-d4, d6-b6, c2-c4-c6-c8, d8-d6-f6, e8-e6-e4-e2 (16), a4-a6-c6, e9-c9-c7-c5-e5, g4-g6-e6-e4, c1-e1-e3-e5, f5-d5-d3-d1 (21).

41-hole diamond board

The problem "Vacate f8 or c5, play to the position of Fig. 13" can be solved most simply by playing d8-f8, e6-e8, c7-e7 or c7-c5, e6-c6, d8-d6, then g6-e6, g4-g6, e4-g4, c4-e4, c6-c4, e6-c6 (it can be shown that any solution must contain this cycle of six jumps, either this way round or in the reverse direction, and it is simplest to play them straight away), then e8-e6, g7-e7, e6-e8, e9-e7, h6-f6, i5-g5, f2-f4, d3-f3, e1-e3, f3-d3, f5-f3, h4-f4, g3-e3, e4-e2, d2-d4, d5-d3, c3-e3, b4-d4, a5-c5, b6-d6. Rearrangements in 24 moves are possible, giving 26 moves to reduce to a single survivor. One of them, rotated through 90 degrees, appears in the next paragraph.

The problem shown in Fig. 14 can be solved by playing c3-e3, d5-d3, d2-d4, b5-d5-d3 (4), b4-d4, c7-c5, d7-d5-b5, a5-c5 (8), f7-d7, d8-d6, e9-e7 (11), f5-f7, h6-f6, g4-g6, i5-g5 (15), e4-g4, f2-f4, d3-f3-f5-h5 (18), e1-e3, h4-f4, g7-g5, e6-g6-g4, g3-g5, f8-f6 (24). We now have Fig. 13 rotated through 90 degrees and the man initially at b5 is now at h5, and we can finish by playing h5-f5-d5-d7-f7-f5-f3-d3-d5-b5 and b6-b4 (26). This solution is also an optimally shortest solution to the problem "vacate e3, finish at b4"; indeed, each of the single-vacancy single-survivor problems solvable on this board has a solution in 26 moves but none shorter.

Appendix B: A specimen non-computer analysis

In principle, any unsolvable Solitaire problem can be so proved by trying every possibility in turn and verifying that none works, and this is just what a computer search does. But this is rarely practicable by hand, and non-computer analyses normally use techniques developed in the 1960s by J. M. Boardman, J. H. Conway, and R. L. Hutchings (Berlekamp, Conway and Guy 1982/2004, Beasley 1985/1992). As a specimen, we show the uniqueness (to within symmetry and order of jumps) of the solution to "vacate and finish at d1" on the 39-hole "semi-Wiegleb" board.

Our basic approach will be to write down the numbers in Fig. 15 (–1 at d1, +1 everywhere else), and to try to apply successive adjustments "–1, –1, +1" to the numbers in adjacent holes so that they are all eventually reduced to zero. In effect, we shall play Solitaire with numbers in a table rather than with pegs on a board. The advantage of this approach is that once we see that a particular jump will be necessary, for example because it is the only way to bring a negative number up to zero, we can apply it to the table straight away; we do not need to wait until a suitable configuration of pegs arises on the board.

```
    a  b  c  d  e  f  g
1         1 -1  1
2         1  1  1
3         1  1  1
4   1  1  1  1  1  1  1
5   1  1  1  1  1  1  1
6   1  1  1  1  1  1  1
7         1  1  1
8         1  1  1
9         1  1  1
```

Figure 15: The task in numerical form

We now note that the first jump of a solution must be d3-d1, and the next jump d5-d3; also that the last jump will be d3-d1 again, and the penultimate jump d5-d3. If we apply these jumps to the table, we get Fig. 16:

```
    a  b  c  d  e  f  g
1         1  1  1
2         1 -1  1
3         1  1  1
4   1  1  1 -1  1  1  1
5   1  1  1 -1  1  1  1
6   1  1  1  1  1  1  1
7         1  1  1
8         1  1  1
9         1  1  1
```

Figure 16: After considering d3-d1 twice and d5-d3 twice

Next, we assign a value to each hole on the board as shown in Fig. 17. We shall be adding up the values of the holes which are occupied, and these values have the property that if A, B, C are any three adjacent holes in line and f(A) etc are their values then f(A)+f(B) is at least as great as f(C). Since the effect of a jump from A over B into C is to replace the contribution f(A)+f(B) by a contribution f(C), *the sum of the values of the holes occupied can never increase.*

If we evaluate the task shown by Fig. 16 according to the values in Fig. 17, we find we have contributions –1 from d2/a4/d4/g4/a6/d6 and +1 from b4/g4/b6/d6/f6/d8, total zero. But the value of our target position (all zeros) is also zero, and it follows that we can never make a jump which

```
     a  b  c  d  e  f  g
1          0  0  0
2          0  1  0
3          0  0  0
4 -1  1  0  1  0  1 -1
5  0  0  0  0  0  0  0
6 -1  1  0  1  0  1 -1
7          0  0  0
8          0  1  0
9          0  0  0
```

Figure 17: An assignment of values to holes

reduces our evaluation according to Fig. 17; once this evaluation has become negative, we can never get it back up again. In particular, a jump over d8 will have just this effect (it will replace a contribution 0+1 by 0), so our solution cannot contain such a jump. But we must clear d8 somehow, and the only remaining candidate is d8-d6. Apply this to Fig. 16, and also the jump d4-d2 which is needed to bring d2 up to zero, and we have Fig. 18.

```
     a  b  c  d  e  f  g
1          1  1  1
2          1  0  1
3          1  0  1
4  1  1  1 -2  1  1  1
5  1  1  1 -1  1  1  1
6  1  1  1  2  1  1  1
7          1  0  1
8          1  0  1
9          1  1  1
```

Figure 18: The task after considering d8-d6 and d4-d2

Fig. 19 shows a second assignment of values to holes. Again, f(A)+f(B) is at least as great as f(C) whenever A, B, C are any three adjacent holes in line, so once more the sum of the holes occupied can never increase. But this time, if we evaluate the current task (shown by Fig. 18) according to the values assigned, we find we have a net total of +1 (there are contributions –4 from d4, –2 from a4/g4, –1 from d5/a6/g6, +2 from b4/f4/d6, and +1 from a5/b5/f5/g5/b6/f6). In other words, we can afford to lose 1 (and indeed we must lose it at some stage, since we need eventually to reduce everything to zero), but we cannot afford to lose 2.

```
    a  b  c  d  e  f  g
1         0  0  0
2         0  2  0
3         0  0  0
4 -2  2  0  2  0  2 -2
5  1  1  0  1  0  1  1
6 -1  1  0  1  0  1 -1
7         0  0  0
8         0  1  0
9         0  0  0
```

Figure 19: A second assignment of values to holes

Now, reverting to Fig. 18, how are we going to clear a5? The only candidate jumps are a4-a6, a6-a4, and a5-c5, but each of the two latter loses 2 when we evaluate according to Fig. 19 and we have just seen that we cannot afford this. So we must play a4-a6, and by similar arguments we must play a6-c6 twice, d6-b6 (the two jumps a6-c6 have left us with –1 at b6, and to play b4-b6 would lose 2 according to Fig. 19), and b4-d4. We shall need equivalent jumps g4-g6, g6-e6 twice, d6-f6, and f4-d4 on the right-hand side as well, and if we apply all these jumps to Fig. 18 we get Fig. 20:

```
    a  b  c  d  e  f  g
1         1  1  1
2         1  0  1
3         1  0  1
4  0  0  0  0  0  0  0
5  0  1  1 -1  1  1  0
6  0  0  2  0  2  0  0
7         1  0  1
8         1  0  1
9         1  1  1
```

Figure 20: The task after considering a4-a6 etc and g4-g6 etc

We still have value 1 according to Fig. 19 (+1 at b5/f5, –1 at d5). We need to reduce this to zero, and the only way of doing this without incurring an intolerable loss according to Fig. 17 is to play c5-e5 or the symmetrically equivalent e5-c5. For present purposes, let us suppose c5-e5. We shall now need b5-d5 and f5-d5 to bring the number in d5 up to zero, and we have Fig. 21:

```
     a   b   c   d   e   f   g
1            1   1   1
2            1   0   1
3            1   0   1
4    0   0   0   0   0   0   0
5    0   0  -1   0   1   0   0
6    0   0   2   0   2   0   0
7            1   0   1
8            1   0   1
9            1   1   1
```

Figure 21: After considering c5-e5, b5-d5, and f5-d5

We now have non-zero numbers only at d1/d9 and on the c and e files, and we can proceed a little faster. We need to clear d1, and the only candidates are e1-c1 and c1-e1. Try e1-c1. There follows c1-c3 twice, c4-c2 to liquidate the resulting deficiency at c2, c6-c4 to liquidate the deficiency at c4, c7-c5 twice to liquidate the double deficiency at c5... No, it's not possible.

All right, try c1-e1. We must now play e1-e3 twice, e4-e2, e6-e4, c2-c4, and c7-c5, and we have reduced to Fig. 22:

```
     a   b   c   d   e   f   g
1            0   0   0
2            0   0   0
3            0   0   2
4    0   0   1   0   0   0   0
5    0   0   0   0   0   0   0
6    0   0   1   0   1   0   0
7            0   0   1
8            1   0   1
9            1   1   1
```

Figure 22: After considering c1-e1 etc

To clear d9, try c9-e9; no, the surpluses on c4/c6/c8 prove intractable. Try e9-c9; c9-c7 twice, c6-c8, c4-c6, c7-c5, and we have Fig. 23.

Now, at last, we have a choice:

(a) a pair of jumps e2-e4/e4-e2 across e3, e6-e8, a pair e9-e7/e7-e9 across e8;

(b) a pair e2-e4/e4-e2 across e3, e8-e6, a pair e7-e5/e5-e7 across e6;

(c) a pair e2-e4/e4-e2 across e3, e8-e6, a pair f6-d6/d6-f6 across e6;

(d) e3-e5 twice, e6-e4 twice, e8-e6.

```
      a  b  c  d  e  f  g
1           0  0  0
2           0  0  0
3           0  0  2
4     0  0  0  0  0  0  0
5     0  0  0  0  0  0  0
6     0  0  0  0  1  0  0
7           0  0  1
8           0  0  1
9           0  0  0
```

Figure 23: After considering e9-c9 etc

However, this has been playing Solitaire with numbers. If we revert to the real board, we find that the region e1/e2/e3 starts full and finishes empty, so we need two jumps outwards across its boundary (one to broach it initially, one to remove the last man from it), and only option (d) provides them.

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Addendum

Since the above was written, our attention has been drawn to two articles in **Mercure Galant**, August 1697 (pages 88-134) and September 1697 (pages 59-84), which contain a description of the game and several examples of play. They are a likely source for much of the later French material.

Makonn and the Indian Ocean: East African slave trade and the dispersal of rules

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An unpublished game with few rules may disperse through the work of a single traveler, but a mancala game requires practice considering the complex interaction of its rules. Mancala rules cannot travel as a consistent whole without long-term contact between players or the migration of players (see [9]). As a consequence, the presence of a series of near identical mancala games across wide geographical areas is only explained through intensive contact. Such contact is possibly established through trade, assuming that the traders also play. A second, equally credible, mode of dispersal is migration in which a group of players settles in another area. Slave trade, it is generally assumed [1], has brought games from West Africa to the Caribbean. This trade moves groups of people, creating dispersal as with migration. The situation on the Seychelles suggests that East African slave trade [6] and mancala are linked in the Indian Ocean.

The Seychelles are an independent island country in the Indian Ocean, located between Madagascar, the Maldive Islands, Oman and the African coast, including Tanzania, Kenya and Mozambique. Mancala games have been attested for all countries surrounding the Seychelles [2, 5, 7, 8, 9, 10]. Contrary to its neighbours, the Seychelles were uninhabited until the end of the seventeenth century when French settlers took possession of the islands. African slaves were introduced in the course of the eighteenth century and slavery has continued well into the nineteenth century [4]. The supply of slaves is said to have originated in Mozambique and sometimes occurred via the island of Zanzibar.

During a visit to the Seychelles in 2007, the following rules were collected of the game of *Makonn* that is still being played in the islands. Its popularity

coincides with that of *baka* (or *bacca*, see [4, p. 80]), a local alcoholic drink based on fermented sugar cane. The rules below were collected at a baka bar where the owner played and taught *Makonn*.

The players

The National Historic Museum at Mahé owns one *Makonn* playing board [access number 0119/99]. It consists of four rows of ten holes and, according to the museum information, was brought in by World War I soldiers as a souvenir. With the assistance of the senior curator Ms Bella Rose and assistant senior Curator Miss Jeanne Pothin, the following players were located near the capital Mahé.

On March 22, 2007, Barry Marengo (1933–) was invited to the museum and illustrated the game using the museum board. He confirmed that the name was *Makonn* and that the configuration had always been four by ten holes. He played with stones, although cowry shells are also known to be used, that were placed one by one in each hole and he spread the stones in anti-clockwise direction. Singles were not allowed to be played unless the player had singles only. He had learned the game at age fourteen and used to play in a group of circa eight players.

Two days later a visit was paid to Robin Pierre Marie (1934–) who owns a *lakanbiz* or baka-bar in Pointe La Rue, south of Mahé. In his bar there was one *Makonn board*, a ten by ten draughts board and another board game similar to draughts and known as *Damn la tete*. On arrival players were involved in playing *Makonn*.

Mr Marie started his bar in 1989 and used a self-made board for play. The players in the bar were mostly taught by the owner although in former days other players, already familiar with the game, had also joined. He started playing the game at age sixteen and also played in Diego Garcia from 1959 onwards with other men from the Seychelles and Mauritius. He later played in Desroches, part of the Amirantes archipelago and Aldabra. In 1988 he left Desroches and returned to Mahé where he had resided since he was nine. He was originally brought up on the island of La Digue.

The game was not known to him with any configuration other than four rows of ten holes. Since the game is associated with drinking *baka*, women do not commonly play with men but they are known to play the game in separate areas. Both Mr Marie and Mr Marengo were not familiar with any competition or tournament play for this game.

The National Sports Council produced a document in which the game of

Makonn is described but the rules cannot be inferred from this description [3]. The following rules were obtained after observing, playing and asking questions about the game of *Makonn* in Pointe La Rue.

The *Makonn* rules

Makonn is played on a board with four rows of eight holes. It needs forty counters, usually stones or shells. Each player owns two rows of eight holes that are closest to the player as well as the counters in those rows. The object of the game is to capture all counters of the opponent.

The game can be divided in three stages.

The opening

The game starts with one counter in each hole. One player begins by rearranging the counters in the two rows owned by that player. The player may rearrange these counters in any way as long as they remain on the board and on the player's side of the board. One counter may be placed in order to capture the opposite occupied holes of the opponent (for capture moves, see middle game).

Once ready, the other player may rearrange the other part of the board and, if possible, also place a counter to capture the content of the opposite hole(s).

The middle game

Once the counters have been arranged, the first player starts a move by picking up the contents of a hole on the player's side that contains more than one counter. These counters are placed one-by-one in consecutive holes in counter-clockwise direction within the player's own two rows. When the last counter of such a sowing reaches an occupied hole, that hole is emptied and the contents are sowed starting in the next hole and in the same way and direction. This continues until the last counter of a sowing ends in an empty hole.

When the last counter ends in an empty hole the move ends or the player makes a capture. The player can only capture if this empty hole is directly adjacent to an occupied hole of the opponent. The complete contents of the opponent's hole and, if present, the contents of the hole directly behind this hole in the back row of the opponent, are captured and taken from the board.

This game continues until one player has nothing left and lost the game or when one player has only holes with single counters in which case this player enters the singles game.

The singles game

If a player has only single counters in the two rows of holes, this player is still allowed to play. The player may now move a single counter in the same way and direction, but only into an empty hole. It is not allowed to play a single into a hole that already contains a counter. Captures are made in the same way as in the middle game.

Since the game starts with all holes containing a single counter, it is necessary that in the opening game at least one change is made to allow the players to make a move.

The rules of the singles end-game is much similar to the game of *Hawalis* found in Oman. The games found in Zanzibar and Madagascar, although featuring four rows, are much different. Instead, similar games may be found in Mozambique. A brief comparison between Oman and Seychelles mancala suggests that in both countries the game of mancala was introduced from a similar areathe Mozambiquan coast.

The comparison

Oman boasts a four-row mancala game, one of few found outside of the African continent (see [10]). It is played by men in clubs and despite its recent decline it can still be found in Muscat near taxi stands where card and other games are also practiced. The Omani fixed the board to four rows of seven holes and usually play in the sand using stones. The game strongly resembles descriptions that have been made of Mozambiquan mancala games [2].

Makonn is fixed on four rows of ten holes but despite the larger board, the rules and thereby the playing strategies are remarkably similar to those of Hawalis. The following list shows some of their similarities:

	Hawalis (Oman)	Makonn (Seychelles)
playing counters:	stones, pebbles	stones, pebbles
playing direction:	counterclockwise	counterclockwise
places of capture:	capture front±back	capture frontback
exception to play:	no singles played	no singles played
	if only singles rules change	if only singles rules change

Moving and capturing counters are near identical in these two games. The main differences are found in the size of the board and the opening game that is fixed in Oman with more than one counter in each hole and open to more variation on the Seychelles where the configuration of counters is changed by the players. The singles end-game is almost identical and requires specific playing tactics.

There is no link between the Seychelles and Oman in their history or in their present contacts. It is argued that the slaves that entered the Seychelles played a similar game compared to the game introduced by Africans that settled in Oman. The opposite route in which Omani traders introduced the game to the East African mainland from where the game spread to the Seychelles is ruled out. No other four-row games appear in Oman or near Oman, instead two-row games abound in the Middle East and the Indian Sub-continent with rules that do not compare to those found in Oman.

It is concluded that African slaves from specific regions on the East African coast have been instrumental in distributing a four-row game of mancala to Oman and the Seychelles where these games can still be found today with few local variations. With increasing knowledge of mancala in the Indian Ocean, the distribution patterns of mancala invariably follow (slave) trade routes that date from the age of coastal trade and migration.

Mr Marie observing a Makonn game. Mahé, Seychelles, 2007

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Birth of the Chess Queen

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Marilyn Yalom, Birth of the chess queen. Harper-Collins, New York, hardcover ed. 2004, paperback 2005.

Chess, born in the East, is a war game. This can be demonstrated by the pieces. The piece alongside the king for example was a vizier, a counsellor: a vizier gave the king advice in important matters as the strategy on the battlefield. After chess was carried to Europe (10th c.) the counsellor was replaced by a queen.

A possible relation between living queen and chess queen, this is Yalom's subject. Since many Western female sovereigns willingly left combat and war to their husbands, the presence of a queen in Western chess is a proof that chess took on a social dimension [2005:XIX]. The author did not confine herself to this observation, but asked the intriguing question if there were living models, so female sovereigns, for the chess queen.

The method Yalom chose to find an answer guarantees the reader some fascinating hours. She describes a work on chess from a certain period and thereupon the life of the female sovereign of the territory in the time the chess manuscript was written. Then she checks whether this sovereign could have served as a model for the chess queen. I give an example that is illustrative for her method of reasoning.

On p. 15-18 Yalom describes the Einsiedeln poem from the late 990s, a Latin poem written by a German speaking monk. On p. 19-24 she describes the lives of Adelaide of Burgundy and her daughter-in-law Theophano, a Byzantine princess. "Which queen served as a model?", she asks on p. 19. She cannot make a choice, for "both Theophano and Adelaide provide plausible sources for the birth of the chess queen. Both were famous during their lifetime as consorts sharing power with their husbands and as queens regent successfully protecting their dynasty. Both were highly cultivated

in the realm of art and literature, and had a working knowledge of Latin. Both have been credited with inspiring the Ottonian Renaissance at the imperial court. Both died in the 990s (Theophano in 991, Adelaide in 999), the decade during which the Einsiedeln Poem was composed. What more fitting tribute to a recently deceased empress, or one about to die, than a poem attesting to the existence of the chess queen?" [2005:25]. There could be something wrong with my sense of logic, but I am not able to understand why there should be a connection between a chess queen and a female sovereign because the latter has a working knowledge of Latin.

Identification

A second objection concerns Yalom's identification of chess as a board game and the position of the game in literature and the plastic arts. A striking example is to be found on p. 147: "By the late fifteenth century, when the chess queen's supreme powers were officially codified, the game itself was at the height of its popularity, with a special meaning for couples. They could look to chess as a privileged space for the interchange of intellect, feelings, and sexual desire." Yalom's observations do not relate to chess itself but to the literature, of course. Chess is not more than a pastime: to kill the time two persons in turn move a little wooden figure on a rectangular surface.

I just wrote "Yalom's identification". This is an undeserved reproach, however, for the American only reproduces an argument used by chess historians to prove the popularity of chess as a game. The German Joachim Petzold, for example, argued that chess responded as a seismograph to social changes [4, p. 151]. Not chess responded to social changes: an artist applied chess as a motif, and the way he developed the theme is subject to the place and the time where and when he lived. See the great differences between poems on chess and manuscripts on the game written by chess players, a difference which even becomes visible in the vocabulary: literary men mentioned the chess queen *regina* or invented another female name, chess players (almost) always preferred the Muslim name *fierge/fers* [Murray 1913 quoted many works].

On the background a question asks our attention that Petzold did not touch. This one. Different from our time, a medieval writer did not strive after originality. On the contrary, he eagerly borrowed metaphors and themes from earlier generations. In the French romances of chivalry knights invariably enjoyed playing chess and tables. But was this reality, would it not be better to suppose we have to do with a stereotype? A much read genre in

the trivial literature of the West is the doctor novel, where at the last page a male physician and a female nurse press each other in their arms after a lot of setback. In the 15th c. a loving couple had a date with the chess board as an excuse, in the 21st c. lovers meet with an operating table in between. The doctor always is sporty, slim, tanned, charming and attractive, his female patients yearn for his coming, but the real hospital gives me quite another impression. The real world in medieval France, reflected in the French vocabulary, tells us that the most popular board games was draughts [7, pp. 149-154].

Spanish queen and chess history

Yalom's quest starts about 1000. After a number of gripping descriptions of chess manuscripts and absorbing depictions of strong female queens and empresses, Yalom arrives at 15th Spain, a place and time where and when chess players broke the old Muslim game. The Einsiedeln poem was devoted to a game with a chess queen which could move only to a diagonal adjacent square; in the late 15th c. the piece was allowed to advance diagonal and straight lines as far as it liked. Yalom pays attention to the poem "Scachs d'amor" (Love chess) from the 1470's, the first manuscript referring to the new chess queen [2005:193-194]. The governing queen was Isabella of Castile; we make acquaintance with her on p. 199-211. "Can we establish a connection between the new mighty chess queen and Isabella?", asks Yalom [2005:191]. Her answer is affirmative, based on the argument that Isabella was a militant queen, and that the new chess queen with her unlimited power is militant too [2005:211].

This argument is not new, Yalom borrowed it from Spanish chess historians. She adopts it to sustain her claim, but is it valid? I am afraid not; for the second time I lodge an objection against the method used by chess historians. Clarification.

A "female" word for the Muslim *fierge/fers* like *regina* was not invented by a chess player but by a literary man, who did not see chess as a board game but as a representation of (some part of) the society. In this case a sociological explanation for the birth of *regina* is demanded.

The Spanish name *dama* = 'chess queen', however, rose in the vocabulary of chess players, was coined by people who experimented with the rules of their game, the kind which looses himself so deeply that he forgets the world around him. This escape out of reality is an essential characteristic of play [Huizinga 1950 5:41]. For this reason a social explanation is methodologically

wrong, an etymological investigation is requisite. This investigation was carried out. The Spanish word *dama* = 'chess queen' is a new sense of an existing word 'dama'. This older word *dama* means 'row where the chess pawn is promoted'. Chess players borrowed it from draughts players [7, pp. 38-43].

On p. 194 Yalom refers to Westerveld 1997, who claimed that the Spanish name for draughts, *juego de damas*, originally meant 'game with chess queens' and was linked to the prestige of the Spanish queen Isabella. This is an easy assumption, not based on investigation. A linguistic approach revealed that the game name *juego de damas* was borrowed from French and dates back to the 14th c. [5, 6] [7, pp. 25-37].

The mythologisation of chess

Petzold's "Kulturgeschichte" is a serious historical study on chess, and Westerveld and other Spanish investigators do serious research too. They cause me a problem, however. In my latest book (2007) I tried to compare the position of chess with the position of draughts and other board games. Leaving literature and plastic arts aside as in principle unreliable, I found a game which has not been very popular for many ages. Only in the 19th c. chess began to outstrip its sister game draughts, for instance; in the 15th and again in the 18th c. chess was drastically influenced by draughts [7, pp. 38-48, 98-101].

Following the description of the position of chess by chess historians, I see –again– a methodological inadequacy. Chess is a trifling pastime, like tables, draughts, goose or halma. In the chess literature the game is proclaimed, but without any comparatative investigation, as an exceptional board game, a game of mythical proportions. By linking chess to historical female sovereigns, Yalom contributes her mite to the mythologisation.

In this context I cast a doubt on Yalom's story [2005:103] about king Louis IX of France. One day Louis saw his brother playing chess while at sea during the Crusade, and he dumped the board and all its pieces into the Mediterranean. Yalom's source is an edition of Jean de Joinville, *Vie de Saint Louis* published in 1995. But in the edition of this work by Natalis de Wailly, Paris 1888:22 it is said that Louis' *brother jouoit aus tables a monsignour Gautier d'Anemous*. Louis was ill, but left his bed, went to the players *et prist les dez et les tables et les geta en la mer*, and scolded his brother because the latter played for money. The game in question is tables, and Louis threw the dice and the table pieces into the water.

Draughts-chess

A last matter. On p. 179, Yalom without comment takes a remarkable line from Linder's book on chess in Russia: "And we played draughts-chess together". *Draughts-chess* is the literal translation of the Russian combination *shashski-shakhmaty*, a riddle that Linder cannot settle, no more than the conjunction *peshi-shakhmaty* [2, p. 118]. Can we solve the puzzle looking to the pieces Russian draughts players used? The Ancients played their board games with flat circular pieces. Gaming pieces which have been preserved from old times and which are not flat, all originate from Egypt and the Near East, see for this [7, pp. 169-172]. In former days, the Russians probably played draughts with pawn shaped figures, with "chess pawns". This could explain the Russian game name *shashki*, the plural of the word *shashka*, literally "small chess piece", so a pawn [5, p. 216]. Reading both *shashski* and *peshi* as 'pawn', we interpret the conjunctions as "game with pawn shaped figures in which checkmate plays a part". Chess.

Conclusion

To the reader who is interested in the past, particularly in the contribution of female sovereigns in the European history, or who wants to read palatable stories about chess in literature and arts, I can warmly recommend Yalom's book. It does not contribute to our knowledge of chess; on the contrary: it increases the ingrained prejudices about the position of chess among other board games. But it would be unjust to lay this at Yalom's door, she might trust on the literature. The chess history, however, contains some major methodological flaws, which clearly surface in Yalom's book. Hence my conclusion: the book may be fascinating and captivating, it is far from a contribution to our knowledge of board games.

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Board Games Studies was first published in 1998, an initiative inspired by the colloquia on board games held at Leiden University, the Netherlands, in 1995 and 1997. Five institutions affiliated themselves with the journal: the Institut für Spielforschung und Spielpädagogik in Salzburg, the International Institute for Asian Studies in Leiden, the Russian Chess Museum in Moscow, the British Museum in London, and the Department of Computer Science at the University of Maastricht. The journal, which was published by CNWS Publications in Leiden on a yearly basis, was partially funded through the assistance of patrons and boasted a modern layout, trilingual summaries and color plates. The broad ambition of this journal required a continuous commitment from the editors, who reviewed contributions in German, French and English, provided translations of summaries for each article and, in several cases, collaborated extensively with authors to develop manuscripts that were to the academic standards of the publication. The journal had a trial run of three years, after which the format, content and review process was evaluated. The authors of the articles integrated wide-ranging literature necessary for a comprehensive understanding of particular games. Contributions from different disciplines — including psychology, computer science, philology, classical archaeology and history — allowed for a better historical and systematic understanding of board games to emerge. Starting in 2000, a section with a translation of primary sources was added. Book reviews and research notes further complemented the multi-facetted contents. Its first ambition, to serve as a platform for the publication of board games research, was met quickly, while gradually the journal gained prominence among researchers by publishing seminal historical overviews. The colloquia continued from 1995 onwards, moving from a biennial to a yearly schedule. The host institution was expanded beyond Leiden to universities and museums throughout Europe as well as Jerusalem, Philadelphia and, in 2013, the Azores. The colloquia continue to gather an enthusiastic group of scholars, players and collectors. Despite the institutional affiliations and a group of patrons, the production of the journal became financially and logistically problematic with CNWS no longer able to serve as a publisher. Reluctantly, the paper version of the journal was discontinued after volume 7 was published in 2004. The possibility of an online version of the journal had been explored with the online publication of the first issues, a decision that greatly assisted the dissemination of knowledge accumulated in those early volumes. The next step, an online journal that operates again as a platform for recent board games research, was not far away but required the skills and enthusiasm of previous and new editors to materialize. In these last fifteen years, the study of board games has gained momentum and this journal will not only showcase new results but, most of all, will encourage and publicize the work of the dedicated researchers in this field.

<div align="right">Alex de Voogt</div>

To the authors

Board Game Studies is an academic journal for historical and systematic research on board games. Its object is to provide a forum for board games research from all academic disciplines in order to further our understanding of the development and distribution of board games within an interdisciplinary academic context. Articles are accepted in English, French, and German and will be refereed by at least two editors under the final responsibility of the Editorial Board. Please send your contributions in any editable format (Word, LaTeX, rtf, . . .) with a matching PDF file. Please send all the illustrations in separate files.

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TABLE OF CONTENTS