P R O G R E S S I N C O M P U T E R C H E S S

(Report on the Third Conference on Advances in Computer Chess).

[This article is reprinted from the AISB Quarterly by permission of the author and the editor of the Quarterly.]

The third conference on Advances in Computer Chess was organized as a 2-day meeting, held on 9-10 April 1981 at Imperial College, London University. The lectures were given by a varied company of computer chess researchers and presented clear evidence of the progress being made in the field. This progress was also obvious on the evening of the first conference day, in an exhibition of blitz games played between Ken Thompson's program, BELLE, and strong chessplayers, such as Pritchett and Kopec. One should take into account that Thompson had only brought along the 1978 version of BELLE; his present chess machine is much stronger.

The conference was planned by Mike Clarke; he clearly had paid a great deal of attention to its organization. The evident success of the conference was largely due to his efforts.

At the opening ceremony, Clarke especially welcomed Dr. M.M. Botvinnik, the former world chess champion (1948 - 1963, with some interruptions). Next, he announced the presence of the spiritual father of a world champion, meaning, of course, Ken Thompson, one of the designers of the BELLE chess machine.

On the first day of the conference, two lecturers (I. Bratko, D. Beal) dealt with a theoretical topic which had failed to draw attention up to 1978, when Don Beal reported his first research in this area. The topic might simply be reduced to: 'To what extent is minimax search useful?' or in an equivalent formulation: 'Why are the minimax backed-up values more reliable than the static values?'

From a previous model (on strong, but not unreasonable assumptions) Don Beal had shown that the minimax principle did not offer any improvement relative to the static evaluation function. This is the more remarkable because experience seems to indicate the opposite.

Ivan Bratko reported that together with M. Gams (J. Stefan Institute and Faculty of Electrical Engineering, E. Kardelj University, Ljubljana), he had reinvestigated Beal's assertion, under the assumptions that

(i) there is a two-value model, which
(ii) has a uniform value distribution.

His conclusion was: The uniform value distribution is unsuitable as an assumption: experiments using the minimax method under this assumption showed improved results for some positions, while yielding worse outcomes for others. On this showing it would be unwise to extrapolate to positions as yet unspecified. About the other assumption, the two-value model, Bratko remarked that a multi-value model does not help to substantiate current ideas about searching. From this, the speaker drew the tentative conclusion: "We have to accept non-uniform value distributions". The main reason was the observation that, in real games, values of positions tend to cluster closely around the value of their parent node.

By the approach suggested by Bratko reasonable results are obtained provided that the discrepancy between the static and the backed-up evaluation remains moderate. This latter depends heavily on the position considered, i.e., on whether the position is *stabilizing* or *interesting* in Bratko's terminology.

After the lecture held by Bratko, Don Beal showed some of his results on the same topic. He had investigated the influence of backing-up values in the KPK ending. The moves proposed by the minimax procedure were compared to the moves of a KPK data base, focussing on the clustering effect in particular. Moreover, Beal also took into account other factors, such as *consistency search*, forward pruning and cutoffs, all of which are important in his model.

In the lecture by K. Coplan, 'A special purpose machine based on an improved algorithm for deep chess combinations', two topics were discussed:

(i) a search algorithm;
(ii) chess-specific algorithms.

His ideas were interesting but rather similar to those of Barend Swets implemented in his program BS '66'76. Swets's program embodying these ideas did not play too well, mainly because his processing took too long. This may imply that his program was searching a very narrow, but rather deep game tree; it might then happen that the program would finally reject a move which had taken a vast amount of time to compute. Under tournament conditions, the program must play its move within a limited amount of time; it was therefore constraint to play a move analysed only superficially. Coplan's idea to implement his model on a special-purpose machine might diminish the handicaps of Swets's ideas as realized in his program.

Of course, the conference was eagerly looking forward to the lecture by Ken Thompson, who, with Joe Condon designed BELLE, the 1980 Computer Chess World Champion. In fact, Thompson gave two lectures, 'Computer Chess Strength' and 'BELLE Chess Hardware'. During his first address, Thompson dealt with an experiment which he had developed for getting possible insights into the intriguing question: 'How strong will chess programs become?'

Thompson succeeded in showing the importance of the processing speed of a program to its playing strength. He made this point by exhibiting the results of the 'BELLE-computer-chess-machine-tournament', diagrammed below. The participants of the tournament were all BELLE programs with the difference that their depth of "thinking" was restricted to a certain ply level (e.g., P3 meaning 3-ply full width searching, followed by capture search). In order to calibrate the results and to extrapolate from them, Thompson had rated his programs. Of course, the reliability of these ratings is not similar for every version of BELLE. So, the rating of P5 (1500 USCF points) has not the same impact as that of P7 (2052 USCF points). For European readers of the AISB Quarterly, we remark that USCF points directly transfer to ELO points. One gets a fair impression of playing strength by regarding the USCF points as if they were ELO points. (Karpov's ELO rating is estimated at 2690 as of 1 January 1981).

In the tournament, the P_n played the P_{n+1} for a 20-game match. The table below displays the results.

	Rating	P3	P4	P5	P6	P7	P8
P3	1091	X	4				
P4	1332	16	X	5½			
P5	1500		14½	X	4½		
P6	1714			15½	X	2½	
P7	2052				17½	X	3½
P8	2320					16½	X

From this, the tentative conclusion can be drawn that every additional ply corresponds to approximately 200 ELO points. Thompson also showed recent results of BELLE in several otherwise human tournaments. Her actual USCF rating now is 2140 (comparable to expert performance), but she has done much better meanwhile. In order to estimate her real playing strength more accurately, Thompson showed the results of BELLE's participation in a strong tournament, in which the chess machine had achieved a tournament performance of 2334, i.e. that of a strong national master (the international master level starts around 2400).

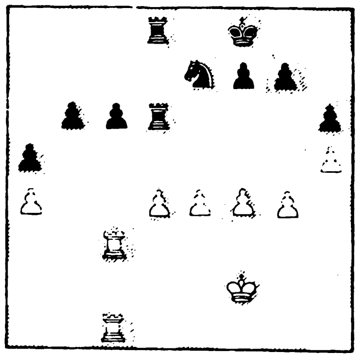
Ken Thompson's second lecture concerned the BELLE chess hardware, in particular the processing speed of all its chess elements, such as move generation, tree traversal and evaluations. In this context Ken showed a number of slides and furnished an overall description of his machine. These will be published 'Advances in Computer Chess 3', to be edited by M.R.B. Clarke and to contain all the papers of this conference.

Moreover, Thompson told us that he suspected that it would be difficult to accelerate BELLE significantly. He regretted that his enthousiasm was somewhat dampened by the prospect of advancing in slow and painful steps. Still, in order to give an example of its present speed, we mention its ability to read its opening library. In just one of BELLE's data bases, holding its knowledge about openings, there are 5 volumes (A to E) of the famous Yugoslav chess opening encyclopaedia in a very compact notation .... . This is completely read in within 3 seconds ... . Answering a question from the audience about his own playing strength, Thompson stated with a smile: "I don't play chess."

After Thompson's presentation the attendees were clearly impressed by the possibilities and the playing strength of his chess machine. The sequence of lectures being well-ranked, the next topic was the general ability of chess programs and machines to match the performance of human beings. Danny Kopec started by recalling De Groot's research (1946, better known in its 1965 and 1978 editions, 'Thought and Choice in Chess'). De Groot's main point is that the grandmaster "knows" how to handle a certain position and that this is why he immediately "sees" the "right" move.

Ivan Bratko and Danny Kopec had performed an experiment testing some popularly accepted hypotheses about (computer) chess. They had tried to conceptualize the notions of human beings and computer programs when confronted with special configurations. The main theme in their investigation was the concept of what they termed *lever*. In order to clarify this concept a simple example will serve: White has a Pawn on b5; Black, with pawns on b7 and c6, is subject to a minority attack. The goal of applying a lever is to destroy the opponent's pawn structure or to seek some other advantage, such as taking the lead in play or spatial advantage. Bratko and Kopec submitted 25 test positions to many players of various strengths.

The result of their experiments with human beings was that their test scores rose with their ELO strengths; we are inclined to dismiss this as self-evident, yet the comparison with computer play enriches the experiment. The performance of BELLE, especially, often showed what cannot but be called an *understanding* of the position. As a case in point, they offered the following characteristic lever position.



White: Kf2 Rc1 Rc3 Nb3 a4 d4 e4 f4 g4 h5;
Black: Kf8 Rd6 Rd8 Ne7 a5 b6 c6 f7 g7 h6;
White to move.
(taken from a position played by Bogoljubow).

Acting on first impulse, White would almost certainly play 1. Ke3, but a more alert White would do better, notably by the possibly optimal move 1. d5!, potentially leading to: 1. ... cxd5 2. e5! Rd7 3. Nd4.

The striking advantages of the position so reached are: the d-Pawn is blocked by the Knight (Nimzovitch); the black Rooks over-protect (the usual chess term is *überdecken*) the d-Pawn, though to no good purpose in this case; the c-file is open for White's exclusive use, Black having no direct possibility for opposition along this file; Black's pawn structure is broken up into three groups which is less favourable than a division into two groups. Hence, the pawn sacrifice (1. d5) is part of a long-term plan. White has a winning position. In the actual game Bogoljubow did not find this winning continuation and drew the game.

In the evening of the first conference day, an informal meeting consisted of demonstrations. Much attention was given to Kopec's simultaneous play against BCP (Don Beal's program) and BELLE. They played under approximately normal tournament time control. Danny Kopec was obviously too strong for both programs. The subsequent blitz games were more interesting; BELLE ('78) turned out to do rather well. The success of the informal meeting can only be described as notable, judging by the participants' enthousiasm. Botvinnik, for one example, appeared to enjoy kibitzing computer chess no less than looking over human players' shoulders.

On the second day of the conference, one of the main topics was the representation of domain-specific knowledge. Of course, special types of end game were discussed, but also important features of domain-specific knowledge in the middle game, such as the minority attack, were given their due share.

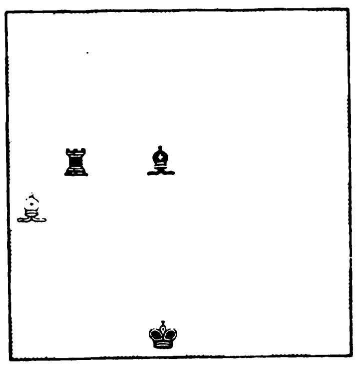
Max Bramer explained the relative merits of *optimal* and *correct* playing strategies. Furthermore, he described a method for testing whether a given playing algorithm is correct. Two procedures were proposed for producing fully correct algorithms by a process of iterative refinement, based on an analysis of *win-trees*. Bramer instantiated his methods by the KPK (King and Pawn against King), KRK and KQK end games. He also referred to some four-piece end games.

Reporting on his research, especially on testing against a data base, Bramer remarked that storage requirements of end games involving more than four pieces were prohibitive. The lecture given by Shapiro on the research of Niblett and himself, 'Automatic induction of classification rules for a chess end game', was directed to the use of human knowledge in end-game programs. The strategy of their model was based on generating a tree prior to traversing it. For the strategy in KPK endings they introduced the concept of CLIP (Cellular Logic Image Processor). Although their decision trees were by no means optimal, the results were acceptable on the whole, from which they concluded: "Adding a *humanly understandable* structure to the solution of a problem does not necessarily add to [the difficulty of] the task of solving the problem".

Their current investigation concentrates on KPKR. For the specific domain KP(h7)KR, it turned out that 15 attributes were necessary. A remaining research problem was and for some time is likely to remain how to construct the attributes. Of course, one of the (future) goals will be constructing the attributes by programs, but it is very difficult to achieve this, it was reported.

This last asseveration becomes more crucial as one considers fuller ranges of the game of chess. Therefore, the attempt of Thomas Nitsche, one of the designers of Mephisto, a commercial chess computer, was interesting. His lecture, titled 'A learning chess program', dealt with refinements of heuristics applicable to given configurations. The computation of the final heuristic has been performed with the help of the least squares method. To many of the audience, Nitsche's proposal was reminiscent of techniques used by A.L. Samuel in the late 1950s and early 1960s, although it should be explicitly stated that Nitsche's technique appeared to be more generally applicable.

After these three theoretical lectures, the appearance of Bramer and Alden provided a delightful entertainment. Not that their discourse was basically frivolous, far from it, but their way of presenting it appealed highly to the audience. Their lecture: 'A program for solving retrograde analysis chess problems' was serious in essence and the problems dealt with are very difficult to handle indeed. Their ideas were taken from Raymond Smullyan's book 'The Chess Mysteries of Sherlock Holmes'. After having presented their model and especially after having emphasized its link with A.I.-research, Bramer and Alden adduced some examples, highly successful, going by the audience's delighted response. As stands to reason, an animated discussion about possiblities and impossibilities in chess resulted. For the reader's amusement, we reproduce one sample of their discourse. (Hint: consider the history of the position not its continuation).



White: Ba4;

Black: Kd1 Rb5 Bd5.

The relevant questions are: (i) What was the previous move, and whose was it?

(ii) Where is the white King?

[solution at the end of the article]

The afternoon session of the second conference day was devoted to a number of challenging issues. The afternoon started by Prof. Donald Michie presenting 'Information and Complexity in Chess'. The audience's expectations were well satisfied from the start. Their attention was captured from the very beginning by the speaker's clarifying the relation between research on the KPK ending and its relevance to other case studies. Having introduced a definition for *concepts* (a concept equals a (machine oriented) description), he stressed the aspects of (i) intelligibility and (ii) executability by human players.

Michie compared and contrasted several known approaches to the KPK end game, ranging from complete data bases at one end of the scale to exhaustive computation at its other extreme. Within this spectrum, the *human window* was defined; approaches to an end game are more acceptable to humans as they come closer to or even fall within this human window. This window is acceptable to humans by virtue of its being intelligible to humans as well as executable by them. Bramer's KPK program was stated to be well within the human window.

Apart from chess, Michie considered the field of A.I. as a whole, drawing up an inventory of progress. In summary he stated that A.I. obviously had made a start in putting pieces together, yet the vast majority of them were still unconnected to the conglomerate constructed. Elaborating Weaver's classification, comprising 3 classes, Michie distinguished 5 classes of relevance in bringing subject matter within the human window; the distance, within a class, of a problem from the human window determines the complexity and difficulty of a task. Michie's classes of problems were:

(i) technical problems	(transmission)
(ii) semantic problems	(meaning)
(iii) effectiveness problems	(behaviour)
(iv) comprehension problems	(understanding)
(v) humanisation problems	(application)

In his five classes Michie appealed to the well-known thought experiment consisting of sending an algorithm to beings in another galaxy; these beings, if they are properly to receive the message sent, will have to solve successively the problems of deciphering its meaning, of appropriately adapting their behaviour, of understanding its impact and finally applying the algorithm in a suitable context.

After Michie's lecture, Kaindl from Austria was given the task to recapture the audience, by no means easy after Michie's performance. He proved his mastery by a well-prepared discourse presented quickly and expertly. He had larded his topic, 'Positional long-range planning in computer chess', with some well-chosen examples from chess practice. The main point of his exposition was the implementation of heuristics concerning positional aspects, principally minority attacks. He stated - nearly everybody agreeing - that computer programs must be given additional chess-specific information in the form of patterns. In order to implement his ideas, Kaindl has developed a new language, PPDC, for Positional Pattern Description Language.

The last lecture of the conference was by the former chess world champion Mikhail Botvinnik, the designer of PIONEER, the Soviet Russian chess program. The organizers had arranged for an interpreter, because Botvinnik preferred not to rely on the adequacy of his knowledge of English. For this reason too, he had also decided to distribute his paper, 'Decision making and computers', at the start of the conference. It might therefore be presumed that attendees were sufficiently familiar with the topic formally to be presented by Botvinnik; therefore the Russian grandmaster elected to provide some background information about PIONEER.

In doing so, he explained why PIONEER does not currently play at all and what has happened to that program. "In April 1980", Botvinnik stated, "we submitted the last position to PIONEER. Afterwards, we were deprived of computer time. We were told that there was another job for us, although the work on our chess program had not yet been finished. It was clear that the Institute of Engineering hesitated to take an interest in chess playing programs. The job given us was to transfer PIONEER's methods to an economic planning program. Our task was to create a new program to plan distribution for the whole Soviet Union in 1982. We, Sasha Resnitsky and I, will perform this job and so now we have computer time again. After having fulfilled this great task we shall return to the development of our chess program PIONEER. In fact, I cannot live without PIONEER. We shall implement the new ideas we have about chess planning, maybe even at international master level, and then BELLE will have a hard struggle to beat our program."

After these details about the how and when of his program, Botvinnik had to answer numerous questions. Most of these were answered in extenso by the speaker. At long last Mike Clarke intervened, remarking that Dr. Botvinnik should not suffer from having no speaker timed to succeed him in the program. He therefore suggested that the audience would do well to terminate the dialogue in spite of their obvious fascination.

At the end of the conference, thanks were voted to Mike Clarke for his essential share in the organization. This reporter wishes to stress once more that the conference constituted quite clearly a major contribution on the continuing road to progress in computer chess.

[Solution: The white King has to be placed on c3; from the position

White: Kb3 Ba4 c2;

Black: Ka1 Rb5 Bd5 b4;

White to move,

the continuation was as follows:

1. c4 bxc3 e.p.†† 2. Kxc3†].

Jaap van den Herik
Delft University of Technology
The Netherlands