The
Computer
Museum

300 Congress Street
Boston, MA 02210
(617) 426-2800

31 January 1986

David Woodfield
1 Gloucester Road
Brookhouse Estate
Walsall
W Midlands
England

Dear Mr Woodfield

First of all let me thank you belatedly for letting John Billingsley borrow Thumper and Enterprise for our micromouse event last November. I hope you will have seen a copy of his writeup of the event, and therefore know how well it all went. Enterprise impressed the spectators greatly, and definitely won confidence as a mouse to entrust your life to on an alien planet. We will be publishing a story on the event in our next report and I will send you a copy.

We are going to be able to hang on to the maze for the next few years at least, and would like to demonstrate mice on a continuous basis. We would also like to build up a collection of mice to serve as a record of the contest and the technology used. John indicated that there might be a chance of us being able to have Thumper in the Museum permanently, and I wondered if you would consider donating or lending him to us? We would be willing to pay for packing and shipping.

I enclose a couple of recent issues of The Computer Museum Report to give you a little more background on the Museum.

I look forward to hearing from you and to whether Thumper can join us in Boston.

Yours sincerely

Oliver Strimpel

COLLEGE OF ENGINEERING

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September 13, 1985

Dr. Oliver Strimpel
The Computer Museum
300 Congress Street
Boston, MA 02210

Dear Dr. Strimpel:

I have returned from Japan and have much to discuss with you concerning the forthcoming November 17 unveiling of the micromouse exhibit at The Computer Museum. The question: How big an event do you want in November?

The World Micromouse Contest at the Tsukuba '85 Expo was a well organized affair that lasted for three days, August 23-25, 1985. It took place in Expo Hall, an auditorium that had seating for several hundred people. The entire contest was videotaped and appeared as a half-hour television show at 6:00 PM on the Japanese NHK television station about one week later. There were two masters of ceremonies (a man and a woman, as typical of such shows) plus a pair of off-stage commentators (one from the Japan Micromouse Association) and a roving reporter (a most charming young lady). One of these weeks I should receive a videotape of the final day of competition. I also took videotapes using my own video camera, but have yet to look at the results.

August 23 was reserved for the all-Japan Micromouse 1985 contest. August 24 was devoted to the Micromouse preliminaries, namely, new mice. The finals were held on August 25, and included "seeded mice" (winners of 1984 national competitions in Japan, U.S., Europe, and Korea) and winners from the preliminaries.

Let me now comment on the finals. About 30 mice were entered, 20 from the preliminaries. Eight mice were foreign entries (U.S., two from Britain, two from Korea, two from Finland, and West Germany). Unfortunately, only one "foreign mouse" successfully negotiated the maze: Enterprise by David Woodfield (Britain), who took seventh place in the contest. The remaining mice had detector problems, which were caused by the intense incandescent lights that were used to light the stage. One foreign mouse was dropped and never recovered; Alan Dibley (Britain) was philosophical about the accident and quite the comedian on stage.

The World Contest belonged to the Japanese and, specifically, to a single micromouse club called Fukiyama (Hiroshima prefecture). Five of the top six awards were given to members of the club, who apparently perfected a type of mouse (the "gyro" mouse) that was clearly superior to most other mice. The manager of the club, Mr. Nomura, the winner of the 1984 all-Japan

Micromouse contest, is a veterinarian. I find it difficult to describe how fast the Fukiyama mice were (wait for a videotape). They negotiated the final maze on August 25 in about 20-23 seconds, and the preliminary maze on August 24 in 15-17 seconds. There is not much room for further improvements in speed, in my opinion. The accomplishment is a tribute to the ability of the Japanese to develop and refine a product.

Now to the November 17 event. I called the Washington DC office of the IEEE Computer Society to find out if the maze has been shipped to you. Expect shipment imminently if you do not already have it. I still have the Official Micromouse Association mouse, "Mappy", in my basement, and still have no instructions concerning how to run it. I kept the November 17 event uppermost in my mind as I participated in the World Micromouse Contest and developed a number of ideas for the program that I would like to present for your consideration. Keep in mind that the following ideas have not been tested on others and are being suggested as a trial balloon. If you are interested, I could present them to my colleagues at the IEEE Computer Society. I have all the contacts necessary to help us make arrangements with specific individuals.

1. Micromouse Maze

You should plan to display, if possible, the full 9' x 9' micromouse maze for the November 17 event. You can put it on the floor in an area where your audience can view it without difficulty (at Tsukuba, the maze was on the floor of a stage). My videotape of the Atlantic City contest should give clues concerning how to put the four pieces of the maze together. An absolutely critical aspect of the maze is the lighting. It should be uniform and of a certain intensity (perhaps with the ability to vary the light intensity). The high-intensity incandescent lights in Tsukuba bombed out about 50% of the competing mice, which could not handle the large quantities of infrared that were generated. The West German mouse was built and tested under fluorescent lighting, and never completed the maze in Tsukuba because of the infrared problem.

2. Official Micromouse, "Mappy"

The Computer Museum should send an official written invitation to the Japan Micromouse Association (I will give you their address and an appropriate name) requesting participation of a Japanese official in the November 17 event. This official should be the one who would operate "Mappy". I requested written instructions months ago, but have not received them. Another idea concerning how we could learn to operate "Mappy" is to request a videotape with instructions in English. Since "Mappy" will only be used once, on November 17, perhaps we should not bother.

3. Other Mice

The November 17 event would be very interesting if we could exhibit more than one micromouse. In fact, it would be valuable to exhibit the world's best mice if suitable arrangements could be made. At the same time, we could use the event to make arrangements for the longer term exhibition of selected mice by The Computer Museum. I explored this idea with several of the international contestants at Tsukuba and received a very positive response. Here are my recommendations:

a. MicroGonzales (the successor to Speedy Gonzales), a crowd pleaser at the Tsukuba contest. Micro Gonzales was developed by Ralf Hinkel, a West German graduate student. It was one of the smallest mice I have seen, used three charge-coupled-device cameras to sense location, is a state-of-the- art mouse in terms of technology (the Fukiyama Club was impressed, and made him an honorary member), looks like a mouse (or perhaps a large, red rat), runs like a mouse, and in general is the type of mouse that you would prefer for your exhibit. I discussed the possibility that Ralf would lend it to The Computer Museum for your exhibit, and he was interested.

b. Noriko X2, or any of the several Noriko Xn mice that were among the top six winners at Tsukuba. This type of mouse, developed by the Fukiyama Club, is a state-of-the-art mouse that employs a built-in micro-gyroscope to sense direction. The ability of such a mouse to turn a corner at full speed is amazing. Mr. Nomura, manager of the club, would be most interested in coming to the U.S. His English is so-so, but he is a charming person. In my opinion, it would be a good move politically to invite him provided that we have a translator available.

c. Enterprise, the excellent entry from David Woodfield of the United Kingdom. David is a professional designer of microcomputer hardware and software, and his products can be seen in stores worldwide. He is a very unassuming individual, but a brilliant designer. Enterprise is very smooth, can accelerate very quickly (impressing the Fukiyama Club in this respect) and can negotiate a complex maze in near-record time. It is probably the best non-gyro mouse around.

d. Moon Knight Delight, the U.S. entry from a group at California State University. This mouse is not fast, but it can negotiate a maze successfully and is the best that we have at present. For balance and to show where the U.S. stands at this moment internationally, it may be appropriate to invite Baxter Cheung, the student who knows the most about this mouse and operated it in Japan.

4. Micromouse Kit

Namco Corporation, the sponsor of the Japan Micromouse Association, has recently marketed a micromouse kit. The IEEE Computer Society is negotiating for the opportunity to market the kit. The Computer Museum store would be one appropriate place where to sell it, if you are interested. I have obtained a kit and will construct it within the next month or so. An EPROM could be brought over from Japan to permit this mouse to be run through the maze at the November 17 event. At present, all I have is a test EPROM that tests the detectors and motors; I have no software to traverse a maze.

5. John Billingsley

Professor Billingsley (United Kingdom) is one of the founders and consistent supporters of the European Micromouse Competition. His specialty is robotics, and he is intimately familiar with micromouse construction and operation as well as maze-searching tactics. As you will soon observe on a videotape, he was one of the judges at the Tsukuba World Micromouse Contest finals and provided the English-language technical commentary during the event. Above all others, he is the proper spokesman and lecturer for this type of competition, and should be one of the key speakers at the November 17 event at The Computer Museum. At Tsukuba, he made the competition more interesting by his discussions of the types of problems that the mice were having.

6. A Media Event?

If you gather the finest micromice and spokesmen for the competition on November 17, you will have an opportunity to invite media representatives--for example, educational TV (NOVA?), magazines (OMNI, National Geographic, Scientific American, and so forth), local and national TV stations, local and national newspapers, and so forth--who could take advantage of the assembled talent for their own purposes, such as articles and TV programs. This all could provide useful publicity for The Computer Museum, which at the time would have the only Official Maze and the inside track to exhibit, on loan, several state-of-the-art mice. I suggest this possibility because of the next item, which is . . .

7. At What Cost?

To make November 17 a media event, you will need to pay the travel and lodging costs for the individuals whom you invite to Boston. At the minimum, I would invite Ralf Hinkel (because he might be willing to loan you the mouse for exhibit) and John Billingsley. Third on my list of priorities would be Mr. Nomura (because all of the best mice to date come from the Fukiyama Club in Japan, which has the most extensive experience with this type of competition). Fourth would be David Woodfield and fifth would be Baxter Cheung from California. These individuals should have at least a day or so prior to November 17 to test their mice and adjust their sensors to existing light conditions at The Computer Museum.

Perhaps students from M.I.T. and other regional colleges and universities could be invited on Saturday to watch the mouse tests. I would recommend that you attempt to get both the Japanese Noriko X-2 mouse and David Woodfield's Enterprise mouse in addition to Micro Gonzales on loan for your permanent exhibit. The November 17 event could be videotaped so that somebody associated with the museum could learn how to operate the mice.

Who would pay for all this? Do you have a corporate sponsor who would be willing to be the financial angel for international travel/lodging costs? The IEEE Computer Society New Activities Committee, which is in charge of the 1986 competition(s), has no funds for such a purpose to the best of my knowledge.

Perhaps my ideas for a November 17 media event are wild, but it does not hurt to suggest them. Done properly, the micromouse could become a popular exhibit because it is dynamic. You must get at least one, good mouse to exhibit.

Sincerely yours,

Peter

Peter R. Rony

Micromice at Expo 85, Tsukuba.

John Billingsley

The Japanese set out to create the world's greatest Micromouse spectacular; they achieved an overwhelming success. A packed audience in the Tsukuba Exhibition's "Expo Hall" saw Japanese mice take the first six places, with a leading time of under twenty seconds.

Mice were invited from Britain, Finland, Germany, South Korea and the United States. With only one exception, disasters or weaknesses prevented any of the visiting mice from presenting any real challenge. Mice do not travel well, indeed only one Japanese mouse has survived the trip to Europe, and that was the Namco exhibition mouse "Mappy", packed in a crate which could have comfortably held a body. Even at the top of their form, however, it is unlikely that any of the visitors could have matched the agility of the home team.

David Woodfield's achievement in obtaining a near-perfect performance from "Enterprise" must be seen as a masterpiece of reliability. Enterprise was unpacked, virtually untwiddled, and quietly did its best. Unfortunately for David, its best was about twice the time of the winner - but there is still much room for future tuning and refinement.

Since their introduction to the contest in 1980, the Japan Science Foundation has worked hard to build interest in the Micromouse association; now they have over eight hundred members spread throughout Japan. No less than fifty mice battled on Saturday for a place in the Sunday finals, to join the invited mice and the Japanese mice already qualified. These performed, two at a time, on a pair of mazes filling the stage. Among the contenders were Alan Dibley's T6, Ralph Hinkel's Micro-Gonzales and David woodfield's KnownAim.

Ralph's qualifying run took place on Saturday in mid morning, and it was immediately evident that he had lighting problems. He had tested his mouse under the dazzling levels of light announced beforehand, but he had used fluorescent lighting, not the infra-red laden spotlights which made the Expo Hall stage as bright as day. His vision system is a sophisticated one, based on a camera which recognises the boundary between floor and walls; he was not helped by the lack of contrast of a floor not altogether black to infra-red. The lights were then dimmed for him, but he stalwartly refused to let the rules be bent in his favour; Micro Gonzales would only perform a demonstration run on Sunday.

A little later it was Alan Dibley's turn to suffer. He was still badly jet-lagged. A devious travel agent had told him the hogwash that Tsukuba was as near to Osaka as it was to Tokyo. So laden with a trunk full of mice, he stumbled off a plane in Osaka to face an overnight stay and an early flight to Tokyo. Had it not been for the help of the organisers in meeting his flight and helping him to Tsukuba, he might not have arrived at all !

Alan's jet-lag was nothing to that of T-6. Whether the trouble was lighting, contrast, travel damage or just plain finger trouble I do not know. The result was an agonised expression and a mouse which failed to qualify.

KnownAim was another non-event. A belt had snapped in transit. This could have been repaired, but as a result a wheel had fallen off, scattering miniature ball bearings across the world. Repair was impossible. It was with some trepidation that the visitors looked forward to the day of the contest.

The stage management was superb. To the left of the stage was a twelve-foot high list of runners, to the right a ladder of results. In the centre, a large screen displayed close-ups from the many television cameras. Among speeches and fanfares the contestants were paraded in Olympic fashion behind their national flags. Then the judges were announced one by one, marching in to take their seats behind a long table overlooking the single maze. Business was ready to commence.

As UK judge, I tried to forestall a few problems by provoking a careful inspection of the maze. One or two patches of fluff, left behind by the concealing cover, could have caused havoc to somebody's sensors. They were easily dealt with, as were the three or four wall pegs which stood a millimetre or two proud. More of a problem were the patches of glue on the wall tops near the pegs. Although hard to see, these were even better infra-red absorbers than the maze base. Nothing much could be done about them, and so mouse after mouse wobbled down the straights.

Two professional presenters introduced each mouse, interviewed its builder and gave a running commentary. By noon, we were still watching mouse number seven, and wondering whether the contest would be completed by midnight.

The first mouse, Kojokan, was the forerunner of many by the Fukuyama club. It spent a full ten minutes exploring every corner of the maze, then ran back to the start. It was lifted out, its battery and EPROM were changed, and it then started running with some determination to the centre. Between runs, adjustments were made to DIL switches to an extent which would most certainly be frowned upon in Europe, but which was entirely within the Japanese rules. At the end of its time, the mouse had a best time of one minute and four seconds to its credit.

When we broke for lunch, eight mice had run and seven of them had reached the centre in times ranging from three minutes to just within the one-minute barrier. The presenters had at last realised the problem of time-scale, and were now saving their remarks until the mice had started.

It was plain that the subtle differences in the Japanese rules had greatly influenced the strategy of the contestants. Battery changes were permitted, so they became the order of the day. Contestants would set out heaps of five or more sets of cells, and a battery change would follow each run to the centre. Changes and adjustments were also permitted, provided the weight of the mouse was unchanged. So ROM's flashed in and out of zero-insertion-force sockets while banks of switches were painstakingly set from manuals of strategy tables.

The contestants had settled on an optimum strategy, with which it would be hard to quarrel. First the mouse was set on an exploration program, moving slowly and minimising any risk of disorientation. Ten minutes elapsed before the speed was allowed to build up. Now the maze was locked into memory and safe against corruption. The fastest route was determined, and from then on the contest became a simple race against time. Performance was determined by the ingenious "add-on"s with which individual contestants varied the standard chassis design used by their particular club.

In fact the rule change needed to fire up the excitement and stretch the contestants is not great. Catastrophes can still be averted by permitting changes of batteries, components, or even of the entire mouse. But by enforcing a total memory erasure after any such change or major adjustment, the contestants will be placed under pressure to produce mice which are truly autonomous. The long, slow plod can be removed by a slight scoring modification; to each run time should be added one sixtieth of the elapsed time as the target is reached. Thus a twenty second run achieved after five minutes has a score of twenty-five seconds, but the same run made after twelve minutes has a value of only thirty-two.

Lunch for the judges was a hastily snatched few minutes, with a plastic-packed snack meal. The rest of the visiting party enjoyed a sumptuous banquet in the company of Japanese dignitaries - pity the poor workers ! Then back to the blazing lights for another session.

Almost without exception the mice were "wheelchairs" with either stepper or DC servo drives. Some had a diamond arrangement of wheels and castors, some were offset to form a castor tricycle. Noriko-X4 had castors which were refined so that they were driven to aid a turn, Nanacy-M had a single castor tail-skid. The exploration routine appeared strange and inept to the European contestants, who had always sought an early solution to the maze. Some mice had excellent recovery routines, detecting and correcting for any any unexpected encounters with walls.

Labo-2 was a cylindrical wheelchair guided by sonar. It was when Labo-3 ran later, another sonar machine in the shape of a neat little mouse, that a serious hazard was detected. In the middle of a smooth performance, Labo-3 suddenly staggered as if poleaxed. It took a member of the audience to realise that it had been zapped by an autofocus camera which also used sonar. As if flash was not hazard enough !

The first visitor to run was Sapience, Kim Kee Hee's wheelchair mouse which was runner-up in Korea. It overran the second turn time and time again, and retired a probable victim of lighting levels. Tellu ran next, nursed by Hannu-Matti Jaervinen and his team from Finland. After long pauses for diagnosis and attempted repair, and showing a serious case of underdamping in its steering, Tellu retired with the promise that we would see greater things from Manu, its twin.

Now it was T-5's turn. A disconsolate Alan Dibley had to explain to the audience that T-5 had leaped off a table and suffered a broken wing - the cover in which the wall sensors were mounted. Even with the help of the Japanese mousers (special thanks to Mr. Higasa) the necessary lining up and adjustments could not be made in time. T-5's servomotors had then been sacrificed in an attempt to help the Finns. T-6 had been left at the hotel in disgrace after its failure to qualify, leaving the visitors still with a zero score.

After a ten minute break at three o'clock (sixteen down, fourteen to go) it was the turn of TZ80B, from the Yachiyo Micon Club. After its lengthy exploration it tried both shortest route and the route with fewest corners, becoming the fourth mouse to break fifty seconds. Soon afterwards Nazca, yet another mouse from the Fukuyama Club, clipped the time to just over thirty-one seconds.

Now came the leading Korean mouse, COCHOO2HO by Lee Hyeok, followed by Baxter Cheung's "Moonknight Delight" from the United States. COCHOO2HO (organic?) fared no better than its compatriot, and retired. The US mouse clearly used a chopped drive to its motors. The sonic effect was one of advanced rust, as the mouse squeaked and groaned through the maze. Although first on the micromouse scene in the 1977 contests inspired by IEEE Spectrum, the USA has now fallen badly by the wayside. The Berkeley team is working hard to catch up, but their efforts produced no reward.

Then the Shibaurakogyo Unit's S.I.T.XIII and two more Noriko's all slashed the thirty second barrier to leave a target of just twenty seconds (and five hundredths). They shimmied a slalom course along the diagonals of the route, leaping forward along the straights. Sensory aids among the mice included neat little gyroscopes to preserve precision on the corners and a side-slip sensor to correct the track. The performance squeezed out of the simple wheelchair drive was truly amazing. To achieve the necessary split-second timing, photocell sensors had been set up in both the starting and target squares, linked directly to the computer which served as a clock.

Now Ralph Hinkel put Micro Gonzales through its paces. This is a beautifully engineered little tricycle, using imaging cameras to determine its location. When lighting levels proved impossible, he produced a twin fitted with sunglasses. This ran well until it reached a wall in relative shade. Unable to grope further, it retired with dignity.

Manu now arrived to uphold the reputation of Europe. Lighting again seemed the bugbear, and the Finns trotted around the maze holding umbrellas hastilly borrowed from the audience. When this failed, they revealed that a motor fault had been patched using a spare purchased in a toy shop for under a pound (300 yen). It only goes to reinforce the problems of competing away from home.

Now it was all up to Enterprise. David Woodfield placed the frail-looking tricycle on the maze and pressed the button. Admittedly a restart or two were needed when Enterprise grew over enthusiastic, but in a businesslike way it mapped out the maze, sprinting wherever it knew of a straight, and refined its path in times of one minute eight seconds, then fifty-two seconds, forty-four and finally forty-one. No battery change, no twiddling, Enterprise performed in the spirit of the European rules. But the twenty second target remained far out of reach.

With two more mice to go, it became a simple matter of which Fukuyama mouse would be the actual winner. Noriko-XI took the honour, literally by a whisker. The commentator had given a wonderful commentary on each finish, in best horse-racing style. The language became a marvellous staccato frenzy, so that without understanding a word we were carried along by the excitement of it. Now as N-XI neared the target in the dying seconds of its race, hit the entrance and slewed sideways I thought the commentator would burst. But one whisker sensor had flipped through the opening, and was enough to trip the light beam and the clock. Noriko-X1 was the winner by a mere fifth of a second in a time of 19.83.

The judges missed seeing the spectacular prize-giving, with its dramatic vapour effect as the curtains were opened, with trophies tall as a steeple and man-sized cardboard cheques. Five places out of the first six went without question to the Fukuyama club, fifth place being held by Shibaurokogyo. The judges were locked in deliberation for a full hour on the allocation of the special extra prizes for innovation, hardware and software. It all seemed so obvious when the Japanese chairman put together a decision, but by then we had missed the best part of another banquet. It's a hard life.

John Billingsley:

David Allen, BBC Television
Villiers House
Ealing Broadway
London

Write re set of BBC tapes of show:

Write to Herman Hauser? re BBC Micro

re English micros – get announcement in Personal Computer World
Write to editor

British Computer Society – Association of Young Computer Enthusiasts
Electronic Systems News –

Nakamura, pres of ~~[illegible]~~ NAMCO or Atari: politics of funding?

Japan: Hiromitsu Miyamoto, Japan Science Foundation, same as Ueda
in charge; coordinate Japanese contribution
also close to Science Museum

Helpful w solution exhibits

Prof. Ryoichi Mori, University of Tsukuba,
Japanese director of Euromicro (mention John Billingsley)

Get him to Drop in

Mitsuo Ueda in charge of new exhibits at Science Museum

Yasuko Yakazaka?; in planning dept at Museum

*. Eiji Mizushima; planning dept at Museum

Micromouse British Finals 1985
London, 3-4th July.

John Billingsley

The International Personal Robots Congress at the London West Hotel lacked the bustle of last year's Computer Fair venue, but the micromice enjoyed an exciting final for all that.

Following tradition, the penultimate day was devoted to the novices. This year the newcomers had a hard decision to make: should they enter the open tussle of the novice final, or restrict their mice to the Tunnel Run ?

The Tunnel Run is a test of steering alone, for those mice which have as yet no maze solving ability. A section of maze is laid out as a simply-connected passage with no branches. It starts off straight and gentle, but after a while develops increasingly vicious bends and twists. The score is based simply on time to finish, or failing that on distance achieved before the mouse loses control. Only two mice elected to try it, Pete Boyce's SAM (Simulated Animal Mechanism) and young Howard Urmenyi's Where Rat. While Sam spent two-and-a-half minutes tottering around the passage, Where Rat made businesslike if leisurely progress and completed the course in just over fifty seconds. Where Rat is a committed wall follower, using an effective if primitive dangling microswitch sensor mounted on a leading corner to tap its way around the maze. Howard won a robot watch, while Pete carried off a copy of "DIY Robotics" (author John Billingsley, publisher Sunshine - wonderfully practical!)

The novice final was played for higher stakes: a Zero 2 robot from Intergalactic Robots and a Tomy Dingbat. Mike Windibank's Mad Max had been two months in the making; with one of two more days it might have avoided disaster. Rattus Verticalis could also have done with a little more work from Messrs. Visser, Watkins and Pitt. Sporting a complete keyboard and numeric display, Romeo showed a nice use of guidance control, winning second prize for Daniel Shoop, Robert Holding and David Sweeney. Jerry lost its novice status by being the only mouse to reach the centre. A furry rodent with sensor booms to each side, Jerry won its makers James Chidley and Derek Hall the first prize in a time of 1 min 25 sec.

On Thursday the big battallions moved in for the final. David Woodfield and Alan Dibley were particularly keen to try out the maze which had been specially flown from Japan by the Japan Science Foundation. They were able to check for any snags which might mar their performance in the World Finals in Tsukuba, and their suggestion that the floor should be made blacker to infra-red has already been taken up.

The gentle practice maze was reconfigured to a vicious test to separate the champions - but technical problems took their toll more effectively than the clock. Bill Urmenyi's Gonzales tried and retired, to be replaced on the maze by his new mouse Danger Mouse. DM certainly had a good run, but was finally thwarted and settled for third place.

Jerry did its best, but was driven into fourth place by stiff competition an a stiffer maze. Thezeus the Ancient came out of retirement, but even heart massage failed to make it run - its practice exertions had proved too much for its old batteries. KnownAim also failed to live up to its reputation, and eventually retired. That left the contest open to the two favourites, Alan Dibley's T6 and David Woodfield's Enterprise. T6 was suffering battery problems of its own, and after reaching the centre on an early run in a time of 1 min 51 sec was unable to complete a follow-up run to exploit its aquired knowledge of the maze.

Enterprise set off slickly, looking every inch a champion - but after a tortuous exploratory path it objected to one turning and snagged on a wall. It started again, with a clear memory of an initial long straight. It applied full power for a sprint start, winding up to a speed of two or more metres per second! The crunch as it hit the end wall made the audience wince. At the time, it looked as though it had "done a wheelie", lifting the front measuring-wheel off the ground and losing track of distance. Later David decided that the pulses had been arriving faster than his interrupt routine could cope with. Whatever the cause, Enterprise retired to the pits. Even so, its performance won David the second prize of a Commotion vision system - perhaps it will persuade him to build a Robat ping-pong robot. Alan Dibley carried off first prize of a Reekie mobile robot complete with robot arm. The tail-enders won two more copies of "DIY Robotics" (it really is well worth buying) , while all the contestants received copies of the impressive new Salamander "coffee table" book simply titled "Robots".

The contestants met again last week in Portsmouth as guests of the Students Union to tune up their rodents for the next contests. After Tsukuba, there will be a dash to Brussels to take part in the European 85 finals at Euromicro, September 3rd-5th September (finals on the 4th). Then the 1986 season will start, I hope with a rush of new school entries. For details of Micromouse and Robat, write to John Billingsley, Department of Electrical and Electronic Engineering, Portsmouth Polytechnic, Anglesea Road, Portsmouth PO1 3DJ.

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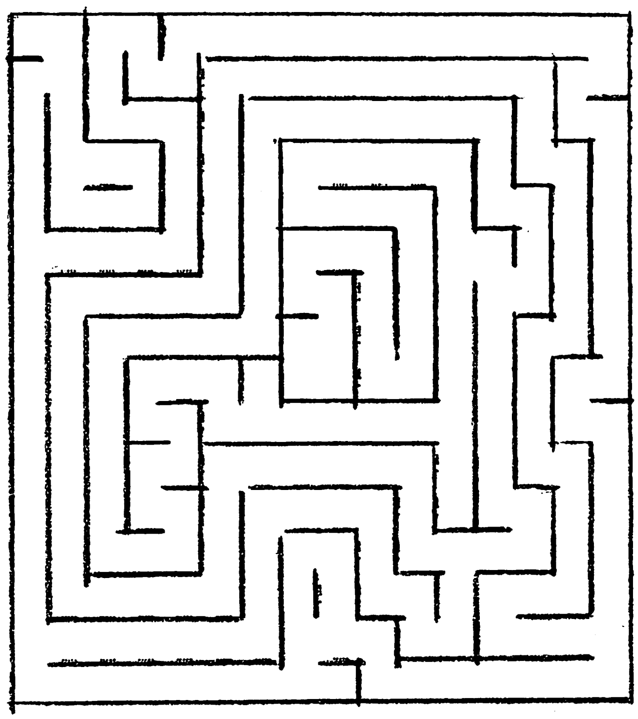


EUROMOUSE MAZE CONTEST

EUROMICRO '86

Microprocessor controlled robot mice must find their way to the centre of the maze.

1. Maze Dimensions

The maze consists of 16 x 16 squares. The squares are based on a 18 cm (7 inch) matrix. The walls of the maze are 12 mm ($\frac{1}{2}$ inch) thick, and the passageways are thus 16.5 cm ($6\frac{1}{2}$ inch) wide. The walls are 5 cm (2 inch) high, painted white with red tops. The target post at the centre, 2.5 cm (1 inch) square, is 20 cm (8 inches) high, and can be removed if desired. The starting square is at the 'bottom left' corner of the maze, and the mouse is initially oriented so that the target is diagonally to its right. The running surface is chipboard, painted with black emulsion paint.

Dimensions should not be assumed to be more accurate than 5%: the maze may be made to metric or imperial dimensions, and quoted figures may be approximations (to 5%). Joins in the maze base will not involve steps of greater than 0.5 mm - possibly covered with tape. However, warping of the maze base during transport or storage may result in a change in gradient at a join of as much as 4°.

2. Mouse Restrictions

Although the superstructure of the mice may 'bulge' above the top of the maze walls, mice must be subject to the following size constraints - width 25 cm, length 25 cm. There is no height limit but beware of toppling! Mice must be completely self-contained and must receive no outside assistance. The method of wall sensing is at the discretion of the builder, however, the mouse must not exert a force on any wall likely to cause damage. The method of propulsion is at the discretion of the builder provided that the power source is non-polluting - internal combustion engines would probably be disqualified on this count. If the judges consider that a mouse has a high risk of damaging or sullying the maze they will not permit it to run. Nothing may be deposited in the maze. The mouse must negotiate the maze; it must not step over or otherwise illegally cross any maze wall. The means of locomotion of the mouse is again at the discretion of the designer.

3. Championship Rules

(a) Each mouse is allowed a maximum total of 15 minutes to perform. (With increasing numbers of mice, this may have to be reduced to 10 minutes in future). The judges have the discretion to request a mouse to retire early if by its lack of progress it has become boring, or if by erratic behaviour it is endangering the state of the maze.

(b) If the mouse can succeed in finding its way from the start to the maze centre the time is noted. The mouse can then make a second run, either by being lifted out and restarted or by making its way to the start square, perhaps by another exploratory route. Only "inward" times are noted, but as many runs are permitted as are possible within the time limit.

Scoring is designed to reward intelligence, efficiency of maze solving and self-reliance of the mouse. To the time of each run is added one thirtieth of the total time then elapsed. Thus a sixty second run achieved after five minutes "on stage" will score seventy seconds. Until the mouse is first touched, however, a ten second bonus will apply to each run. A mouse achieving a sixty second run after five minutes will score 60 + 2x5 - 10 = 60 seconds if it has not been handled, implying that it will have found its own way back to the start each time. Once touched, the subsequent runs are timed without bonus. The score of the mouse is taken as the score of its best run.

(c) If a mouse 'gets into trouble', the handlers can ask the judge for permission to abandon the run and restart the mouse at the beginning. A mouse may not be re-started merely because it has taken a wrong turning - the judges decision is final. The judges may add a time penalty for a restart.

(d) If any part of a mouse is replaced during its performance, such as batteries or EPROMs, or if any significant adjustment is made then the memory of the maze within the mouse must be erased before restarting. Slight manipulations of sensors will probably be condoned, but operation of speed or strategy controls is expressly forbidden without a memory erasure.

(e) If no successful run has been made, the judges will make a qualitative assessment of the mouse's performance, based on distance achieved, 'purposefulness' versus random behaviour and quality of control.

(f) If a mouse elects to retire because of technical problems, the judges may at their discretion permit it to perform again later in the contest. The mouse will be seemed to have taken an extra three minutes performance time (i.e. if a mouse retires after four minutes, then when restarting it is counted as having taken seven minutes and will have only eight more minutes to run). This permission is likely to be withdrawn if the programme is full or behind schedule.

(g) The judges will use their discretion to award the prizes, which in addition to the major prize may include prizes for specific classes of mouse - perhaps lowest cost, most ingenious, best presented, etc.

(h) Before the maze is unveiled the mice must be accepted and caged by the contest officials. The handlers will place the mice at the start under the officials' instructions.

(i) The starting procedure of the mouse should be simple and must not offer a choice of strategies to the handler. For example, a decision to make a fast run to the centre as time runs out must be made by the mouse itself.

(j) No part of the mouse (with the possible exception of batteries) may be transferred to another mouse. Thus if one chassis is used with two alternative controllers then they are the <u>same</u> mouse and must perform within a single 15 minute allocation. The memory must be cleared with the change of controller.

The Micromouse Maze Contest was first held in the USA by IEEE Spectrum.

November, 1985.

Robot ping-pong has its sceptics. John Billingsley answers one of the doubts about how it is possible to follow the ball in flight

Getting on to the right track

"ROBOTS may be able to play chess but they certainly cannot play ping-pong." Peter Davey, then co-ordinator of the SERC Robotics Initiative, expressed that opinion in a lecture to the Royal Society of Arts. It is obvious, of course, that even a vastly expensive computer system will take some fraction of a second to analyse a frame of a TV image and recognise the ball, and in that time the moment will be lost. So how preposterous to suggest a game of ping-pong.

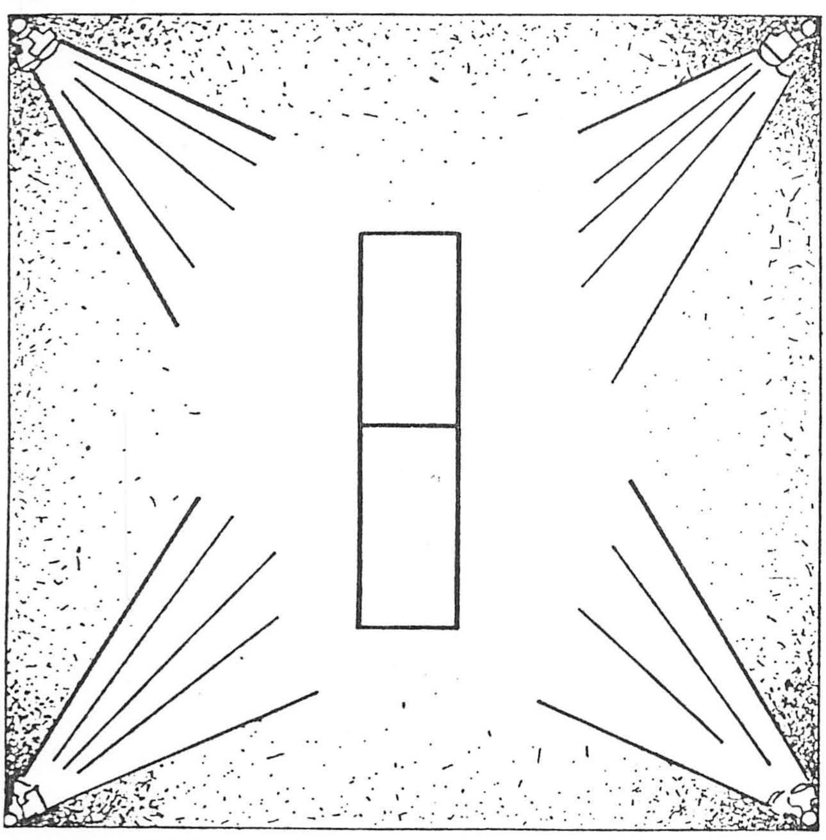
Wait a minute, though. Who needs to spot the ball in the first place? The ball starts in full view of both opponents, who have all the time in the world — well, at least 10 seconds — to lock their vision systems on to the ball before announcing that they are ready for play by lighting a yellow LED beside the playing frame.

Certainly they must track the ball, but since the ball is the brightest object in the field of view that should not call for any computational gymnastics. It is my opinion that the best prospect for the tracking system is one which is essentially analogue rather then digital.

A conventional video camera gives half-frames at a rate of 50 per second. If the flight of the ball is measured by such a system, there may be only a dozen or so co-ordinate pairs from which to deduce the path and, moreover, there will be a bounce shortly before the ball must be hit. Position offers no problem but how would you determine an accurate velocity? Taking differences of successive frames may introduce too much noise, while if you try to average the post-bounce speed over several frames the ball will arrive before you have an answer.

A RAM-based camera may perhaps be driven at a higher frame rate. I suspect, however, that sensitivity will be a problem, since the sensitivity is proportional to the soak-time of the image. Lighting will be by means of tungsten spotlights — the self-focusing bulbs as used in trendy shop windows. Although a high brightness will be the aim, do not count on a light-meter reading of better than 10 — i.e., 1/60 second at f 5.6 with 100 ASA film.

Figure 1. Table illumination.



Servo-driven system

My choice is a servo-driven tracking system, in which the image of the ball is focused on to the centre of an array of phototransistors, perhaps as few as three by three. If the image deviates from the centre, the assembly is deflected to bring it back. Of course, conventional servomotor gearboxes will slow their response too much but a plastic lens and an array of OP500s are light enough to be driven almost directly from the motor shaft. An alternative is to murder a pair of loudspeakers and to use the voice coils as pistons to deflect the camera via a suitable arrangements of pivots.

Continued on page 24

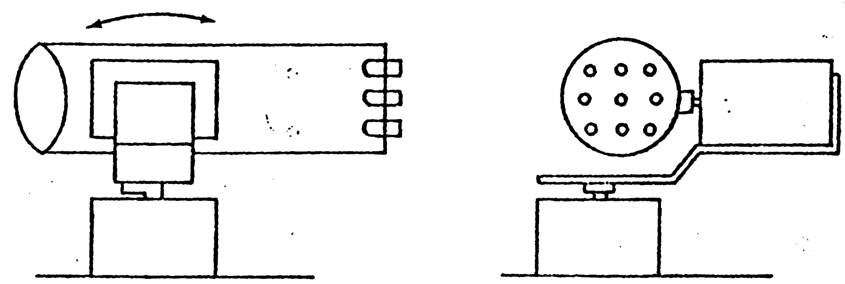
'The assumption so far is that the robots will have optical sensors and that they will operate in the ambient light provided with the table'

Continued from page 20

There is no reason why horizontal and vertical positions should not be tracked by two independent systems. A cylindrical lens can be used to focus the image of the ball into a line, so that a perpendicular line of photocells will pick off a position signal. With one such sensor to give height, and another horizontal sensor at each side of the playing frame, you have both position and stereo range information to pinpoint the ball position. Now there remains only the slight problem of getting the bat into the proper position to hit it.

The assumption so far is that the robots will have optical sensors and that they will operate in the ambient light provided with the table. Some contestants may, however, prefer to incorporate ultrasonic sensors into their robots. How can two such robots compete without dazzling — or deafening — each other? There clearly has to be some rule to ensure fair play. An ultrasonic robot therefore is allowed to transmit only when the ball is approaching it, ceasing the moment it has hit the ball. It must signal to its opponent when it is transmitting by means of a red LED beside the net; the opponent robot can observe that by means of an adjacent phototransistor and the judges can keep an eye on it, too.

Figure 2. Single-lens ball tracker.



Before going into visual sensors in more detail, let us look closer at the problem of lighting the table. The ball must be lit from both sides, so that is appears bright to each opponent, yet in lighting this side of the ball the opponent at the far end must not be dazzled. The lights therefore must be kept away from the line of sight by at least 30 degrees. It is proposed that columns of spotlights should be mounted at the corners of a four-metre square. To a sensor at one side of the playing frame the worst angle will be atan (1.75/3.0) = 30.25 degrees — just enough.

After locking on to the ball, the robots signal that they are ready by lighting a high-brightness LED beside the playing frame. To avoid boring delays a limit of 10 or 15 seconds should be put on this response. The ball is projected towards the server when both robots are ready, or at the end of a 15-second delay, whether the robots are ready or not. If an automatic trigger device is attached to the table serving device, a reasonable strategy for serving might be:

(both robots ready) or (server ready & 10 sec.) or (15 sec.)

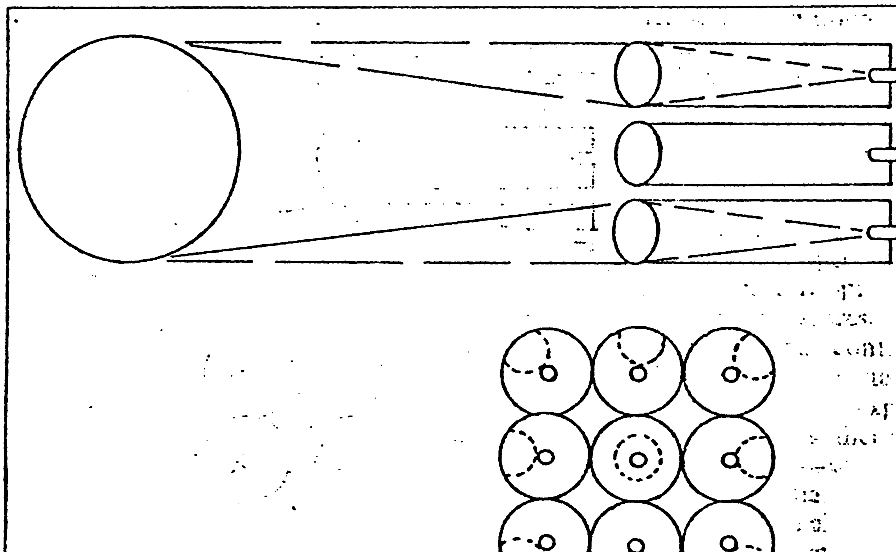


Figure 3. Multi-lens tracker.

The sensors must be mounted behind the baseline — looking through the playing frame or at the side or even above it. I suggest that to avoid systems getting out of hand, the sensors should be within one metre of the centre of the playing frame: if any contestants feel strongly about that, however, it is open to negotiation.

Now to expand to the optical tracker. A three-by-three array of photocells can detect any movement of the image from the centre, while the centre cell gives a confidence signal that the ball really is being tracked. The differences between the sums of left and right columns of cells can be amplified and fed directly to the horizontal servomotor as a velocity demand.

Built-in tacho

If the motor is voltage-driven by a low output impedance amplifier, the motor might provide sufficient damping to represent velocity feedback in the control loop. The alternatives are to use a motor with built-in tacho — expensive; to gang two motors together so that one acts as a tacho — slower, because of doubled inertia; or to derive a tacho feedback signal by connecting the motor drive within a bridge and using an operational amplifier to derive a speed signal from the 'back e.m.f.',

'To use nine photocells might be an expensive luxury. It might be possible to reduce the count to five'

as described in *DIY Robotics and Sensors*. Now the motor is driven to counteract the horizontal error by tracking the ball. In the same way, the difference of the sums of top and bottom sensors can drive the vertical servo to track the ball in height.

The image of the ball will grow in size as the ball approaches the lens. That could have an embarrassing effect on the servo performance. A possible remedy is to use one lens per photocell. The cells then look in parallel and if arranged round the circumference of a circle of the same diameter as the ball should produce a signal more or less independent of range.

To use nine photocells might be an expensive luxury. It might be possible to reduce the count to five. One is still placed at the centre, for confidence, with the others at top, bottom, left and right forming a cross. There is a worrying possibility that the ball could escape along a diagonal but limitations of focusing could make that unlikely.

Position pick-off

The servo systems must have position pick-offs to give an output to the bat driver. They can be used in a variety of ways to enable the computer to direct the sensor to lock on to the ball initially. The analogue signals can be switched into the loop, as feedback to balance an analogue position demand from the computer. Alternatively, the computer can read the position signals, applying drive signals in place of the photocell signals to correct the error between demanded and actual position.

A tracker has the advantage that the photocells can have a small field of view, thus limiting the amount of extraneous light which can get in to confuse the picture. Provided the ball is brighter than any other patch in view, there should be little noise on the signal. The scheme using cylindrical lenses, however, is likely to be much more fussy.

Vertical image

A cylindrical lens, perhaps just a test-tube full of water, will focus a point light source into a line parallel to the lens axis. If the axis is vertical, a photocell on the line will pick up a signal from the ball whatever its height, within reason. Unfortunately it will also receive a signal from every other light object in the same vertical plane as the ball.

Since the image of the ball is now spread vertically, it will be much fainter and the resulting contrast will be much weaker. Some improvement can be gained by using a strongly astigmatic convex lens, giving some additional vertical focusing, although still resulting in a line image.

Now the range must be broken into a number of sections, perhaps eight, and a separate photocell used for each section. Comparisons could be made of the analogue values of the signals received but it might be sufficient to input the eight signals as a single 8-bit byte, with the expectation that just one or two adjacent bits will be set. If the contrast problems can be overcome, the system is appealing in that it has no moving parts and gives immediate x and y information. Add another horizontal sensor system and the resulting stereo signal will give the range of the ball.

It is important to keep the sensors simple if possible, if only to increase their reliability. The present breed of micromice are pushing performance to its limits and are capable of remarkable results. Unfortunately they are also capable of becoming completely bewildered or even stopping altogether.

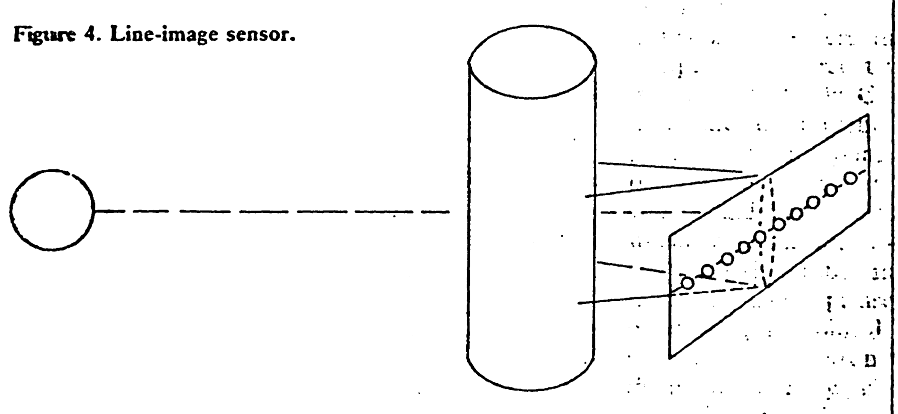
The British finals of the Euromouse Contest were held at the Computer Fair at London's Earls Court. Alan Dibley's T4 gained victory from David Woodfield's KnownAim only because its fastest untouched run was shorter. KnownAim had made a shorter run still but had needed a helping hand round an awkward corner. T5 was also unveiled at the fair but once again reliability let it down.

Preliminary skirmish

Do not feel that to be reliable your robot must be built like a tank. The ancient Thezeus, earliest of all Dibley's micromice, also competed. Built of plywood and old model aero servos, it plodded its way stolidly round the maze for a full 15 minutes, finding the centre once but lacking time to find a shorter route. It may not be bright but it is certainly reliable.

As soon as the dust has settled from the European finals in Copenhagen, where the winners will compete for a free trip to take part in the 1985 World Contest in Japan, it should be possible to arrange a preliminary ping-pong skirmish — I propose some time in November. If you would like to take part in a weekend workshop about then, preferably with a robot in a state where it can be tried, please let me know by writing to John Billingsley, Department of Electronic Engineering, Portsmouth Polytechnic, Anglesea Road, Portsmouth PO1 3DJ.

Figure 4. Line-image sensor.



As interest grows in the ping-pong contest, John Billingley considers some operating systems

Putting the bat on right track

ENQUIRIES are still arriving for details of the Robot Ping-Pong Contest but nobody has yet indicated that a robot is ready to play. Early next year, in January or February, a weekend meeting is to be organised where constructors can compare notes and try the muscles of their robots. Please write to me at Portsmouth Polytechnic Department of Electrical Engineering if you would like to attend and if you are a serious builder. I am looking forward to seeing ideas put into practice which go far beyond any suggestions I have made.

System design

So far, we have looked at simple mechanical arrangements and at a few possible vision systems. One or two mentions have been made of strategy, so what is left?

The most important factor is the design of the overall system. Should the controlling computer have direct control of the bat, calculating the desired position from an analysis of the vision signals? Should the vision unit instead be connected directly to the bat to give a reflex response, with the computer merely adding signals to influence strategy? Should the motors be steppers or DC or even pneumatic? The more variety among the robots the better but here are my opinions.

Horizontal bat movement should be the simplest problem to overcome. Unless the opponent can put vicious spin on the ball, the horizontal speed will not change greatly from one end of the table to the other. It is not too difficult to measure target position of the bat, but why bother? So long as the bat can be driven so that its horizontal position matches that of the ball at each instant, it will be in the correct position when the ball arrives. How can that be achieved?

Using the cylindrical lens system described in the previous edition, an eye-in-hand controller can be made. The image of the ball is focused into a vertical line and its position is detected by a horizontal array of photocells. If the eye is mounted on the bat, or at least is made to track left and right with the bat, what is measured is not the ball position but the error between ball and bat.

If the bat is to the left of the ball, drive it to the right, and vice versa. Some measure of proportional control can be built in by making the bat drive to the size of the error.

Oscillate

Although a stepper motor could be driven via the computer, it certainly looks as if an easier solution is to use a DC servomotor for horizontal position, taking and analogue signal straight from the eye. To damp the position control there must be a certain amount of velocity feedback. If the motor is driven from a voltage signal, as obtained from a loudspeaker amplifier, that velocity term enters almost by accident, since for a given drive voltage the DC motor will attempt to run at a corresponding speed.

Without such damping, the position control will tend to oscillate. If the bat is too far to the left, the error signal will accelerate it to the right the time the error is present, so that it crosses the target position at top speed. Only when it is to the right of target will the bat start to decelerate and will then pick up speed again, again and again.

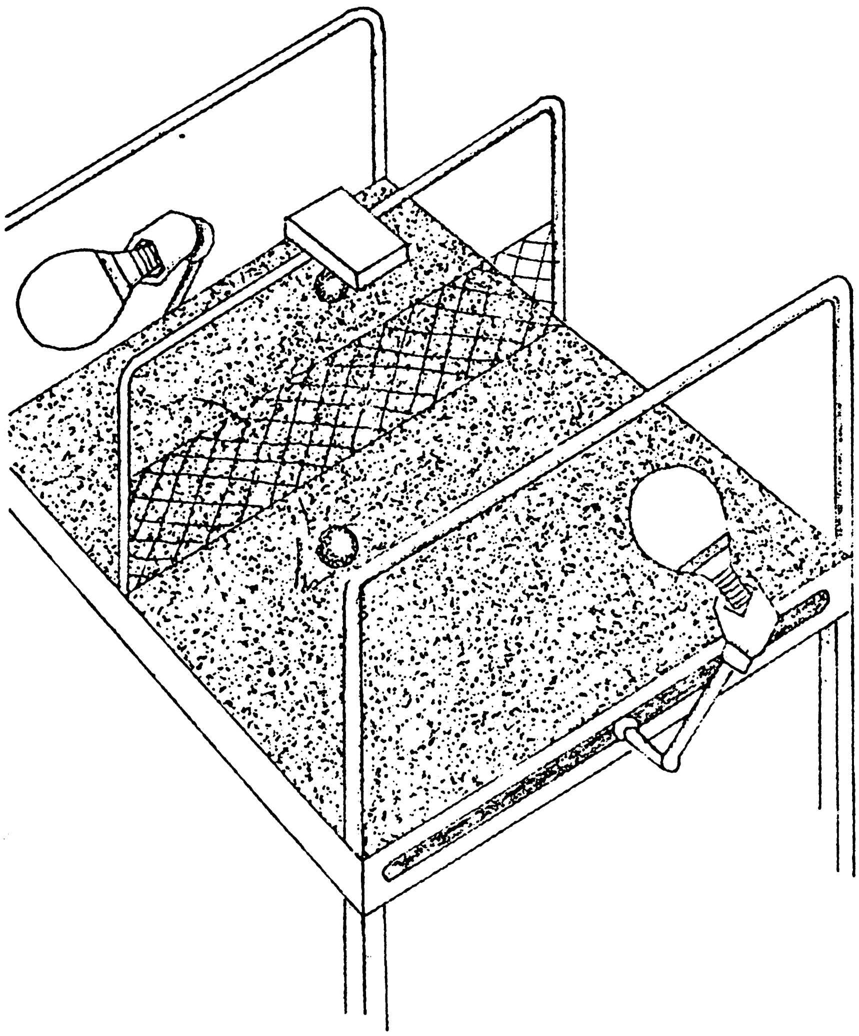
Saucer-shaped bat

With velocity damping, the motor accelerates only when a mixture of error and bat speed is negative. As the speed builds positively, the drive reduces. As the error reduces in size, so the sum of error plus speed becomes positive, resulting in a negative drive to reduce the speed. With a correctly-adjusted system the bat goes neatly to a halt at the required position.

The argument that the bat can be made to track the ball easily ignores the fact that the ball will probably be moving across the table at some speed. As the bat tracks to reduce the error, the ball continues moving to increase it. The result is an error in bat position proportional to the ball speed, in a ratio determined by the size of the velocity feedback term. It is not too difficult to reduce that error by some electronic filtering but need the error really be a bad thing?

Suppose the bat is slightly saucer-shaped, presenting the hollow face to the opponent; if the ball is moving to the right, the bat will be a little slow to follow. The ball therefore will hit the right-hand part of the saucer, which will angle the ball to the left. With some luck, rather more fiddling and a good deal of testing, the control system can return the ball automatically in the [illegible]

'The main difference is the probability that the two interacting servo systems will start to indulge in disco-dancing'



computer seems rather left out it can play its part by mixing an additional signal into the control loop to determine strategy — to return the ball to left, right or centre of the opponent's frame.

You may prefer to use the gun-:urret type of tracker, perhaps findng that the signal-to-background ensitivity is better. Many of the oregoing arguments still hold and if he tracker is mounted on the bat the ffect is almost identical. The main lifference is a result of the limitation .. response speed of the tracker seromotor and the probability that the wo interacting servo systems will tart to indulge in disco-dancing.

If a gun-turret tracker is fixed, ather than moving with the bat, its directly to the horizontal bat serve. Unfortunately the turret measures an angle rather than a true position; thus the signal corresponds to the ball position only as the ball reaches the bat.

Instead of moving steadily across the table the bat will be commanded to rush from the centre only as the ball draws close to it. Even so, the performance need not be bad and will almost certainly out-perform a system which relies on computer calculation between sensing the ball position and moving the bat.

Vertical movement cannot be dealt with so easily. Not only is the ball accelerating downwards most of the time but it has the annoying habit of bouncing and thus chang... its path is not limited by the top of the playing frame. It might not even stop at the top of the net frame, since an awkward lob can peak before the net, falling through the frame to bounce high again, clearing the end of the table as it falls through the far-end playing frame.

Serve successfully

Should the computer attempt to estimate the arrival height of the ball? Should the bat instead track the height of the ball continuously, using analogue feedback? The answer to both questions is probably that it should not. There is not much point in tracking the height of the ball until it has bounced; to propel the bat upwards with sufficient speed is difficult; to reverse its speed to follow a bounce is twice as awkward. Any prediction of arrival height is likely to be fairly unreliable until after the bounce, so once again there is little point in early movement.

What becomes clear is that it is important to detect the time of the bounce. This suggests that another sensor should be added, in the form of a simple microphone and amplifier. Many of the first generation ping-pong robots might be beaten by the simplest of gadgets. A bat is mounted centrally. At rest it is at table level. A motor runs continuously, acting as a power roll. When a pulse is received from the microphone amplifier, it operates a clutch solenoid so that a crank is driven through a single revolution.

That tak . the bat from table level to just below the top of the playing frame and down again. The initial vertical speed matches the vertical speed of the ball as it bounces after falling from the height of the serving device. The vertical deceleration is around three metres/sec./sec.

Such a gadget should at least be able to serve successfully, hitting the ball as it arrives from the serving device and propelling it towards the opponent. It the ball returns near the centre of the frame there is a good

> 'The best combination seems to be a mixture of analogue feedback from tracker to bat serve, with the computer switching the signals in and out'

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the bat surface is hard, intercepting the ball might be sufficient without the need for a positive striking action — although obviously if both robots play that game the ball will soon dribble to a halt.

With the addition of analogue horizontal position control a stonewall player could be constructed which would play a good defence. That type of player would soon become vulnerable to an opponent with a higher level of strategy.

The best combination again seems to be a mixture of analogue feedback from tracker to bat serve, with the computer switching the signals in and out and changing gains where necessary. The bat lurks near the table until the ball bounces, when a motor drive is applied to make the bat follow the parabolic movement of the ball. That is modified in response to the playing strategy.

The area where computing could really come into its own is triggering the striking mechanism. A stereo tracker could require considerable processing to give an accurate prediction. Perhaps a simple beam-breaker system across the front of the bat will be simpler but beware of splashing light towards the opponent.

Accurate timing

What kind of striker mechanism stands the best chance? The grand sweeping arm movement is tolerant of errors in starting time but these can result in the ball being hit too far out from the playing frame; if the ball is rising, a return could be impossible.

A triggered flick from the bat requires accurate timing but is much more controllable. A solenoid could certainly be used to move the bat but will add to the mass of the bat mechanism if mounted in the obvious place.

Whatever principle you use as the basis of your robot, keep it simple. The more grandiose the scheme, the more likely you are to find an unexpected snag. Do not add fancy extra sensors unless they are essential and do not base your software on multitasking with 50 levels of interrupt. Look for legal loopholes in the contest rules and ask yourself whether a brilliantly-designed dumb robot might not perform better than one bristling with intelligence and software bugs.

I was greatly impressed by the neat solution to the Build-a-Robot competition which retrieved the target cube in record time without a shred of software. Of course, every attempt has been made to arrange the Ping-Pong rules so that intelligent strategies will win in the long run but there is no guarantee.

John Billingsley considers some of the difficulties in devising a robot which can play an adequate game of ping pong

Flight time affects the strategy

IN THE INTRODUCTORY article on Robot Ping-Pong I described the ways the rules had been amended to make the contest possible. Let us look more closely at the flight times of the ball and the effect of some fairly legal strategies. A final-year student at Portsmouth Polytechnic simulated some of the moves as a mini-project last year and disappeared with his ideas, leaving a promise that he would prepare an article, complete with photographs. I hope he will be spurred into action. For now, let us be content with some calculations.

For lobs and slams, if the ball just clears the 0.25 metre net, it will fall to the table in a time given by

$$\frac{1}{2} \times g \times t\uparrow 2 = 0.25$$

i.e.,

$$t = 0.225 \text{ seconds.}$$

The journey across the net from table level to table level must therefore take at least 0.45 seconds. If the ball flies high, just below the central frame, that time is increased by a factor of $\sqrt{3}$ to 0.78 seconds. If the ball bounces short, the time is increased still more. Remember, however, that the ball must leave the playing frame after a single bounce and so true drop shots are outlawed.

Figure 1.

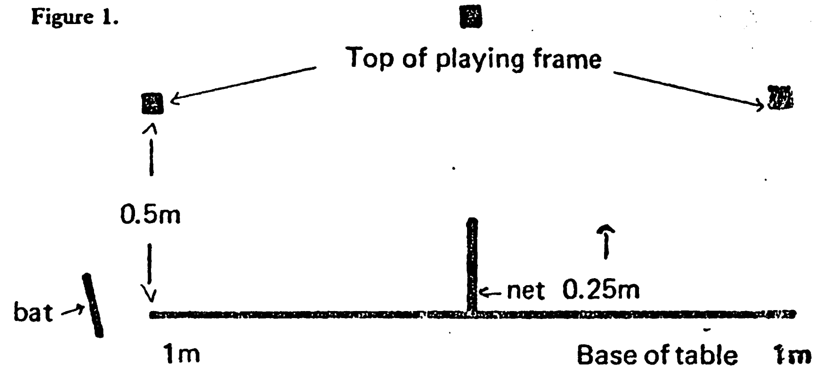


Figure 2.

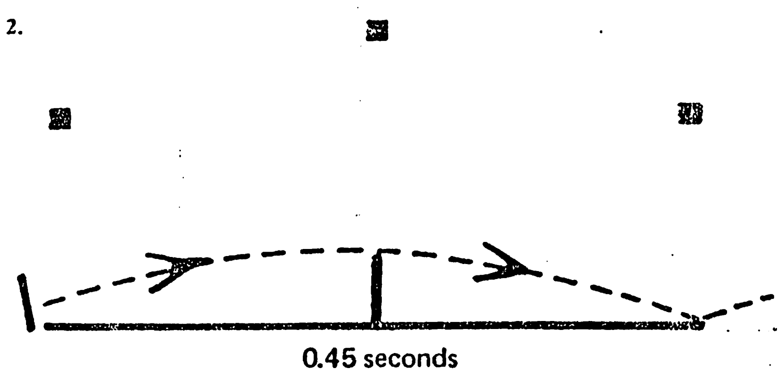
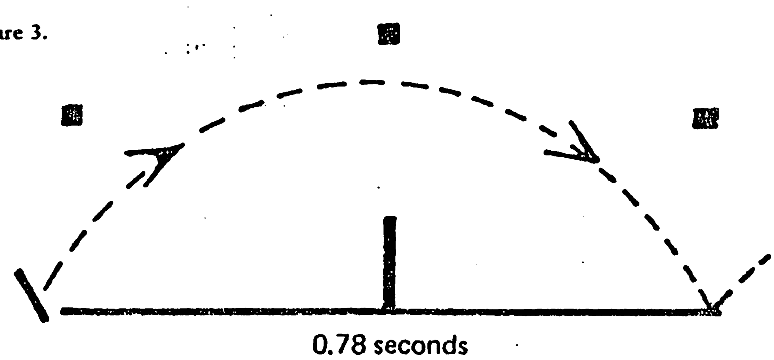


Figure 3.



Faster return

Figures one, two and three assume that the ball arrives to the opponent low in the playing frame. The higher in the frame, the faster he can return the ball, and a slam at high speed is possible if the ball is at the top of the frame. On the other hand, it is easy to show that the faster the attempted return, the smaller is the margin for error. Just as in the full-size game, some shots can be gentle and safe as in the examples in figure five, while a tricky return contains its own risks to the deliverer.

If the ball arrives at the middle of the playing frame, a net-skimmer can be returned in as little as 0.3 seconds as in figure four; putting the ball up has its dangers. On the other hand, if you never send a high ball, your opponent need not lift his bat above table level. That suggests that the bat should be dropped to table level

'The bat is carried on a horizontal arm, along which it traces under the power of a DC servomotor'

Figure 6.

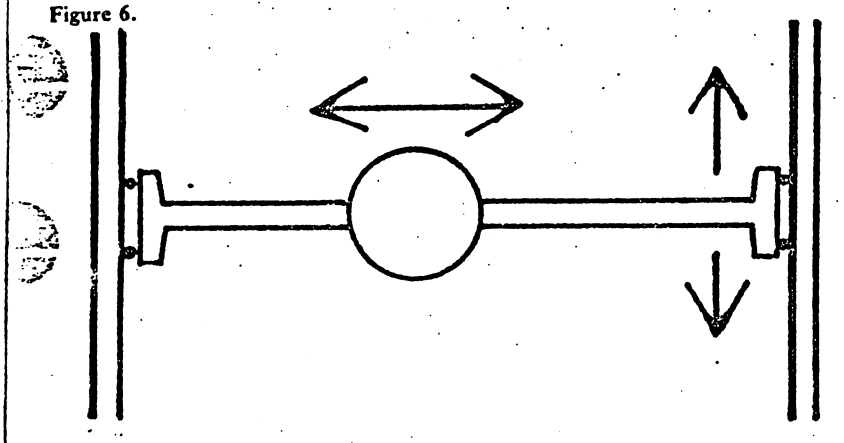


Figure 7.

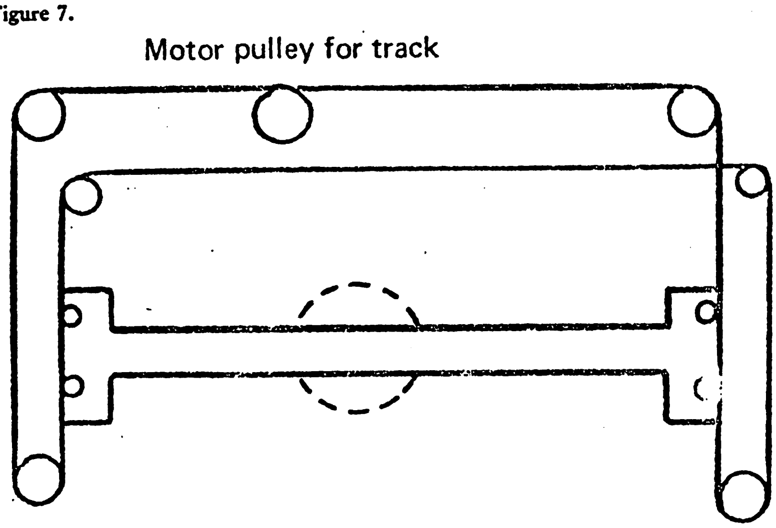
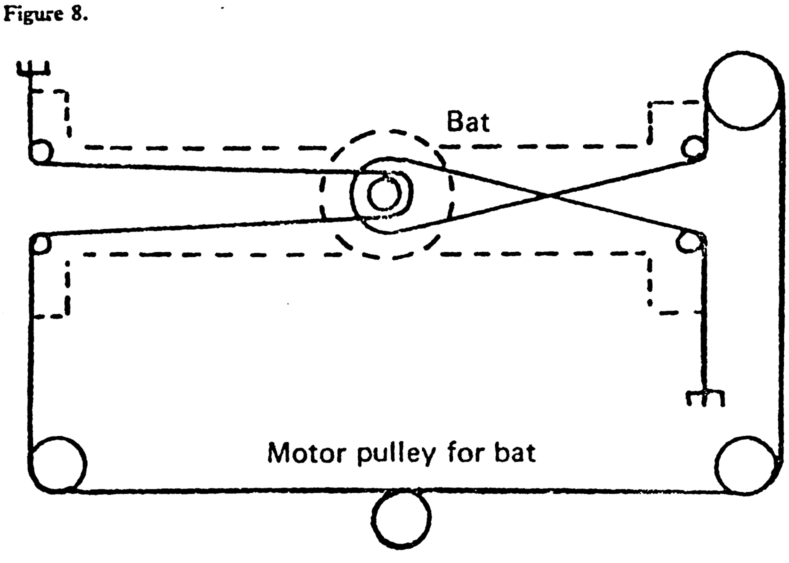


Figure 8.



between shots and need be lifted only after the ball has been seen, or heard, to bounce, since the higher the bounce the more time you have to respond.

Horizontal correction should, of course, be made as soon as you have sufficient data. Since spin is unlikely to be imparted to the ball in the first few contests, you can assume that the horizontal speed across the width of the table is constant. A simple tracking follower will probably give the best results for the least effort. Assuming a 0.3-second minimum to cross the half-metre frame, 1.5 metres per second should be ample; the figure could be halved by centring the bat after a stroke while the ball is moving towards your opponent.

X-Y plotter

What kind of servo mechanism can achieve the necessary speeds to reach the ball in time? The system which first springs to mind will look very much like an X-Y plotter. The bat is carried on a horizontal arm, along which it tracks under the power of a DC servomotor. There is obvious benefit to be gained by keeping the structure as light as possible and so the motive power might be applied via a clever stringing arrangement.

The horizontal arm is raised between two vertical tracks and string could again be useful. I spent a long train journey trying to devise a

Continued on page 26

Figure 4.

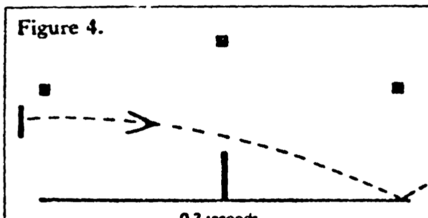
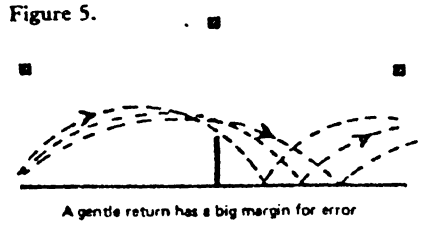


Figure 5.



A gentle return has a big margin for error

‘Pneumatics or even hydraulics are not ruled out although there might neeed to be a limit on power and pressure levels’

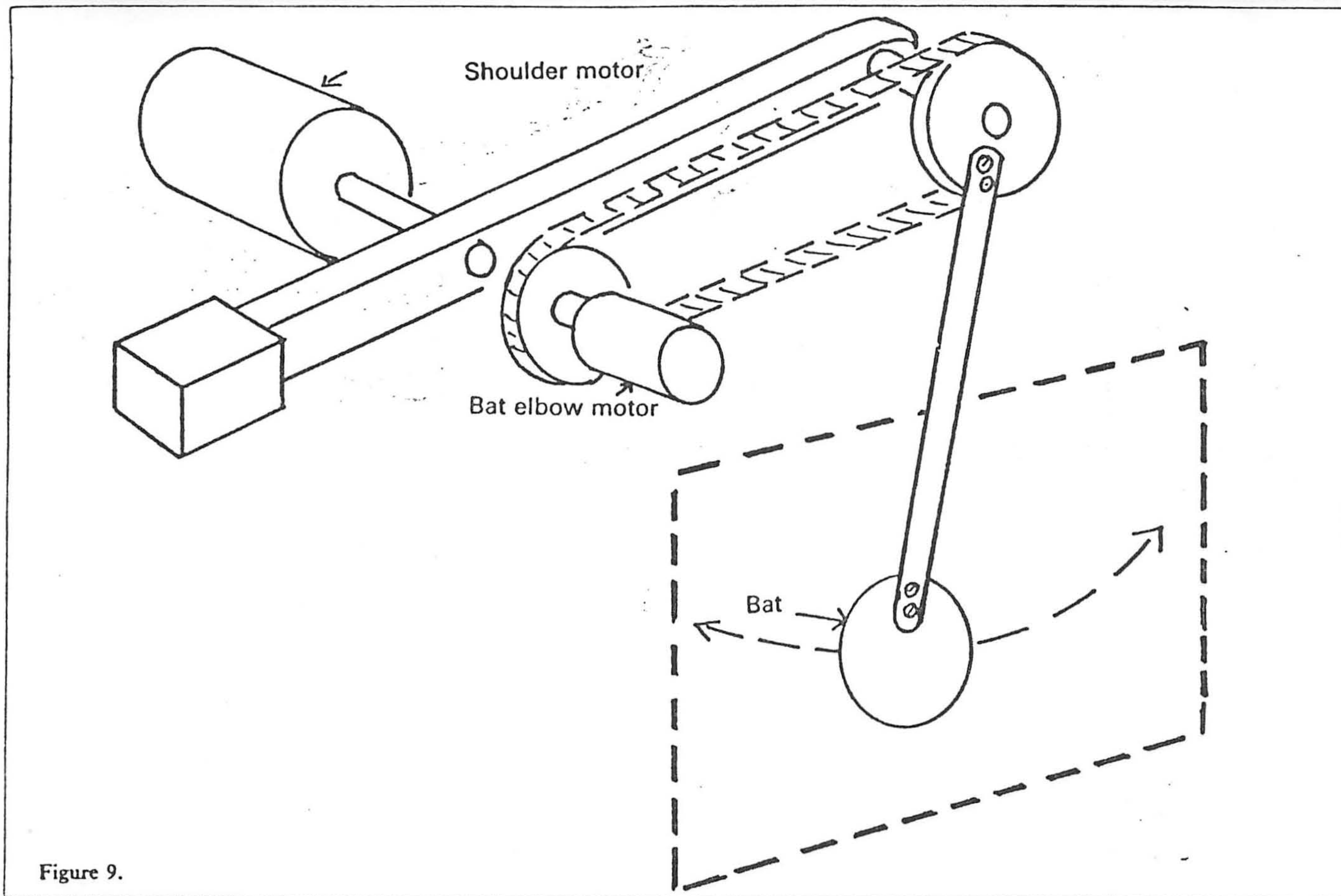


Figure 9.

Continued from page 25

stringing arrangement which did not involve differential gears to decouple the two movements — the results in figures six, seven and eight are not altogether satisfying.

There is an easier method and that is to revert to a robot arm of sorts. The upper arm then extends roughly horizontally from the shoulder, being tilted up or down to raise or lower the bat. The forearm hangs down from the elbow and is pivoted to move from side to side. Provided each arm section is one metre or so long, the horizontal and vertical movements should be reasonably decoupled. With suitable gearing and counterweights the efficiency should pose no difficulty. For now I am avoiding the question of how to strike with the bat.

You will notice in figure nine that I suggested the use of DC servomotors. I feel that stepper motors are not adequate for the job, if not a dead duck. A guesstimate of the mass of bat and striker is around 0.5kg. At one metre per second its kinetic energy is a mere quarter of a joule; to accelerate rapidly enough, however, could require a motor with a good 10 watts of mechanical output. Pneumatics or even hydraulics are not ruled out, although there might need to be a limit imposed on power and pressure levels for safety reasons.

Simple loops

I do not want to deal with control problems at this stage, apart from observing that time is at a premium. If commands have to be derived entirely via the computer, the cost of even a short computing loop can be excessive. If, however, there can be a large measure of direct connection between sensors and actuators, then much of the time-critical reflex behaviour can be achieved with relatively simple analogue feedback loops. The computer can then switch gains or add extra signals to impose some strategy but it is no longer a direct part of the response chain.

This column is designed to inspire rather than to instruct. Nothing would destroy the contest faster than a batch of carbon-copy clones of the designs suggested now and in future issues. The louder the cries of “I can do better than that” the more hope there is of an exciting contest, provided you can put your robot where your mouth is.

I would appreciate receiving details of your progress and if there are bright ideas which you do not want made public I will treat them as confidential. As soon as construction is under way it will be possible to plan some preliminary meetings for builders to compare notes and perhaps try a skirmish or two.

If the mechanisms are completed ahead of sensor development, the addition of a joystick could allow you to test servo performance with a game or two of ‘telechiric ping-pong’.

Following the success of the Micromouse contest, the search is now on for the best ping-pong player. John Billingsley reports

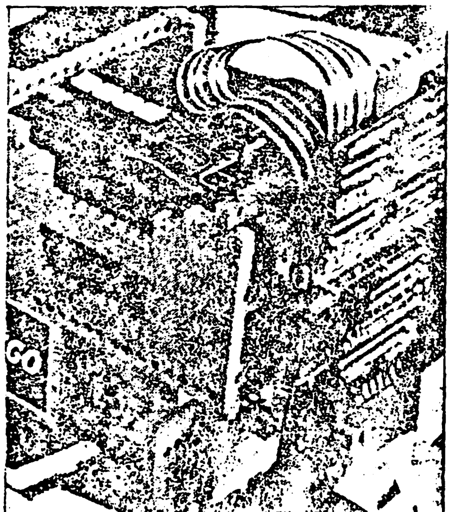
Machineroe joins new title fight

WHEN the Micromouse contest was introduced at the 1980 Euromicro Conference in London, the great problem appeared to be the need to solve the maze to find the shortest path to the centre. The contestants found rapidly that a more urgent task was to design a mouse which could run in a straight line. When any robot system is required to react to its surroundings, control theory raises its ugly head. Finding itself too far to the left, the mouse turns to the right and all too soon runs into the right-hand wall.

Early mice, with only one or two exceptions, spent their time rattling to and fro and getting nowhere. There is nothing like a contest for nailing down the theory and, at this year's British final at the Computer Fair, Earls Court, you will see mice gliding slickly to the centre with amazing precision. All the same, the novice prize will doubtless be won by a mouse with the staggers.

Solving the maze is now one of the easier tasks; Nick Smith's 19 0 algorithm is fundamental and is close to the mathematical optimum. The difficult part is designing a mouse which can negotiate corners at speed, navigate without getting lost, make the best sprint up a straight and, above all, perform reliably.

Finnish micromouse



Transformed into race

From being a conundrum, the contest has been transformed into a race and the mice still have a long way to develop. On the one hand there are the powerful giants bristling with sonars and infra-red sensors, using sheer muscle power to wind their bulk up to one-and-a-half metres per second on the straight. On the other hand there are the midgets, buzzing relentlessly about the maze without a break in speed. The European Championship is at present held by one of the giants but a midget was fastest in practice. Who knows what will happen this year at Euromicro in Copenhagen?

Mice, of course, are a very special kind of robot. They are at the forefront of robotics in their use of sensors and in the combination of learning with analytical strategies, but they have little mechanical relationship to the one-armed bandits which are used in industry.

What contest could offer the same kind of challenge to an industrial-style robot? From a microrobotics meeting there was the first idea of a ping-pong match. It would certainly be entertaining and challenging but could it be possible? More to the point, after the rules had been bent sufficiently to make the contest possible, would it still bear any resemblance to ping-pong?

The first need was to restrict the playing area. A full-blown Puma may well be able to reach across a full-size table but its movements in swiping at the ball would scarcely be conducive to health and safety at play. Instead, the playing area is reduced to a half-metre square frame at each end of the table. The ball must emerge from the frame after bouncing only once, to be attacked by a bat no more then 12.5cm. in diameter. The task calls for a robot no bigger than an Armdroid I, though it must have a much better turn of speed.

With a length of two metres, the table will seem rather narrow. Even so, the tracking task will be difficult enough. So that no robot can resort to a brute-force slam, the net is made a quarter-metre high. Obviously a slam is possible only if the ball is returned to the very top of the playing frame; the faster the return, the greater precision is needed to avoid hitting the net or missing the end of the table.

Service is a problem

An unscrupulous robot could try skying the ball out of reach of the opponent's sensors. To prevent this, another half-metre frame is mounted on top of the net. To get a skier through both net frame and playing frame will require sufficient accuracy and skill that the manoeuvre deserves to remain legal.

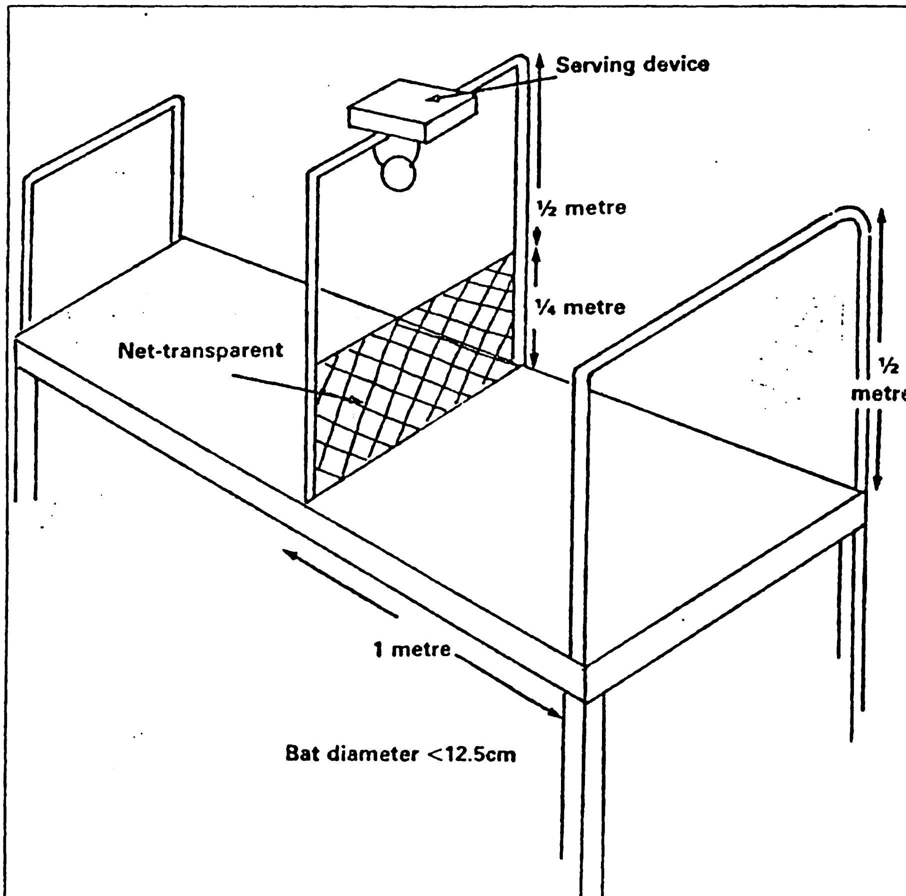
The next obvious problem is the service. The solution is to give the problem to the table. By mounting a fairly simple mechanism above the net, the ball can be served automatically towards one of the players, which can react to the ball as though it had come from the opponent.

The mechanism is based on a wire

'As soon as heats take place many other problems will appear and sharp practices which appear novel may need to be outlawed'

framework, effectively transparent and allowing both robots to lock their vision on to the ball before it is served. When both robots announce that they are ready, the service proceeds. Then the vision task is one of tracking alone—if a robot fails to keep its eye on the ball it must take the consequences.

To simplify the vision problem, the parts of each robot seen by the opponent must appear black, although the back can be made flamboyant for audience appeal. Lighting is provided with the table, so that there can be no question of one robot dazzling the other with special lighting. Lights will be tungsten filament with plenty of infra-red—and four such lights will be mounted to shine at angles of 60 degrees to the centre-line of the table.



Pat-a-cake return

One likely problem in early games will be for the robots to settle into a steady pat-a-cake return. If they can make a rally past 10 returns, they can go on all night. To break the monotony, a rule is needed to award the point to the defender if it can return the ball 20 times. It is then worth the attacker's while to take a chance or two and introduce some variety. Of course, as soon as heats take place many other problems will appear and sharp practices, which appear novel at first, may need to be outlawed in the future if they undermine the contest's sportsmanship.

The drawing of the table is taken from my recent book *DIY Robotics and Sensors,* published by Sunshine Books Ltd.

Let us leave the problems of vision and strategy until later and concentrate on the sheer mechanics of the game. The robot must be able to move the bat to cover the playing frame. At a pinch that can be done with a travel of only 40cm. in each axis. The striking action need not require agile wrist action — a simple solenoid can flick the bat forward to hit the ball.

Again, the bat does not have to be held by a handle but could be a disc supported at its centre if desired. The surface of the bat does not even have to be flat; a curve can be used to employ accurate tracking and following to get the same effect as angling the bat and you will need the best of luck.

Now let us see how much time the robot has in which to position the bat. If the ball is returned fast, it must strike the table near the end and emerge close to the bottom of the playing frame. The bat might therefore lurk at the bottom of its travel to intercept a great number of returns. To emerge higher, the ball must rise after the bounce.

Advance warning

Barring two devious and risky manoeuvres, the maximum vertical velocity will correspond to a fall from the top of the net frame, a distance of three-quarters of a metre. At a little less than four metres per second, that is not exactly slow.

The robot will have advance warning by watching the ball as it rises. The higher the ball, the faster the robot can return it and so there is a balance of strategy between a safe, low return, which the opponent will find easy to intercept, and a lob which might invite a slam.

A low, swift return may take as little as one-third of a second to cross the table. In that time the horizontal bat movement must get its act together. It sounds difficult but is well within the capabilities of a reasonable servo system.

The mechanism need not be based on a robot arm of the conventional type. The IBM robot RS1 uses rectangular tracks and runners rather like an X-Y plotter. For ping-pong, only two dimensions are needed to cover the playing frame and an X-Y plotter mechanism could prove ideal.

A light bat mechanism would be carried from side to side on a horizontal slideway, requiring a minimum of force to accelerate it. To track the ball up and down, the

Continued on page 16

'Speed of overall response is vital to success and the best solution may be to combine both analogues and digital control techniques'

Continued from page 15

slideway would move vertically on a pair of vertical rails. The better the tracking strategy, the more warning the motor mechanism will have of the target position and the less power will be needed. Even if the bat is driven to keep position with the ball as it travels, however, the motors need not be massive. Could the slideway perhaps be arranged to bounce off vertical stops as the ball bounces off the table?

The whole exercise of positioning the bat will be in vain if the robot cannot predict the position of the ball. The task of recognising and locking on to a ball would be a tough one but such an effort is not necessary. Before the service both robots can find the ball in an expected position above the net and can lock a simple tracking system on to it.

An array of five or so photocells can detect any movement of the ball from the centre of view. An analogue tracker might well be based on the use of loudspeaker coils and, if necessary, could use mirrors to reduce the moving mass. More exotic methods based on television cameras are probably doomed from the start. Not only is there a delay between frames but the analysis time will be exorbitant.

Bat hitting action

Speed of overall response is vital to success and the best solution may be to combine both analogue and digital control techniques. Signals from the optical tracker can be fed straight into the bat servos, modified by strategic commands from the computer. The computer can then concentrate on planning the game and can leave the task of hitting the ball to the reflexes of the system.

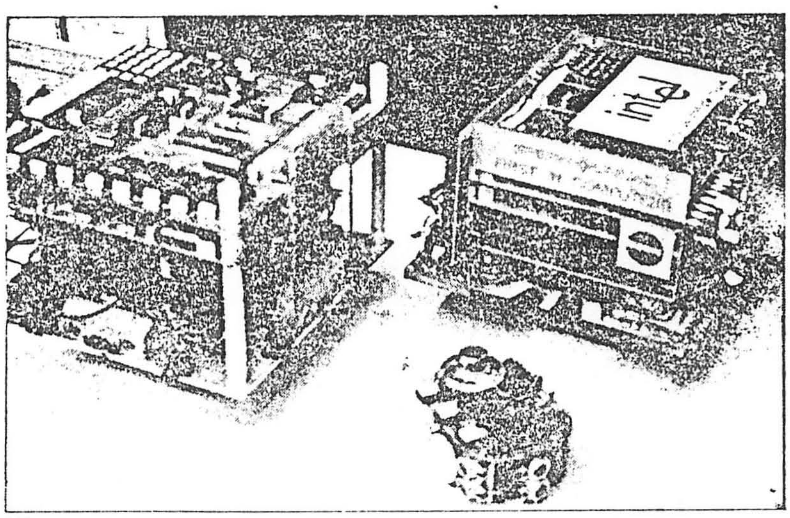
An important task which must not be forgotten is the firing of the bat hitting action. Whether it is spring-loaded by a motor during the flight of the ball, or whether it is a servo-driven forehand return, the movement must be timed precisely to coincide with the arrival of the ball at the bat.

One solution is to indulge in stereo vision; another is to use a high-speed proximity sensor. The X-Y method could shine a broad beam across the width of the horizontal slideway, a few centimetres in front of the bat, being careful not to spill light towards the opponent. As the beam is broken, the bat spring is released. If the beam is not broken, the ball has missed the bat, or vice versa.

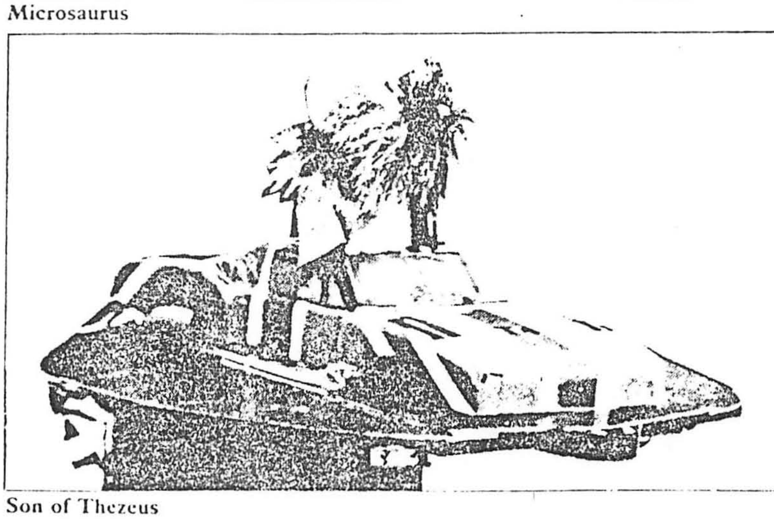
Already several dozen potential contestants have written to show interest. If all goes well, the first serious contest will be held at the 1985 Computer Fair. There will be several friendly skirmishes beforehand, however, when the rough edges are knocked off both robots and rules. Everything depends on you, the builders of the robot players, and by keeping in touch it is possible to fix some of the variables, such as optimum lighting level.

At present, it is assumed that a three-quarter metre square will provide sufficient standing space for the robot but you might decide more is needed to prevent your robot performing back somersaults.

If you are serious about entering the contest, please write to me at Portsmouth Polytechnic, Department of Electrical and Electronic Engineering, Anglesea Road, Portsmouth PO1 3DJ. All interesting points will re-appear later in this column, together with answers to any answerable questions. You should make an early claim to register the name of your robot; already Cy Borg and Machineroe have been christened.



Microsaurus


Son of Thezeus

DIY about the mouse

The Micromouse competition takes place at the Earls Court Computer Fair on June 14-17. Champion Alan Dibley tells how he built his race-winning microprocessor-controlled machines and invites challengers for future events.

THE MICROMOUSE competition has come of age, and now the problem facing most competitors is not how to reach the target, but how to get there faster. However, for some reason there are not enough newcomers to the sport to give the old hands the sort of competition they need, and produce novelty in design to ensure that Britain gets its rightful first place in the European championships every year.

The mice I have built, the Thezeus family, have all been based on Sinclair micros and wooden chassis. They use parts salvaged from models, bits of junk, and items that have been saved because they might be used for something, some day. Mechanisms are constructed from piano wire, brass tube, solder and epoxy. The best material to use for tyres is beige rubber bands. A mouse can be built for less than £50, and if an unwanted ZX-81 is used, with an effective cost of zero, it could be much less.

The first mouse I built, venerable Thezeus himself, uses a ZX-80 because that was what I had. Experiments with some TTL chips produced the simplest possible interface — see figure 2.

Thezeus uses microswitches to sense the walls and to measure wheel revolutions. The switches are wired directly across the keyboard connections, so need no port or interface circuit. They are read by a short piece of Z-80 code modified from the ZX-80 ROM keyboard routine. All of the maze-solving logic is written in Basic, and is fast enough for the slow mechanism it controls. Sinclair ZX-80 Basic is very fast because it only uses two-byte integer arithmetic. You do not need floating-point arithmetic to solve a 16 by 16 maze.

The standard 4K RAM pack has an extended cable to allow it to lay down on top of the processor for the sake of appearance. It seemed necessary to keep down the centre of gravity, but the mouse is too slow to topple over in action. The keyboard was cut off with a hacksaw — which hurt because a ZX-80 was still state-of-the-art at the time — and reconnected by a plug and socket. This keeps the processor dimensions within the overall 25cm. limit demanded by the rules.

All motive power and control motions on Thezeus are produced by model radio-control servos. This is a simple way to produce controlled motion from a micro. A servo needs a standard TTL positive pulse of between about 1ms. and 2ms. duration, repeated every 20ms. or so. Feeding the servo with short pulses makes it position itself towards one end of its travel, and feeding it long pulses makes it settle at the other end, the final position being proportional to pulse length. If you stop feeding pulses the servo stays where it is. The servos are not fussy about the repetition frequency of feeding pulses and between 30 and 80 per second will work. I check by trial and error.

No overlap

The interface shown in figure 2 allows the port to be addressed by making bit 15 active in an Out command. To prevent overlap with other functions, I use address 80FF hex. A better port could be built using a PIO, but the one I use is adequate. The same interface is still used to control the infrared emitter systems, and the drive-motor switching on the latest mouse.

To make a servo revolve continuously — to be used as a drive motor for instance — you disconnect the internal feedback potentiometer and substitute an external fixed one so that the servo cannot balance its internal position-comparison logic. This produces a servo that goes one way when fed with short pulses, the opposite way when fed with long pulses, and stops when fed with none. However, some servos only have partial output gears, since their intended use for model control only needs about 120° output motion, or they have built-in stops at about 80° from centre, which must be cut away. Second-hand servos can be bought for about a fiver from your friendly local model shop. The high-speed specials for top-notch mice cost about £25.

The method I chose for turning Thezeus seems quaint now, but at the time appeared to be the only logical method to use. He puts a foot down on the floor, lifts himself up about 3mm. and turns around the central pivot which carries the foot. I refer to Thezeus as "he" because in my experience most of the successful mice have been chaps.

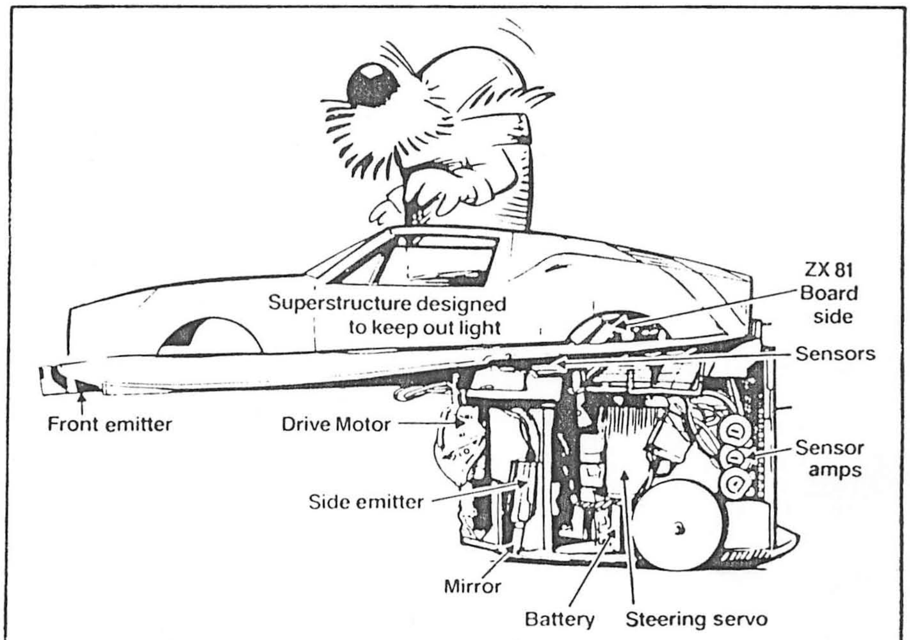


Figure 1. T4's overhang at the front detects a far wall when a square is entered.

Son of Thezeus was faster than his predecessor on the straights and used a different method to turn. He also used 500mAh nickel-cadmium cells rather than Thezeus's 1.2Ah cells, and had an infrared emitter/sensor for tracking wheel motion. But he did use similar mechanical steering and microswitch wall sensors. Mechanical sensors must be retracted during a turn, and result in complication and wasted time, so later versions use infrared sensors, which are also faster to act and do not bounce. The microswitch used to keep track of wheel revolutions on Thezeus would not be reliable at any higher speed.

T3 was my first second-generation mouse, and works quite differently. The single front wheel is driven by a motor and gearbox mounted on a vertical pivot. It is steered by a radio-control servo working through a pair of connecting links similar to steam-locomotive con-rods — but a bit smaller. The mouse has two rear wheels which are free running. The tricycle arrangement allows the mouse to turn about his own centre at corners and dead ends.

Accurate turning

During straight running, steering is controlled by a hardware system, which consists of a multi-vibrator producing the sqaure waves needed by the steering servo. The mark timing of the multi-vibrator can be adjusted by four infrared-sensitive diodes. If the mouse wanders too close to a wall, one of the two infrared detectors above the wall is obscured from its emitter, which is mounted low down by the back wheel and adjusts the steering servo pulse length. The system only prevents the mouse approaching too close to a wall, not from wandering away from a wall, so needs very accurate turning control. There is a trade-off between accurate 90° turning and instant correction for straight-steering errors.

A separate infrared system is used by the software to detect the presence or absence of walls. It is a simple on/off system used to update the wheel-count tables, at the disappearance of a wall to right or left, and as input to the maze-solver routine. By now the software had become mostly machine code, with a few Basic instructions for setup of maze maps and other storage.

The processor is a ZX-81, built from a kit to allow a few changes like fitting a 6116 2K storage chip and connecting all the bits not needed by the mouse via a plug and socket. The mouse carries only the printed-circuit board and chips. The keyboard, TV modulator, power regulator, and ear/mike/power sockets are in the case mounted on a dummy circuit board, with a 10in. cable to connect to the mouse during loading and starting. A 16K ZX-81 with a printer is used to write the code, using the incredibly fast ZX-AS assembler from Bug-Byte. It is a simple program, but sufficient for the 700 bytes of code needed by the mouse.

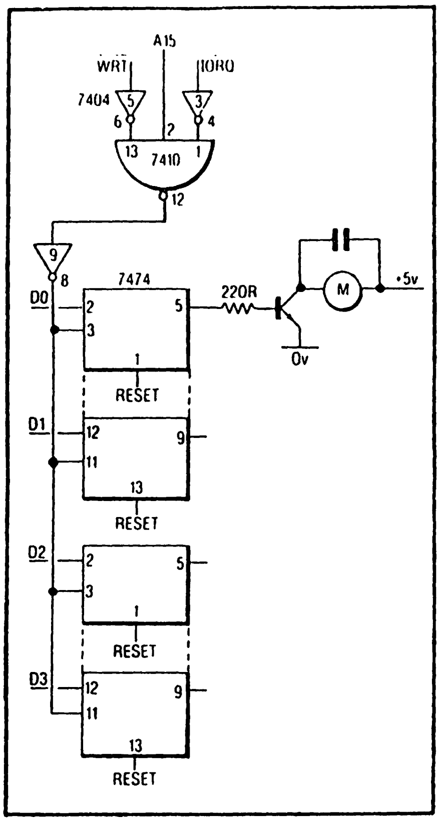


Figure 2. Thezeus's interface.

To turn, the mouse stops at the centre of the square. Then the software takes control of the servo, turns the front wheel 90° left or right, turns the motor on for the correct count of wheel pulses, straightens the steering, switches back to hardware steering control, and restarts the motor. The turning servo actions and delays for braking take too long. So the next stage of development had to be a mouse that did not stop at corners.

T4 was the first non-stop Micromouse. He stops at dead ends, but that does not affect his final shortest run time, since he has learnt to avoid them by then. The chassis of T4 is similar to that of T3 but has much more overhang at the front, to allow detection of the far wall when a square is entered. All functions are controlled by machine code, which fits in about 900 bytes plus 512 bytes for two maze maps. There are still a few lines of Basic to make it easier to set up the mouse ready to run, and I am too lazy to code it into assembler.

By bringing the steering under software control it is easier to make it smart enough to follow one wall, an obvious but significant improvement. The same simple interface is used, and the four functions controlled are motor on/off, steering servo, and two drivers for the pulsed infrared emitters.

The emitters must be pulsed to overcome outside sources of infrared. The sun is the worst source of interference, but although the sun rarely shines in exhibition halls where Micromouse contests are held, there does always seem to be a bank of a dozen 1kW incandescent lamps immediately above the maze.

Some more info on the various bits of T4 may give you some ideas to encourage you to take up the challenge and turn up at a competition to threaten T5. I deliberately have not mentioned him yet, and I will not mention him again since by the time you read this article he may be finished.

Figure 1 shows T4, which uses a drive motor from an old radio-controlled servo, epoxied to a gearbox cut down from a surplus timer mechanism. All three wheels were turned on a model lathe from a piece of plywood to get the exact size required. The rubber band tyres are held on with cyano-acrylate. The light chassis is made as accurately as possible from thin plywood, balsa and card. Such a method of construction has advantages in cutting, sanding, sawing, sticking, drilling, painting and pinning. Also you do not feel too bad if it becomes clear that you should throw it away and start again.

Fast steering

A ZX-81 processor with 4K of RAM sits on top. The output-port chips and transistors are stuck to the board with double-sided adhesive tape. The power comes from four 500mAh nickel-cadmium cells with no regulator. The steering servo is the fastest I could find and is used by the electric-car racing fraternity. It cost nearly as much as the ZX-81 kit but was worth it.

The wheel revolution sensor disc is made from a washer stuck to the side of the front wheel, carrying alternate sectors of reflective adhesive tape and matt black paint. Two very small diodes watch the segments go past, and are strobed every 10ms. by software. The receiver diode is connected directly across a keyboard contact.

The specification of the software to drive a mouse is surprisingly complex. First it must collect information from sensors, which may be an active task involving control of infrared emitters and strobing a dozen or more receivers. Most of this information must be stored for later use by the maze-solving routine and the route-decision function. Also in most mice, software controls the steering. Further, it should be capable of some error recovery to cope with transient mechanical problems, since competition mazes have bumps in different places to those you get used to at home. Finally, it must keep track of where the mouse is in the maze, and which way he is facing. Some builders use hardware assistance for some of these functions, depending on their individual skills.

But it is not necessary to write everything at one attempt. Try a step at a time, write a bit of code to turn a motor on and off, or steer with a servo.

For rules of the Micromouse competition and entry information write to John Billingsley, Department of Electrical and Electronic Engineering, Portsmouth Polytechnic, Anglesea Road, Portsmouth PO1 3DJ. Entry is free.

WHEN THE CAT'S AWAY...

John Billingsley reviews the development of advanced robot learning techniques by non-professionals – The Micromouse and Robot Ping-pong contests.

Robotics has been glamorised as a subject, often far beyond the achievements of the devices on the market. In industry, the old cam-driven pick-and-place machines now face competition from computer-driven manipulators; these take their commands from a digital recording, but they seldom exhibit any sort of 'intelligence'.

The larger robots on the personal market are worth noting more for their stylish plastic mouldings than for their agility; some are the result of development budgets of many millions of dollars. Harnessing vision systems to such tasks as robot welding has cost much in money and top University effort, and industry still finds it hard to apply robotics to any but the most routine of tasks.

In one field, progress has been rapid and dramatic; that is the development of Micromice to compete in the Euromouse competition. The contest was first launched in 1979, on the heels of the IEEE Spectrum competition. At the first national final a mouse succeeded in solving the maze – and one or two other mice were only prevented by mechanical glitches from reaching the goal. Adaptation, learning, strategy and analytic problem solving are all

Micromice proving their abilities on a typical test course.

embodied in the ten-inch-square mobile robots, and new advances are seen each year.

A new contest, Robot Ping-Pong now seeks to put an even greater emphasis on speed and agility. It is already starting to bring more hidden talents out into the open.

MICROMOUSE TECHNOLOGY

When the tasks of the mouse are broken down, the list appears daunting. They can be summarised as propulsion, wheel configuration and steering, power source, local guidance, track sensors, wall sensors, map building, maze solving, error detection and goal detection. Some mice also have timers, so that as their time expires they can modify their strategy towards high-speed, high-risk performance. They may also increase their speed in familiar territory, accelerating along a known straight.

A variety of ingenious designs have come forward for the transport mechanism. The most obvious is the "wheelchair", wheels on either side of the vehicle being driven together to run straight, or at different speeds to turn a corner. Although mechanically simple, these present thorny control problems. Recent champions have adopted the "dodgem" approach, with a steered front wheel. This may also be the drive wheel, or a pair of motors may deliver torque to the rear wheels to give the effect of a differential. It is instructive to look at the less conventional devices.

In the first London Euromicro contest in 1980 a mouse, "Lami", appeared from Switzerland. It had four wheels, each parallel to one edge of the square body. The 'tyre' of each wheel was made up of many miniature wheels, mounted crossways. They allowed the large wheel to slip sideways without resistance. Now to go forward the two side wheels were driven together, while the wheels fore and aft remained fixed. To go left or right, the fore and aft wheels rotated while the side wheels merely slipped sideways. The mouse could be driven in a circle without rotating its body, or could spin on the spot. Lami was defeated by an uneven join in the maze, since all four wheels must keep contact with the ground. Last year, however, a very similar mechanism won prizes at a robotics conference – but by having three wheels on a triangle instead of four on a square the new robot overcame the terrain problems.

Another square mouse, "Thumper", was designed to rotate no more than needed for steering corrections. Its four corner wheels could be swivelled through rather more than ninety degrees, to run forwards or sideways. A long O-ring belt carried torque to each wheel, dropping vertically through a section which could be twisted; in fact the belt became the tyre. The first of the "Thezeus" family of mice chose a more radical, if slower, solution to the problem of turning. A circular plate was driven down onto the ground, lifting the wheels of the mouse clear. The mouse then pivoted about the shaft of the pedestal, gracefully descended and set off in the new direction. Particularly elegant was the way that the mechanical sensors were retracted during the turn, to avoid fouling.

One early mouse was made by shortening the wheelbase of a model car. Although it made little progress, it was a master of the three-point-turn.

SENSORS

Sensors are essential to the Micromouse's performance, whereas many of the industrial robots perform their tasks "blind". Some of the simplest sensors are the most effective, but their development is far from trivial. Simplest of all is the contact sensor, in the form of a microswitch or simple contact pair. The touch must be heavy enough to be reliable, but light enough not to impede the mouse. The hysteresis of a microswitch can be enough to destabilise a guidance control loop. Alternatively a mechanical 'whisker' can activate a potentiometer, to give a continuous displacement signal to the controlling microcomputer.

Non-contacting sensors have so far always been optical or ultrasonic. Here again there is room for great variation. Ultrasonics have had limited success for short-range detection and guidance, but have been dramatically effective for mapping distant walls. One Finnish mouse could place walls in its map along a complete cross-section of the maze, while several use an ultrasonic 'look-ahead' to warn of the need to brake.

Most infrared sensors now use modulated illumination – although each year there are sad stories of mice being dazzled by room and television lighting. Most robust is the beam-breaker, where an emitter near the wheels is viewed by a receptor mounted below an overhanging 'sunshade' skirt. The line of sight is now broken by a side-wall, and detection is certain. Others bounce light from the tops of the walls, relying on a good black surface on the maze floor. These signals are on-off in nature, and several such sensors may be needed to give good, stable guidance. One German mouse, however, bounces light from the walls on either side, comparing the intensities of the returned signals to gauge the displacement of the mouse from the middle of the passageway.

The simplicity of these sensors contrasts with the full-frame vision systems being pursued for industrial robots. It is true that such a system could reduce the exploration time, if the mouse could acquire a rapid bird's-eye view of the maze. On the other hand, it would not increase the speed once the shortest path is known. Provided the mouse is sufficiently agile to explore the maze within the time allowed, simple sensors are just as effective. Could it be true that many industrial systems could profit as greatly from purpose-directed vision systems as from full images which require complex analysis?

GUIDANCE

In the case of a tricycle, feedback from the lateral displacement measurement can be applied directly to the steering

Last year's award winner receiving his prize of a visit to Japan.

wheel. The displacement must be measured forward of the main axle, and then it is seen that a damping term is inherent in the geometry of the system; the control is stable. Some simple contact-based sensors do not in themselves give a proportional error signal, merely an on-off level. Two or three more switches, however, can give sufficient information for acceptable control if set at different levels.

A wheelchair configuration is much more difficult to guide if driven by conventional DC motors. The control must include terms relating to the angle of the mouse as well as its rate of turn. If stepper motors are used, or if feedback pulses are detected from each wheel, then the angle can be deduced from a difference in counts.

In general, guidance is the weak point of many mice. It is important to the mapping function that orientation is not lost, but in some mice the guidance correction can leave the mouse rotated through ninety degrees, without the fact being recorded in its navigation.

MAZE SOLVING

A map is held of the walls of the maze, and in general this is initially clear of walls. They are entered into the map as they are found; in one particularly clever design, they are entered at two levels of confidence when found for the first and second time. This mouse even has a recognition algorithm, so that if placed at random in the maze it will identify the local geography and deduce its location.

There are many ways of using the map data to deduce the routes to the centre, but the simplest have their foundation in Dynamic Programming. Imagine a wave, propagating from the centre of the maze in a numerical simulation. The cells of the maze are initially set to the value zero, except for the central squares which are set to one. On each pass through the computation the wave propagates by marking each reachable (i.e. not cut off by a wall) neighbour of a 1-cell. These marked cells are then also set to value 1. Now if the cell corresponding to the position of the mouse is marked, but not yet 1, then it has a 1-neighbour which is pointing the best way to go – the wave is about to reach the mouse, so head for the wave.

This method requires a complete solution of the maze for each square moved. Another method sets up more information for immediate use; this is the method used by Nick Smith. Again start by numbering the cells with zero, but now clamp the centre target at zero throughout the computation. Each cell in turn is set to a value just one greater than its lowest accessible neighbour. If the computation starts in the top left corner, then soon every cell will have the value 1 except the four centre cells. On the next pass, each cell will rise to value 2 except the centre four and the eight cells bounding the centre – these will remain clamped at 1 because of their zero-neighbours. The process continues until the maze is numbered as an inverted pyramid, with value 14 in the start square. Remember that at the start, no walls are known. As walls are inserted, the links are broken, so that the values reflect the distance of each square from the target. From each square, the mouse is directed to the lowest-valued neighbour. If a shorter route could exist through terra incognita, then the mouse will be led there, otherwise that part of the maze will be ignored. The method is thus efficient in mapping effort.

ADDITIONAL STRATEGY

A little cunning can give the edge to a good mouse. An early Finnish mouse explored cautiously until it had found the shortest route. It then ran over the route repeatedly, each time driving its motors at greater speed, until it finally went out of control. In this way, a good time was assured before the increasing risks were taken. Some of the faster mice will take a little longer to turn a corner than to run a straight path. One or two therefore solve for the fastest route, which is not necessarily the shortest.

It is optional for the mouse to be lifted back to the start, or to find its own way. Some mice exploit the return journey for efficient exploration. "Thumper" is equipped with a voice, with which it announces key items of strategy amongst a lot of banter. In particular it indicates when it has found the shortest route, and when it is at the centre.

ROBAT

The new ping-pong contest is already bringing out a great variety of technology. Vision systems range from simple photocell arrays to a Baird-like spinning scanner – in triplicate. One particular robat (no misspelling!) has an arm of plastic drainpiping – excellently light and rigid – and is powered by springs. These are rewound between strokes, when the arm is 'cocked'. At the last moment the arm is released to fly upwards, being halted in the required position by magnetic clutches. For a machine with such a Heath-Robinson appearance, its performance is remarkably repeatable.

CONCLUSION

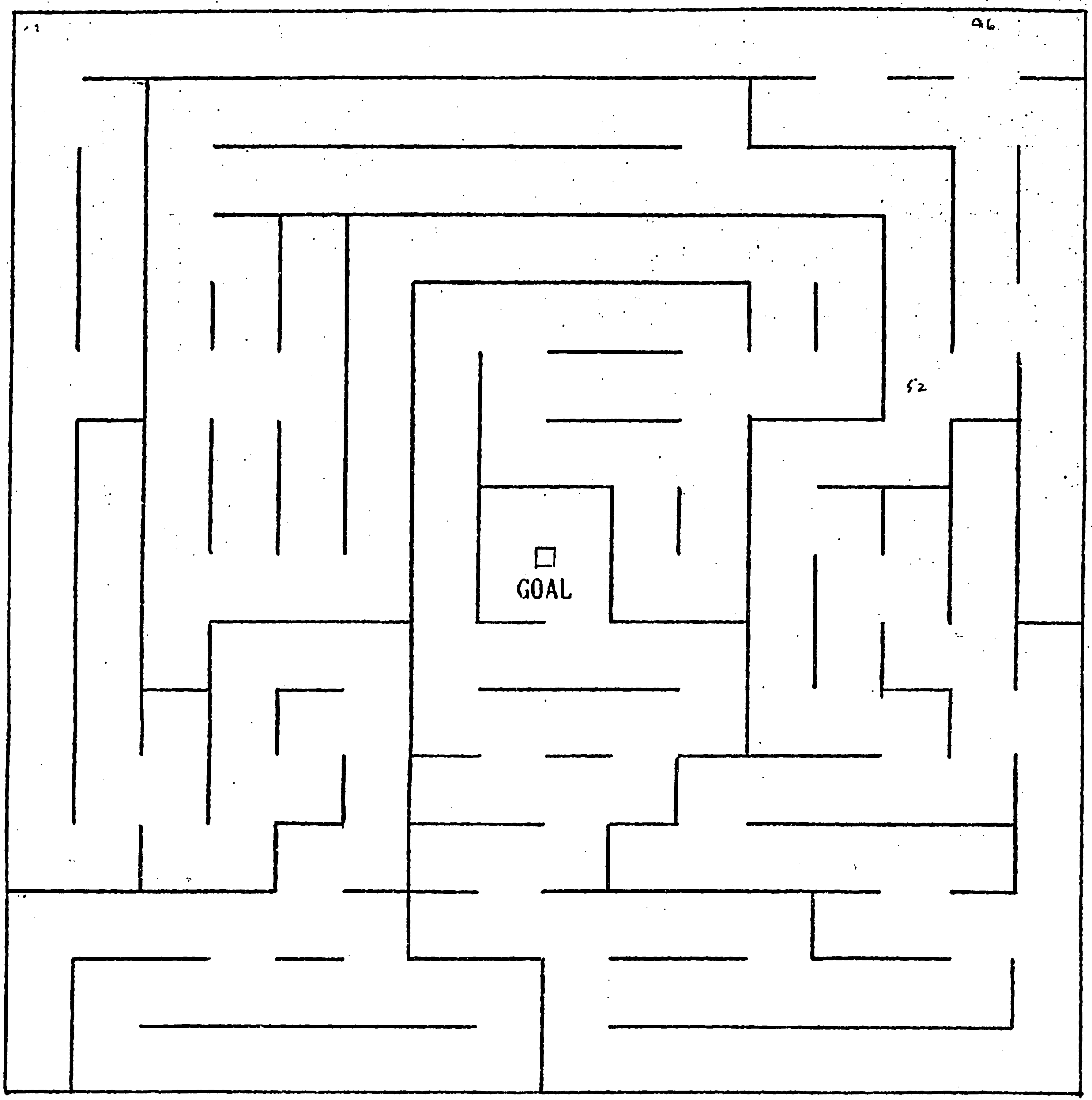
In many respects, the mouse builders have incorporated advanced techniques of sensing and learning which are at the very forefront of research – or even beyond it. Although engineering skill is essential, formal qualifications are irrelevant as such. Builders of mice and robats have come forward with an amazing diversity of backgrounds, from a diplomat to a milkman. Their efforts have a double edge. On the one hand, they are sometimes 'discovered', and given the opportunity to harness their talents to engineering design; on the other, they certainly put the

「'85マイクロマウス世界大会」

World Micromouse Contest

決　勝

1985．8．25（日）



START

代表的短路８５歩４２折，８７歩４０折
８９歩３８折，101歩３０折

エントリーNo.＿＿＿＿＿＿＿＿　　記録＿＿＿＿分＿＿＿＿秒＿＿＿＿

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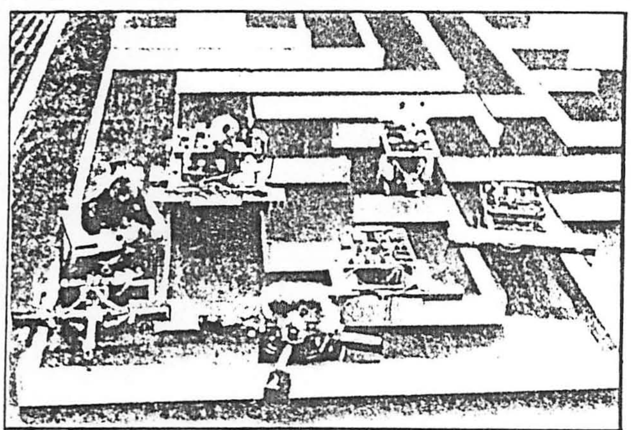
CHIP CHAT

On the ball: W H Smith must be a rather boring place to work. An issue of its staff newspaper describes the Atari 130XE (yes that's right, the old 800 in yet another new box) as 'one of the most exciting new products to be launched this year'.
Legalised piracy?: if a levy on blank tapes is approved in order to compensate loss of royalties through piracy, does this mean it will then be okay to copy?
Horror stories: tales of the treatment handed out to floppy disks tend to be apocryphal, but Xitan swears that the following is true. Underneath the warning 'Floppy disks — do not bend', one friendly neighbourhood postman penned 'Oh yes they do!' before proving it. Or there's the one about the user who cut his 5¼in disks down to 3½in before complaining that they didn't work. Also worth a mention is a call we received from an engineer. Sent to sort out some disk drive problems, he soon found the cause of the trouble — a mouse lurking inside the drive.
Armchair critic: bored with things to do with your micro? One enterprising BBC owner uses the machine to publicise a career as a film critic. Video films rented from Video Palace in London's West End sometimes carry a page of text from a Beeb at the very end of the tape, reviewing the film that's been loaned. So far we've agreed with all the reviews, except for the one for Dune.
The camera never lies: June's photo showing two of our contributors in less than complimentary poses brought some interesting suggestions for captions but a lot of them are unprintable. For an aggressive-looking Guy Kewney clutching an Amstrad under his arm, RL Savage of Littleover suggested: 'Who said this handbag doesn't go with my jumper?' and wins £10. David Tebbutt was pictured gleefully holding various dismembered pieces of yet another Amstrad — a second £10 goes to A Neville of Newlyn for: 'Once you've taken these parts out, you have quite a useful box.' An honorary mention goes to William Poel of Amsoft for his, scurrilous but very amusing suggestions. How about sending us a photo of yourself, Bill, so that we can exact our revenge?
Mac attack: one dealer tells a story of removing the Apple logo from the Macintosh and substituting IBM's in order to win over corporate buyers. Don't these people know the saying that you'll never win promotion by buying IBM? Another Apple story currently doing the rounds concerns a magazine which suggested a shortage of Mac software. Apple had the bright idea of sending a very slow telex back listing every package that runs on the Mac. Just in case you're reading this, Apple, we agree the software exists — so leave our telex machine alone! END



This summer's robot ping-pong competition attracted an intriguing array of entries, energetically being given their finishing touches the day before the finals.

Mike Geaney, Matthew Hampson and Eddie Forrester brought a lethal-looking contraption quickly christened the Guillotine. Within a square vertical dexion frame, stout cord drove a crossbar carrying the bat at a very respectable speed. The ball location system was rather optimistically based on a set of sonar transducers, but much needed to be done to close the position control loop.

The Bognor team of Julian Griffin, Aaron Ridout and Simon Butler had relay problems. The most obvious new feature on their pantograph-driven APPE was a square cage around the transparent bat. At great risk to his fingers, Aaron demonstrated the crisp response of the bat when the curtain of infra-red beams was broken. Even with the aid of elastic supports, however, the two motors at the base of the rhomboid mechanism seemed rather ineffectual. Behind the bat, an impressive lens assembly promised the use of an advanced vision system.

The Kung-Fu mechanism by John Knight and David Lowery had been masked in black to comply with the rules. The controlling computers, a Dragon and an Acorn Atom, were now mounted in a black pulpit topped by the vision system. In this, three rings of cylindrical lenses whirled to scan the scene in stereo, showing on the screen an accomplished ability to track the ball. The bat position was controlled by electromagnetic brakes which halt the bat in a spring-driven lunge, to be dragged by motors and cords back to the starting position in time for the next stroke.

John Marr's Zillian was a more dainty device altogether. Slender rods resembling an anglepoise lamp held a transparent bat. Behind the bat, a 45° mirror reflected the field of view to a lens system mounted on and parallel with the forearm.

The morning of the finals passed in a bustle of activity. APPE's new relay was fitted, only to fail as its contacts fused together. The old relay underwent surgery and hopes were raised. Guillotine seemed to be eroding as parts were stripped off for modification, and Kung-Fu was festooned with software listings. Despite frantic efforts, it became clear that the judges would have to make their decision based on design and potential, rather than actual table tennis playing prowess.

The judges were John Collins, Chairman of the British Robotic Association, Michael Shortland, Chairman of the Computing and Control Division of the Institution of Electrical Engineers, and Peter Pugh, representing the Institution of Mechanical Engineers, which offered a prize of £100 towards travel to complete at Euromicro in Brussels. First prize was £500 to enable the winner to travel to San Francisco to compete at IPRC — the second International Personal Robotics Congress.

First to the table were Kung-Fu and Zillian. The inability of the robots to play a full game led to the devising of a complicated scoring scheme for this first contest — one point for a touch to the ball served by the table, five for clearing the net frame and 10 for achieving a playable service, with return strokes marked up by a factor of five. 10 balls were served to each end, in groups of five, and Zillian showed its supremacy by detecting and reacting to any ball which came close enough. APPE then played Guillotine, although the table serving mechanism really played the prominent part. Although happy to snap at fingers, APPE refused to acknowledge the ball. Guillotine could be made to leap about by judicious dabs at its wiring, but was far from automatic control.

John Marr, a general practitioner from Middlesbrough, is now looking forward to a trip to San Francisco, while John Knight and David Lowery are preparing for Brussels. Each contestant won a Copy of Robots *from Salamander Books, together with a copy of* DIY Robotics, *published by Sunshine Publications and written by John Billingsley (to whom ChipChat's thanks go for this report).*

Although the standard of play was rather short of Wimbledon, the robots all have great potential. Vision systems and actuators are coming together and great strides will be made before the autumn contests. Micromouse (pictured here in its latest incarnation) got off to an equally faltering start in 1980, and robot ping-pong was proposed because the maze-solving task was beginning to seem too easy. Robot ping-pong hasn't quite reached that stage yet!

Top mouse

John Billingsley reports on the European finals of the Micromouse contest.

THE LURE of five free trips to Japan brought 14 micromice to Copenhagen for the 1984 European finals — 15 if you include Mappy. Of these, 11 reached the centre in practice. The task of eliminating mice to set the final running order was easy.

Four teams arrived from Britain, intent on winning the championship back from the Finnish holders. Two teams came from Germany, and the Finns were out in force with three mice.

Alan Dibley brought T4, T5 and a Thezeus with revamped software. He also brought Bill Urmenyi's Gonzales, now cured of its sentry-box dithering. Dave Woodfield brought Thumper and Knownaim, plus a new mouse which was christened Enterprise during the time trials. Fullyautomatix was accompanied by David Jones and his team from Bangor-on-Dee.

From Germany came Ralf Hinkel's Speedy Gonzales and a team from Darmstadt with a mouse simply named Maus. Hannu-Matti Jarvinen's team brought Manu, Telly and Microsaurus, the Finnish champion mice for the past two years.

Gonzales and Thezeus started off with times around six minutes, while Fullyautomatix at last lived up to its name with a three-minute score. Speedy Gonzales had some sensor trouble, but put up 2½ minutes all the same. Ralf Hinkel has designed a cunning guidance system which balances the reflections from the walls to place his tower-shaped mouse in the centre of passageway. Unfortunately it was developed with matt-white walls, on which the method works perfectly; the Euromouse maze had a gloss-painted walls which made Speedy shy away.

The gigantic Microsaurus with 1¼ minutes was slightly faster than T4 and Knownaim, while Manu and Telly were just behind T5, around the one minute mark. Leading by 12 seconds was the new Woodfield mouse, which was being introduced to a maze for the very first time. Enterprise is a steered tricycle, earning its name from the two stalk-mounted sensors which give it an outline resembling a certain starship.

After the maze had been reconfigured with some shorter paths and some dead-end tangles, Maus made a brief appearance. It performed very well for a beginner but retired after a few minutes. Fullyautomatix objected to the lighting: fortunately it is not expressly stated in the rules that the team may not follow the mouse around, shading it with an umbrella. The audience loved it, but Fullyautomatix was not so keen. Speedy Gonzales ran next, appearing to do very well until it came to a halt one square from the centre. With scrambled navigation it made off for home again. Surely Knownaim could show the audience how a mouse should behave? Apparently not, as time after time it slewed into a corner.

Now T4 found the centre in 1 min. 27s. and after a repair to a motor lead reduced the time to 1 min. 6s. From then on, mice marched to the centre in procession. Microsaurus reduced the leading time to 1 min. 3s., then Tellu whittled it down to 57s. Its twin, Manu shaved 16 more seconds off to leave the awesome target of 41s.

T5 blundered on an awkward corner and failed to find the shortest path. But Enterprise glided off almost soundlessly, taking up the challenge with a first run of just 47s. Tension mounted during the second and third runs, but on the fourth Enterprise dispelled all doubts by arriving in just 30s. Its lap of honour cut 2.5 more seconds off this incredible time — for a 70-square shortest path — with bursts of up to 3 metres per second.

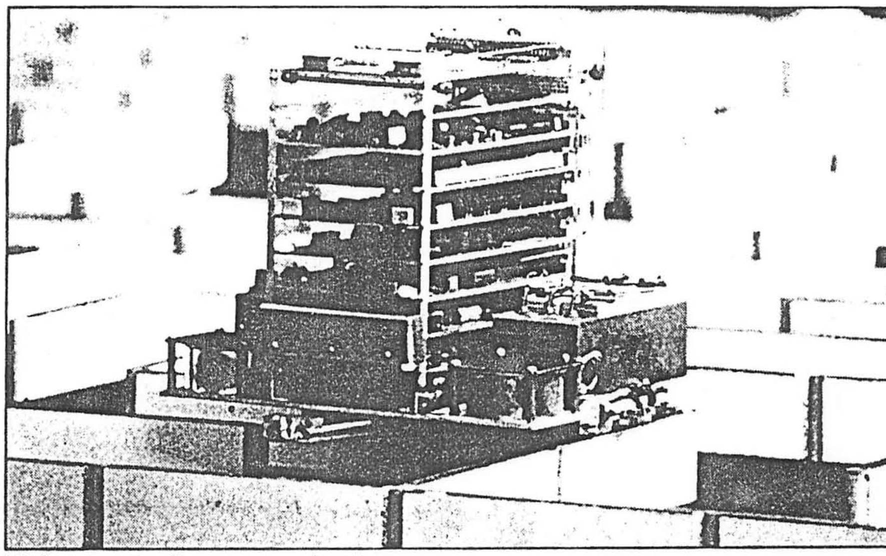
Plans are already being laid for next year's British championships. For novices, the maze will be rearranged to form a single twisting passageway. New mice can concentrate on sensors and guidance, getting the mechanics right before turning to maze-solving. The experts will be tuning up their mice ready for Japan, while many mice might go on to compete at the Euromicro conference in Brussels at the beginning of September.

Alongside the maze, the first ping-pong playing robots should be putting in an appearance. Already several robot builders have written to say that their machines are under way, and it should be possible to have a preparatory skirmish in January.

For details of Euromouse and Robot Ping Pong, write to John Billingsley, Department of Electrical Engineering, Portsmouth Polytechnic, Anglesea Road, Portsmouth PO1 3DJ.

mice battle in Europe

No mouse claimed an easy victory at the Euromouse final in Finland recently. John Billingsley witnessed the fight for first place.



Minitaurus, the Tampere number 2 mouse.

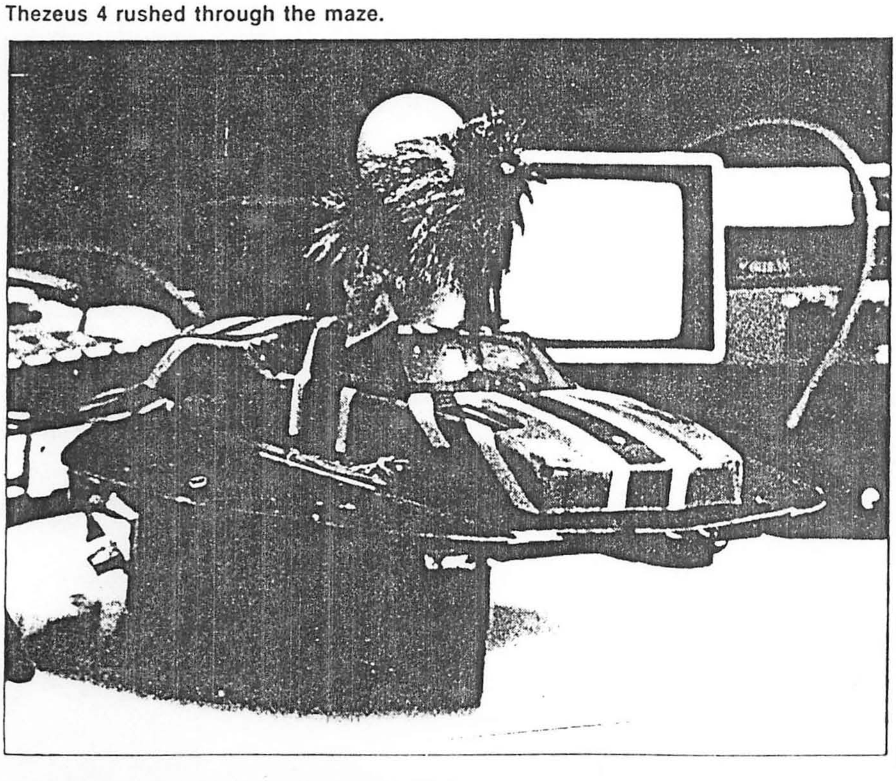
Five times in succession Thumper tried to climb out of the maze at precisely the same spot.

All traces of unconcern had disappeared when Dibley ran Thezeus 4. Supercharged to the limit, it snapped around corners with no break in speed but five times rushed headlong into trouble. At last it made a clean run of 45 seconds to the great alarm of the Finns.

Microsaurus is a 5kg. dinosaur of a mouse which took three years to build with 20 infrared sensors, four sonars and nearly a 100 semiconductors including 52 integrated circuits. Three hundred Finns held their breath as it set off, gasped when it needed a restart, and cheered deafeningly when its second run reached the centre in 47 seconds — still not fast enough. But Microsaurus has a cunning strategy: having found the shortest path it repeats the run with ever increasing speed until it uses its full 1.5 metres per second. On its first such run it needed help and the tension mounted; on seeing a clean run of 40 seconds second time round the audience erupted.

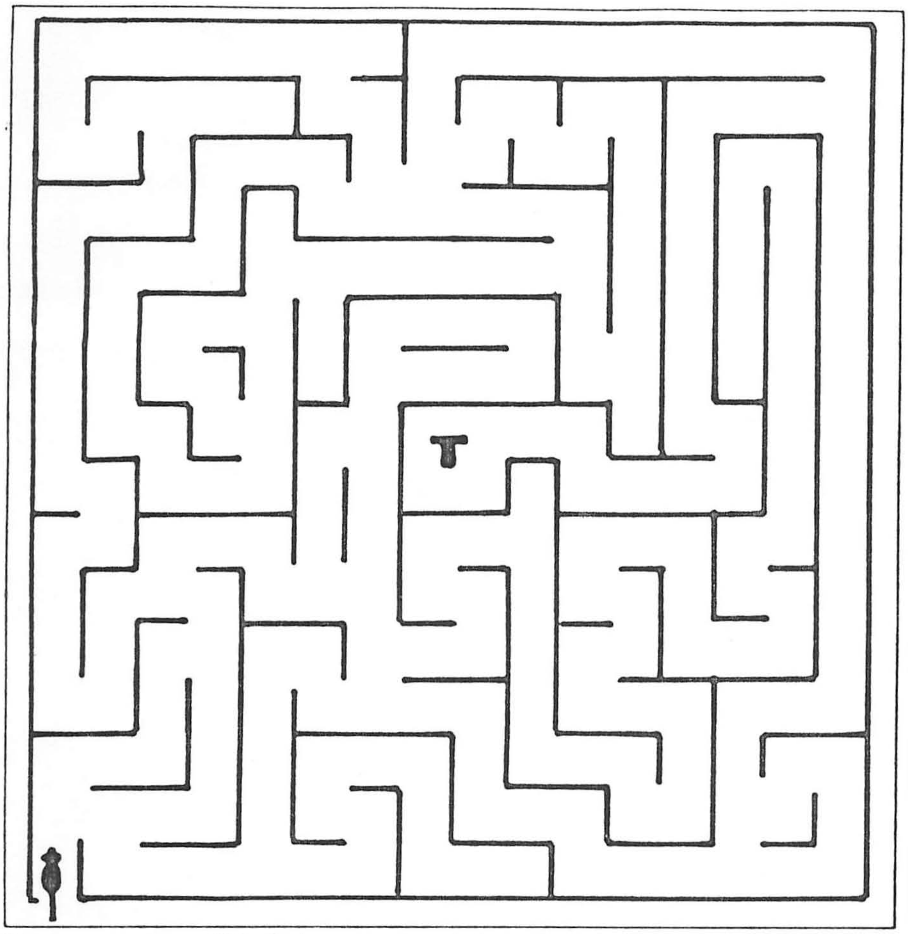
All the contestants are now the proud possessors of pine-mounted mousetraps while three generous cash prizes were given by Tampere Technical University to the winning mice. Next year's final will be held at the Madrid Euromicro Conference in September.

Thezeus 4 rushed through the maze.

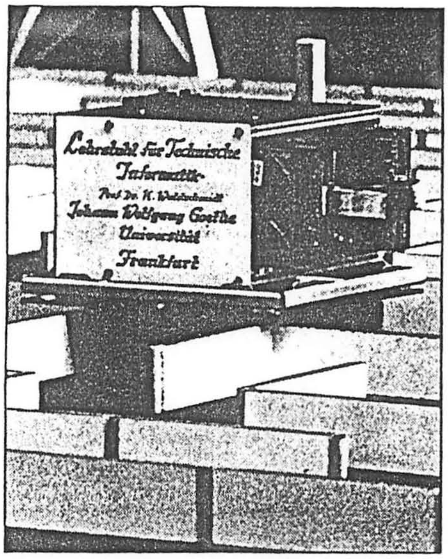


Next year's British final will be held at the Computer Fair, Earls Court, June 16-18, 1983. There will be a special contest for novice mice which have never reached the centre in a national contest. Be sure to enter your mouse even if its performance is still shaky. For full details and rules of entry send a stamped addressed envelope to Micromouse, *Practical Computing*, The Quadrant, Sutton, Surrey SM2 5AS.

Mighty



The maze — more difficult than any seen before.



The German mouse, Superlite 2.

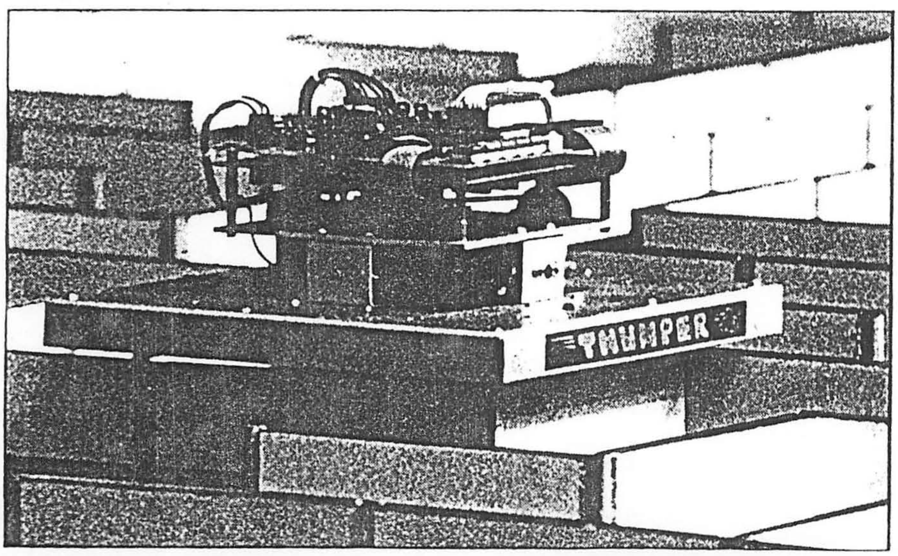
THE MICROMOUSE Microsaurus of Tampere Technical University carried off top honours, following a closely fought battle in the European finals of the Euromouse contest on September 25. The event took place in Tampere, Finland, following the last-minute postponement of the Euromicro Haifa Conference. British mice held the next three places followed by a German mouse, Superlite 2 from Frankfurt.

During the qualifying trials held the previous day it was at once clear that the maze surface would give trouble. To increase the friction sand had been worked into the paint — but there was too much of it and it was too coarse.

Tampere's own Microsaurus set up a disconcerting target of 40 seconds for the practice maze, while Thezeus, Thezeus 3 and Thumper ambled round in 6 minutes 18 seconds, 1min. 27s. and 1min. 3s. respectively. Then Thezeus 4 showed the contest to be no foregone conclusion with a time of 46s. and the promise of a faster strategy and boosted motor volts for the final the following day.

Two of Alan Dibley's four Thezeii suffered gravely when the box was stacked up-side down in the cargo hold of the plane, and Son of Thezeus may never run again. David Woodfield ensured the safety of Thumper by handing it over at Heathrow in a holdall.

Thumper ambled round the course.



Saturday's contest opened to a packed audience with a run by Minitaurus, the Tampere number 2 mouse, in a maze more difficult than any seen before. The time of 7min. 58s. was marred by a helping hand. The German's Superlite 2 ran next. Five restarts were needed before Superlite 2 made a clean run in 6min. 13s.

Thezeus the Ancient then took to the maze as Dibley leant nonchalantly against the far wall with his arms folded while the mouse plodded stolidly to the centre in 11min. 6s. Mousterix, a Finnish mouse from Oulu University failed to find the centre. A little less nonchalant by this time, Dibley then ran Thezeus 3 which quickly achieved the centre in 1min. 53s. but could make no further improvement. Mike, the smallest mouse of the contest made a brief but musical appearance before the "big three" ran. Its ultrasonic sensors let it down although it shows great promise.

Reading carefully from Dave Woodfield's scribbled instructions Dibley then sent Thumper on its way. After three minutes Thumper stopped for an ominous length of time and had to be restarted; 3min. 36s. later it reached the centre. Could it improve on this time? Sadly, no.

Contests in robotics Micromouse and Robat

John Billingsley, Portsmouth Polytechnic

Micromouse and Robat (robot ping-pong), are contests which are open to novices and engineering professionals alike. The design targets can be simply perceived, and although the professional has the power of his expertise, amateurs are unfettered by any preconceptions—and have often shown that a little practical ingenuity is worth a lot of theory. Like the Build-A-Robot contest, Micromouse and Robat can be viewed as a lot of fun. They have to be enjoyable to persuade the contestants to put in so many months of creative effort. But they have a more serious side.

In the six years since the announcement of Euromouse, great numbers of young (and not so young) engineers have come to grips with online computer control, sensor technology, stability theory and problem-solving algorithms. More importantly, they have succeeded in making them work in practice. Many of the entrants have been sixth-formers and younger with no engineering qualifications. But they have shown themselves to be engineers in spirit and achievement.

Robotics research is often fettered by the demands of industry. 'You cannot use this technique—it might not be cost effective. That one is not proven and might be hard to maintain.' No such limitations apply to the enthusiasts, and they incorporate novelties in their mice sometimes years before industry sees them as valuable. Adaptation, learning and responsiveness to sensors are all essential to the Micromouse. Voice output was used several years ago: it enabled the status of the mouse to be diagnosed.

Although Euromouse is a contest of speed, it can be taken gently. While exploring, the mouse can sit and think for a time without imperiling its score for its fastest run. That is not true of Robat—the robot ping-pong contest. Here a moment's hesitation will cause it to miss the ball and lose a point. The level of vision co-ordination which Robat demands is far in advance of any present industrial Robotic task. But is it beyond the bounds of reason for future robots to lob components to each other? A brick-laying robot might well be kept supplied by a hod carrier with an accurate serve!

The then Director of the Science & Engineering Research Council's Robotics Initiative pronounced that games such as ping-pong were clearly beyond the possibilities of robot technology. The contestants are obviously not sophisticated enough to realise this: they seem likely to succeed.

History of Euromouse

When the plans were being made to hold Euromicro '80 in London, the conference organisers felt that some light-hearted attraction would be a relief from the serious technical papers. An account appeared in the American *IEEE Spectrum* magazine of a maze-solving contest with prizes for the fastest first run and the best learning run. It seemed a good idea, and the European contest was launched. Then the *Spectrum* accounts took on a sour note: a high-speed 'dumb' wall follower was outstripping all the brighter mice, and attempts were made to outlaw it—but was that really playing the game? Something was clearly wrong with the rules.

The answer was of course to put the target at the centre of the maze. The paths could be highly connected, and by surrounding the centre with closed routes the wall followers could be baffled forever. By declaring the maze dimensions (16 × 16 for binary convenience) and the co-ordinates of the target, the emphasis could be placed on control, navigation, mapping and strategy. The mice have certainly excelled in all of these.

Two months before the London contest, a trial heat was held at the annual open day of Portsmouth Polytechnic's Electrical Engineering Department. It taught everybody a lot. The first lesson was that mouse builders are shy to show off their creations unless perfect. From 200 applications, the number of contestants prepared to appear dwindled to two—and they were both Polytechnic students! Much pleading by telephone the night before the event brought the numbers up to just five.

Plessey's Fred and Marconi's Meryl were far from complete. Although they were both impressive in terms of their construction and concept, one could only spin in circles, and the other was good humouredly driven by manual switches to entertain the sizeable audience. Algernon's guidance circuitry was crossed, so that it could only run straight into the first wall; one of the Portsmouth mice had processor problems and bounced about at random. Only Freewheelin' Franklin made any real progress—and that was marred by a loose photocell connection. And yet the event was an enormous success. The audience seemed equally delighted by the disasters of the mice as by their successes. Among the spectators was Nick Smith; he had left his mouse at home. Also in the audience were five delegates from the Japan Science Foundation, who took the rules back to Tokyo and built up their own contest to great heights.

The next two months were well spent, and the European finals at Euromicro '80 were quite a different matter. Mice arrived from all over Europe: Midnight Sun from Finland, Lami from Switzerland, Superlite from Germany and Yamahico II from Japan. Fred now took on a rodent shape, Meryl was under full

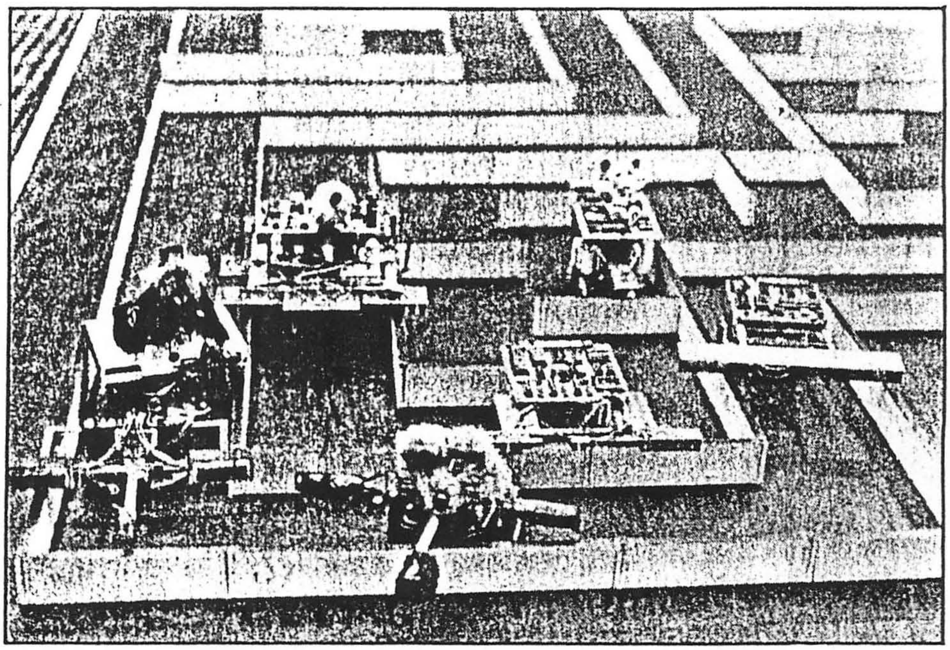


Fig. 1 Micromouse

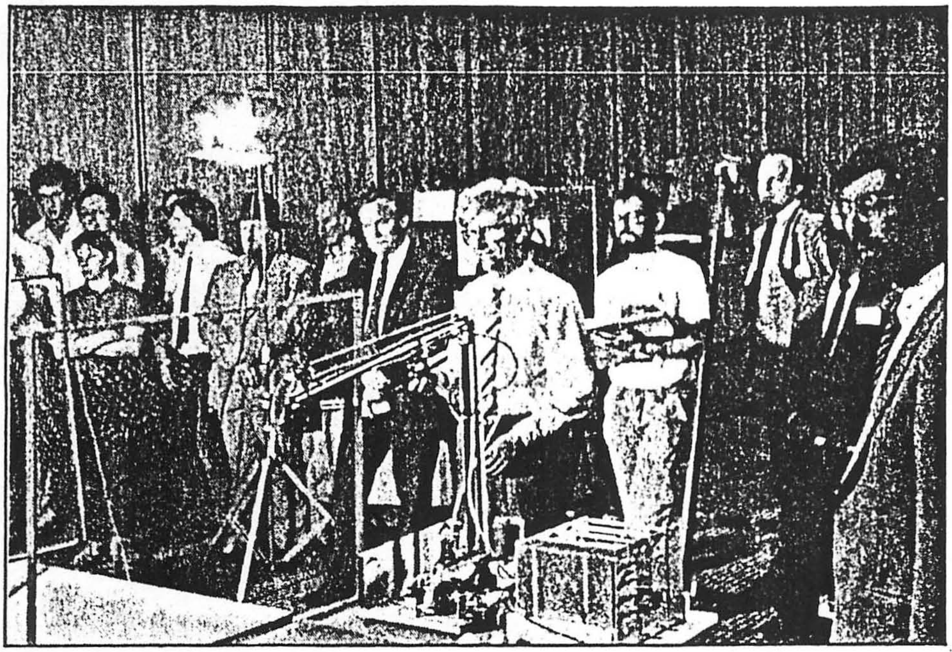


Fig. 2 Robat

control, and a new mouse, Ancomical, was entered by ICL's amateur computer club. Technology ranged from Brainy Bricks, made from Lego, to Pascal, sawn down from a toy car and struggling to clear the corners with three-point turns. Lami was marvellously engineered with tyres made of crossmounted micro-wheels. These allowed it to perform a virtuoso display of driving in a circle while pointing north. The novel wheels unfortunately demanded an absolutely flat surface, and an uneven joint in the maze base marred Lami's contest performance.

One mouse was built around a CMOS processor. The body of aluminium had been carved out with tin snips, and the wall sensors were metal flaps which closed contacts salvaged from a relay. With no previous electronic experience, Nick Smith had put together Sterling Mouse, the first mouse to reach the centre and 'know' it had succeeded. The strategy had its roots in dynamic programming, but was so simple in essence that the calculations could be carried out as a delay routine between motor steps.

An Easter workshop was organised by the ICL computer club, where ideas were exchanged and advances were made. Thezeus and Thumper appeared at Wembley in 1981, founding a dynasty of winners. David Woodfield's Thumper combined ingenuity with superb craftsmanship, using four swivelling wheels which allowed it to manoeuvre without rotating. In Thezeus, Alan Dibley established the practice of building a small personal computer into the Micromouse—albeit with sawn-off keyboard. 15 mice took part in the Paris Euromicro finals, and Thumper became the new European champion. The rules had again been changed slightly, giving each mouse 15 min in which to perform, the best run being counted. This put a premium on learning ability, and the time achieved for the best run had by now been cut to below a minute.

The 1982 British finals were held at the Computer Fair, Earls Court—the first of three such years. Two new Thezei beat Thumper into third place, but all three times were below one minute. The University of Tampere in Finland played host to the 1982 European finals; they snatched victory from Thezeus-4 by a mere two seconds margin, taking 40 s, and retained the title the next year in Madrid. 1983

At last, in Copenhagen, at Euromicro 1984, Britain won the title back through the efforts of Enterprise, grandson of Thumper. The shortest path was 70 squares in length, covered in an amazing 27 s. David Woodfield and Alan Dibley will now join teams from Finland and Germany in the Japanese All World contest in Tsukuba. Even more contestants are expected from South Korea and the United States, and of course Japan.

Robot ping-pong

In November 1981, a microrobotics conference was held at Imperial College. Someone asked the question: 'What can follow Micromouse when solving the maze is seen as easy?' Three-dimensional mazes were suggested, along with noncartesian shapes and walls which move. All these are possibilities, although there are still plenty of challenges in the contest as it is. A contest of a different type was needed, and I suggested robot ping-pong. Playing very safe, I named a date five years off for the first heat—but it has arrived in less than four.

A group of entrants met in Portsmouth on 19th January 1985 to exchange ideas and polish up the rules. Three very primitive pieces of machinery arrived: two bat mechanisms and a vision system. Nothing really worked, although an oscilloscope trace showed a peak where the ball might just possibly be. Less than two months later, the contest was introduced on BBC's Micro Live. One of the mechanisms now leaped about, threatening mayhem to the presenter who stood too close. The vision system put up an excellent screen display of the track of a real bouncing ball, and a completely new arm succeeded in taking a swipe at the ball.

By the time this article reaches print, you will have seen the Robats doing battle in earnest at the European Personal Robotics Congress, and more recently they will have met again to challenge the European contestants at the Euromicro Conference in Brussels, 3rd–6th September 1985 (where Euromouse will also be held). I suspect that the flight of the ball will at first be erratic, to say the least. But from the first few tentative efforts, a whole new technique of dynamic robot response and interception will emerge.

Conclusion

Micromouse has grown up here on a shoestring budget, begging space at annual British exhibitions and scrounging prizes from the exhibitors. It is none the worse for that. In Japan, however, there is a permanent Micromouse Secretariat. They were present at last year's Euromicro finals in Copenhagen, and awarded nine free air flights to European participants to take part in this year's Japanese finals. The maze used at the European Personal Robot Congress has been flown here by the Japanese Science Foundation, so that any incompatibilities can be sorted out beforehand, and mazes have been sent to South Korea and the United States. Could the importance which the Japanese obviously give to such contests be linked with their industrial success, both resulting from it and resulting in further success?

Micromouse and Robat will continue to give qualified and unqualified engineers alike the opportunity to innovate. Their ideas may at times spin off into industrial applications; the contestants themselves may be recruited by marketers of new robotic products. In all events, they enhance the awareness and ability of the country as a whole to ride on the rushing tide of technology.

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This paper is a revised version of a paper presented at the European Personal Robotics Conference, London, July 1985.

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Dr. John Billingsley - M.A., Ph.D., C.Eng., MIEE, FIOA

For twenty years and more, John Billingsley's research has concerned the exploitation of on-line computer systems. In Cambridge University he led a team pioneering the use of multiple linked single-board minicomputers for control system simulation and for research into the optimisation of heirarchical systems. At Portsmouth Polytechnic he now leads a team researching into the 'Craftsman Robot' system for performing intelligent adjustment of a factory product. He maintains a close contact with industry, and a number of his designs are in regular production.

A member of several IEE committees, he has organised many colloquia concerning robotics and microcomputer applications. He is the author of two books on experimental robotics for microcomputer enthusiasts, and for some years has organised the Euromouse Maze contest, in which small robot vehicles must find the fastest path to the centre of a maze. He was a consultant to the BBC television series 'The Computer Programme'.

Robat
The first skirmish and the Official Rules

John Billingsley.

You may have seen the Micro Live programme on March 8th in which two Robats and a balsa-wood model were put through their paces. The machine which actually hit the ball in the opening captions (it missed it later in the programme) was the result of a remarkable bit of high-speed development, since it had not even been designed at the time of the January meeting. It was built by John Knight and Dave Lowry from chipboard, plastic drainpipe, springs, an old solenoid and an assortment of amazing parts - but it worked ! The computer could make it lunge to any position with amazing repeatability.

January 19th saw the first meeting the Robot Ping-Pong contestants. Fourteen hardy souls trudged through the snow to the Nuffield Centre of Portsmouth Polytechnic from as far afield as Glasgow and Zurich, although the only working gadgets came from much closer.

Julian Griffin and his team of Bernard Jacobs and Aaron Ridout brought A.P.P.E from Elmer Sands, some thirty miles away. A.P.P.E. (Automatic Ping Pong Engine) left rather a lot to the imagination. In fact it represented two alternative approaches to the task of hitting the ball, one a rhomboid framework, the other resembling a cross between a mediaeval jousting lance and a miniature tea-chest. The metal rhombus stood on one corner and was driven by two motors at its base. When these were driven in opposite directions, the frame performed a "policeman's knees bend", causing the mechanism at the top corner to dip. By driving the motors together, the bat could be driven side-to-side at a rate claimed to be 800 degrees per second. A simple optical tracker system had been constructed, but was not yet operational.

The jousting lance was not as yet motorised, but displayed some interesting ideas. At its tip was a flat disk for the bat, from which strings led back over a second disk and were attached to the plywood box in which the lance was pivoted. As the lance was moved from side to side, the bat swivelled about a centre far in front of it, so that the ball would be deflected back towards the centre-line of the table. The same was true of up-and-down movement, so that variations in height would be compensated for.

John Knight and Dave Lowry brought their equipment from Fareham, only a few miles from Portsmouth. They had concentrated on the task of building a vision system to detect the ball, and brought a working system as well as a number of discarded prototypes. Their machine owed much to the pioneering days of television, with three spinning disks carrying an array of cylindrical lenses. As the line image of the ball was swept across a photocell a sharp pulse was produced, easily separated from the background waveform as long as the visual contrast was good. The three disks gave a single vertical signal and a stereo pair of horizontal measurements, from which the range could be computed.

As you will by now have deduced, the efforts of the preceding week to construct a serving device were not altogether essential to the day's events. The wire and elastic gadget put together by Kevin West worked perfectly to serve the ball and then retract out of the way, but neither of the Robats was in any shape to do anything about it. The situation was not very different from the corresponding stage of the Micromouse Contest, back in 1980. A lot can happen before the first British Finals at the British Personal Robot Congress in June.

A vital part of the meeting was the discussion session, where among other topics the rules were discussed. These will of course keep on changing in their minor details until the day of the contest - and perhaps long afterwards. It is essential that they should bend to the needs of the contestants, pruning out any difficulties which would not add to the sport of the contest.

The most important modification was the proposal to add "sight screens" behind the contestants. To ensure good visual contrast, the black screens need to be 1.5 metres wide and 2 metres high. They are to be placed 2 metres behind each playing frame, to give plenty of room for the robot, and will be light and mobile to avoid problems when moving robots into position. It is a pity that they will upset the view from behind the players, but the improvement in the vision signals should be well worth while.

Even with a thin and ricketty playing frame, there was concern that it might block the view. An excellent suggestion was made that a larger, more substantial frame could carry a netting frame inside it, edged with a thin thread. The support frame is therefore one metre wide and 0.75 metre high, of material up to 1 cm thick. Threads and fine netting define the actual half-metre square through which the ball must pass. The centre net frame is also supported on a framework of the same dimensions, and the top of the frame is solid enough to carry the serving mechanism.

There were a few discussions about the merits of acoustic sensing. There is already a rule that an ultrasonic sensor may only transmit when the ball is approaching it. As an ultrasonic opponent hits the ball, it signals "all clear to transmit" by putting out its own "I am transmitting" LED. But what if the opponent is optical, and does not transmit ? Clearly a switch must be permitted to allow an ultrasonic sensor to transmit all the time if the opponent is non-acoustic. It was also suggested that a button should be permitted to inform the robat whether it had won or lost each point.

Now let us try to pull the rules together in some semblance of order. Some points, such as size and shape of the table, are well defined. Others, such as whether the ball is allowed to strike the playing frame, need to be tied down. There may well be yet another rethink after the experience of the first round of contests, so please write in with any heartfelt objections.

The first true contest will be held on July 1st and 2nd, 1985 at the First European Personal Robot Congress, London West Hotel, Lilly Rd (the old West Centre Hotel near Earls Court). The European finals will take place in Brussels during the Euromicro Conference, 3rd-6th September 1985. If you have not already received an entry form, please write in with the details of your Robat, listing the events in which you expect to take part and giving a home telephone number.

Now for the rules.

1. The ball is a standard table-tennis ball, with no special markings.

2. The table is 2 metres long and 0.5 metre wide. It stands 0.75 metre above floor level.

3. The table surface is smooth and matt black without boundary lines. For the first heats the surface may be smooth-side hardboard, painted with black emulsion, supported on a chip-board or block-board base.

4. At each end of the table is a vertical "playing frame", internal size 0.5 metre square. The boundary of these frames will be formed by a wire or thread which carries the edge of a fine net, supported on a rigid outer frame 1 metre wide and 0.75 metre high, thus minimising optical obstruction.

5. In the centre of the table a third vertical frame is mounted, internal measurements 0.5 metre wide and 0.75 metre high, of a material similar to the playing frames. A fine wire is stretched across this frame 0.25 metre above the table, supporting a transparent net (similar to hair-net material). Nets will not obstruct more than ten percent of light passing through them - probably much less. The outer supporting frame will be 1 metre wide, but the top cross member is rigid at a height of 0.75 metre above the table.

6. The top of the net frame supports a serving device. This holds the ball in full view of both robots, with centre about 0.625 metre above the centre of the table surface. The structure is of wire not more than one millimetre thick, and

after serving the ball the mechanism retracts entirely above the level of the top of the net frame. The ball is served towards the "serving" robot, to bounce once before emerging from the playing frame.

7. Lighting is provided by tungsten lights, mounted at a height of 2 metres on poles at the corners of a 4 metre square, square with and centred on the table. The light level is likely to be around a Weston meter reading of 10, corresponding to an exposure of 1/60 second at f5.6 on 100 ASA film.

8. A level space one metre square is provided abutting each end of the table within which each robot must stand. No part of the robot must touch or project forward of the playing frame. The robot should not extend laterally more than one metre to either side of the frame centre, i.e. 2 metres overall. A power outlet will be provided at the edge of each standing space. In Europe this will be 220-240 volts at 50 Hz, fused at 5 amps; in the USA it may be 110v, 60 Hz, fused at 10 amps.

9. A movable vertical black sight-screen 1.5 metres wide and 2 metres high will be located behind each robot, 2 metres behind the playing frame.

10. The bat size must be contained within a circle 12.5 centimetres in diameter. The bat must propel the ball by hitting it once with its surface - no catching, blowing, electrostatic repulsion or other variations are allowed. The bat surface can be curved if desired, but double-hitting will lose the point.

11. Those parts of the robot visible to the opponent must be black, including absorbtion of infra-red in the region of 1 micron wavelength. This is satisfied by black emulsion paint. If the opponent insists, and can show that he has sensors to detect it (unlikely in the first year), the bat must carry a high-brightness red LED at its centre and a green LED 5cm away from it.

12. Apart from such LED's, the robot must not project light towards its opponent. To detect the approach of the ball to the bat, a cross beam can be used. It must then be clear that any light spilled towards the opponent will come only from the ball itself, and unreasonable brightness levels must not be used.

13. Ultrasonic transmissions are only allowed while the ball is approaching the bat, and must cease on contact. When ultrasonic transmission is used, a high-brightness red LED must be driven by a cable long enough to permit mounting beside the net frame, where it can be viewed by the judges and by a cable-mounted photocell from the opponent - an exception to rule 8b. It must be lit while transmitting.

This rule is relaxed if the opponent is non-acoustic.

14. The robots will be allowed fifteen seconds to lock their vision systems onto the ball before it is served. It is desirable but not compulsory that they indicate when they are ready (by tone or voice output) so that this time can be shortened. Five serves will be made in each direction. The scoring will be as in table tennis. The competitors may opt to change ends between games, but this must be accomplished within a time of five minutes. Initial setting-up should also be achieved within a time of five minutes. The number of games to determine a result will be at least best-of-three, and will be determined beforehand in response to the number of competitors.

15. A correct return will cause the ball to bounce just once on the table at the opponent's side of the net, before it passes through the opponent's playing frame. The ball may touch the playing frame, the net wire or the net frame.

16. If the defender returns the ball 20 times in one rally, it wins the point.

17. The judges may disqualify a robot on the grounds of safety, or penalise it for serious breaches of sportsmanship.

18. All dimensions quoted here may be subject to a tolerance of 2 percent up or down.

19. The robot may have two buttons or their equivalent with which the handler can inform the robot that it has won or lost the point. A further button can tell the robot that the ball has gone out of play, or is ready to be served. Excessive controls which give the judges the impression that strategy is being determined by the handler, rather than the robot, will be looked on with disfavour and may lead to penalty points being awarded.

It goes without saying that the robots should be easily transportable, and should be entertaining where possible. They should not be excessively noisy.

Robats will come to be known by their own names, just as the micromice Thumper, Thezeus and Sterling Mouse have done. Already Machineroe and Cy Borg have been claimed, and any Robat worth its salt should be graced by a suitably appalling name. You might possibly need to add an explanation.

Let me encourage you with an example: Androbin. If it doesn't seem obviously awful, try it with a capital R.

For a Robat entry form please write to:

John Billingsley,

Department of Electrical and Electronic Engineering,
Portsmouth Polytechnic,
Anglesea Road,
Portsmouth PO1 3DJ.

Contests in robotics Micromouse and Robat

John Billingsley, Portsmouth Polytechnic

Micromouse and Robat (robot ping-pong), are contests which are open to novices and engineering professionals alike. The design targets can be simply perceived, and although the professional has the power of his expertise, amateurs are unfettered by any preconceptions—and have often shown that a little practical ingenuity is worth a lot of theory. Like the Build-A-Robot contest, Micromouse and Robat can be viewed as a lot of fun. They have to be enjoyable to persuade the contestants to put in so many months of creative effort. But they have a more serious side.

In the six years since the announcement of Euromouse, great numbers of young (and not so young) engineers have come to grips with online computer control, sensor technology, stability theory and problem-solving algorithms. More importantly, they have succeeded in making them work in practice. Many of the entrants have been sixth-formers and younger with no engineering qualifications. But they have shown themselves to be engineers in spirit and achievement.

Robotics research is often fettered by the demands of industry. 'You cannot use this technique—it might not be cost effective. That one is not proven and might be hard to maintain.' No such limitations apply to the enthusiasts, and they incorporate novelties in their mice sometimes years before industry sees them as valuable. Adaptation, learning and responsiveness to sensors are all essential to the Micromouse. Voice output was used several years ago: it enabled the status of the mouse to be diagnosed.

Although Euromouse is a contest of speed, it can be taken gently. While exploring, the mouse can sit and think for a time without imperiling its score for its fastest run. That is not true of Robat—the robot ping-pong contest. Here a moment's hesitation will cause it to miss the ball and lose a point. The level of vision co-ordination which Robat demands is far in advance of any present industrial Robotic task. But is it beyond the bounds of reason for future robots to lob components to each other? A brick-laying robot might well be kept supplied by a hod carrier with an accurate serve!

The then Director of the Science & Engineering Research Council's Robotics Initiative pronounced that games such as ping-pong were clearly beyond the possibilities of robot technology. The contestants are obviously not sophisticated enough to realise this: they seem likely to succeed.

History of Euromouse

When the plans were being made to hold Euromicro '80 in London, the conference organisers felt that some light-hearted attraction would be a relief from the serious technical papers. An account appeared in the American *IEEE Spectrum* magazine of a maze-solving contest with prizes for the fastest first run and the best learning run. It seemed a good idea, and the European contest was launched. Then the *Spectrum* accounts took on a sour note: a high-speed 'dumb' wall follower was outstripping all the brighter mice, and attempts were made to outlaw it—but was that really playing the game? Something was clearly wrong with the rules.

The answer was of course to put the target at the centre of the maze. The paths could be highly connected, and by surrounding the centre with closed routes the wall followers could be baffled forever. By declaring the maze dimensions (16 × 16 for binary convenience) and the co-ordinates of the target, the emphasis could be placed on control, navigation, mapping and strategy. The mice have certainly excelled in all of these.

Two months before the London contest, a trial heat was held at the annual open day of Portsmouth Polytechnic's Electrical Engineering Department. It taught everybody a lot. The first lesson was that mouse builders are shy to show off their creations unless perfect. From 200 applications, the number of contestants prepared to appear dwindled to two—and they were both Polytechnic students! Much pleading by telephone the night before the event brought the numbers up to just five.

Plessey's Fred and Marconi's Meryl were far from complete. Although they were both impressive in terms of their construction and concept, one could only spin in circles, and the other was good humouredly driven by manual switches to entertain the sizeable audience. Algernon's guidance circuitry was crossed, so that it could only run straight into the first wall; one of the Portsmouth mice had processor problems and bounced about at random. Only Free-wheelin' Franklin made any real progress—and that was marred by a loose photocell connection. And yet the event was an enormous success. The audience seemed equally delighted by the disasters of the mice as by their successes. Among the spectators was Nick Smith; he had left his mouse at home. Also in the audience were five delegates from the Japan Science Foundation, who took the rules back to Tokyo and built up their own contest to great heights.

The next two months were well spent, and the European finals at Euromicro '80 were quite a different matter. Mice arrived from all over Europe: Midnight Sun from Finland, Lami from Switzerland, Superlite from Germany and Yamahico II from Japan. Fred now took on a rodent shape, Meryl was under full

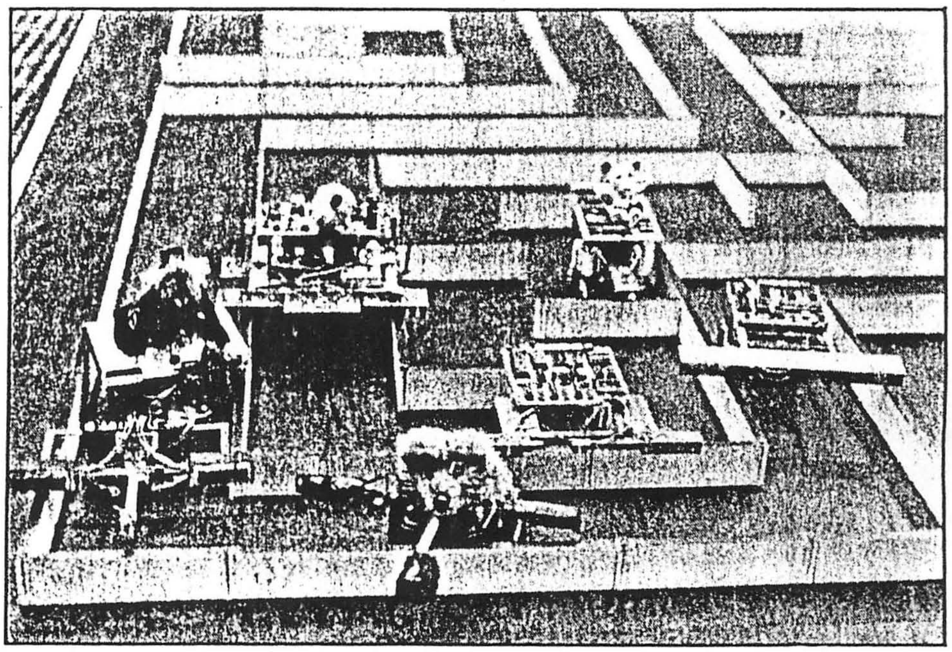

Fig. 1 Micromouse

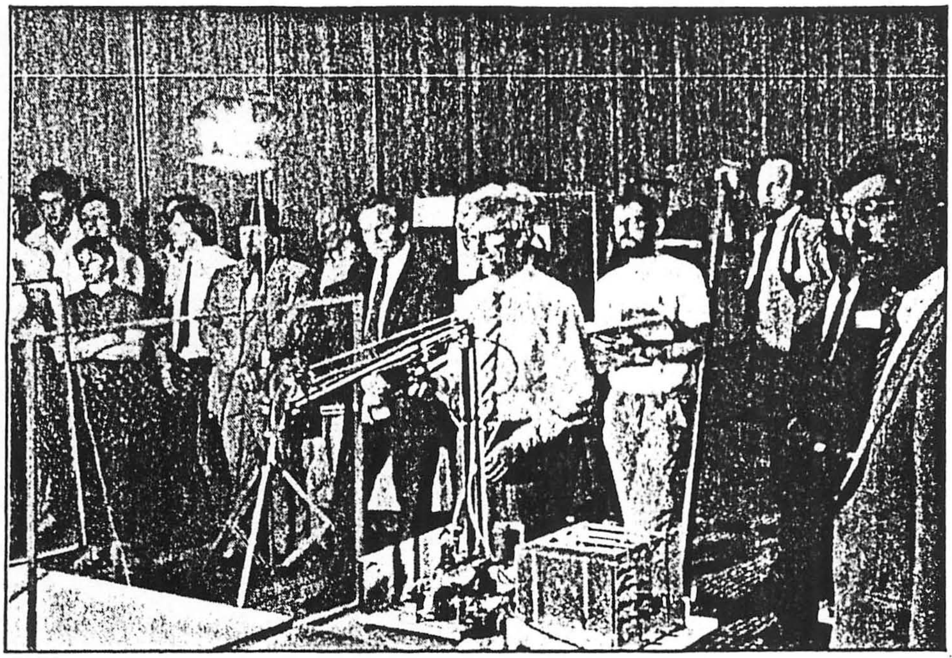

Fig. 2 Robat

control, and a new mouse, Ancomical, was entered by ICL's amateur computer club. Technology ranged from Brainy Bricks, made from Lego, to Pascal, sawn down from a toy car and struggling to clear the corners with three-point turns. Lami was marvellously engineered with tyres made of crossmounted microwheels. These allowed it to perform a virtuoso display of driving in a circle while pointing north. The novel wheels unfortunately demanded an absolutely flat surface, and an uneven joint in the maze base marred Lami's contest performance.

One mouse was built around a CMOS processor. The body of aluminium had been carved out with tin snips, and the wall sensors were metal flaps which closed contacts salvaged from a relay. With no previous electronic experience, Nick Smith had put together Sterling Mouse, the first mouse to reach the centre and 'know' it had succeeded. The strategy had its roots in dynamic programming, but was so simple in essence that the calculations could be carried out as a delay routine between motor steps.

An Easter workshop was organised by the ICL computer club, where ideas were exchanged and advances were made. Thezeus and Thumper appeared at Wembley in 1981, founding a dynasty of winners. David Woodfield's Thumper combined ingenuity with superb craftsmanship, using four swivelling wheels which allowed it to manoeuvre without rotating. In Thezeus, Alan Dibley established the practice of building a small personal computer into the Micromouse—albeit with sawn-off keyboard. 15 mice took part in the Paris Euromicro finals, and Thumper became the new European champion. The rules had again been changed slightly, giving each mouse 15 min in which to perform, the best run being counted. This put a premium on learning ability, and the time achieved for the best run had by now been cut to below a minute.

The 1982 British finals were held at the Computer Fair, Earls Court—the first of three such years. Two new Thezei beat Thumper into third place, but all three times were below one minute. The University of Tampere in Finland played host to the 1982 European finals; they snatched victory from Thezeus-4 by a mere two seconds margin, taking 40 s, and retained the title the next year in Madrid.

At last, in Copenhagen, at Euromicro 1984, Britain won the title back through the efforts of Enterprise, grandson of Thumper. The shortest path was 70 squares in length, covered in an amazing 27 s. David Woodfield and Alan Dibley will now join teams from Finland and Germany in the Japanese All World contest in Tsukuba. Even more contestants are expected from South Korea and the United States, and of course Japan.

Robot ping-pong

In November 1981, a microrobotics conference was held at Imperial College. Someone asked the question: 'What can follow Micromouse when solving the maze is seen as easy?' Three-dimensional mazes were suggested, along with noncartesian shapes and walls which move. All these are possibilities, although there are still plenty of challenges in the contest as it is. A contest of a different type was needed, and I suggested robot ping-pong. Playing very safe, I named a date five years off for the first heat—but it has arrived in less than four.

A group of entrants met in Portsmouth on 19th January 1985 to exchange ideas and polish up the rules. Three very primitive pieces of machinery arrived: two bat mechanisms and a vision system. Nothing really worked, although an oscilloscope trace showed a peak where the ball might just possibly be. Less than two months later, the contest was introduced on BBC's Micro Live. One of the mechanisms now leaped about, threatening mayhem to the presenter who stood too close. The vision system put up an excellent screen display of the track of a real bouncing ball, and a completely new arm succeeded in taking a swipe at the ball.

By the time this article reaches print, you will have seen the Robats doing battle in earnest at the European Personal Robotics Congress, and more recently they will have met again to challenge the European contestants at the Euromicro Conference in Brussels, 3rd–6th September 1985 (where Euromouse will also be held). I suspect that the flight of the ball will at first be erratic, to say the least. But from the first few tentative efforts, a whole new technique of dynamic robot response and interception will emerge.

Conclusion

Micromouse has grown up here on a shoestring budget, begging space at annual British exhibitions and scrounging prizes from the exhibitors. It is none the worse for that. In Japan, however, there is a permanent Micromouse Secretariat. They were present at last year's Euromicro finals in Copenhagen, and awarded nine free air flights to European participants to take part in this year's Japanese finals. The maze used at the European Personal Robot Congress has been flown here by the Japanese Science Foundation, so that any incompatibilities can be sorted out beforehand, and mazes have been sent to South Korea and the United States. Could the importance which the Japanese obviously give to such contests be linked with their industrial success, both resulting from it and resulting in further success?

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INVENTIONGENIUSINGENUITYINNOVATINGENGINEERING

INGEN

(Invention-Genius-Ingenuity-Innovation-in-Engineering)

A CENTRE FOR INTERACTIVE WORKING DISPLAYS IN ENGINEERING AND APPLIED SCIENCE

A PROSPECTUS

Microcomputers have applications in teaching research and in all branches of engineering

INVENTIONGENIUSINGENUITYINNOVATINGENGINEERING

CONTENTS:

This prospectus has been prepared by a Committee of Members from:

Portsmouth Polytechnic

University of Southampton

The Southern Science and Technology Forum

including many representatives of local industry.

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Mr J Gibbs
Portsmouth Polytechnic
Department of Civil Engineering
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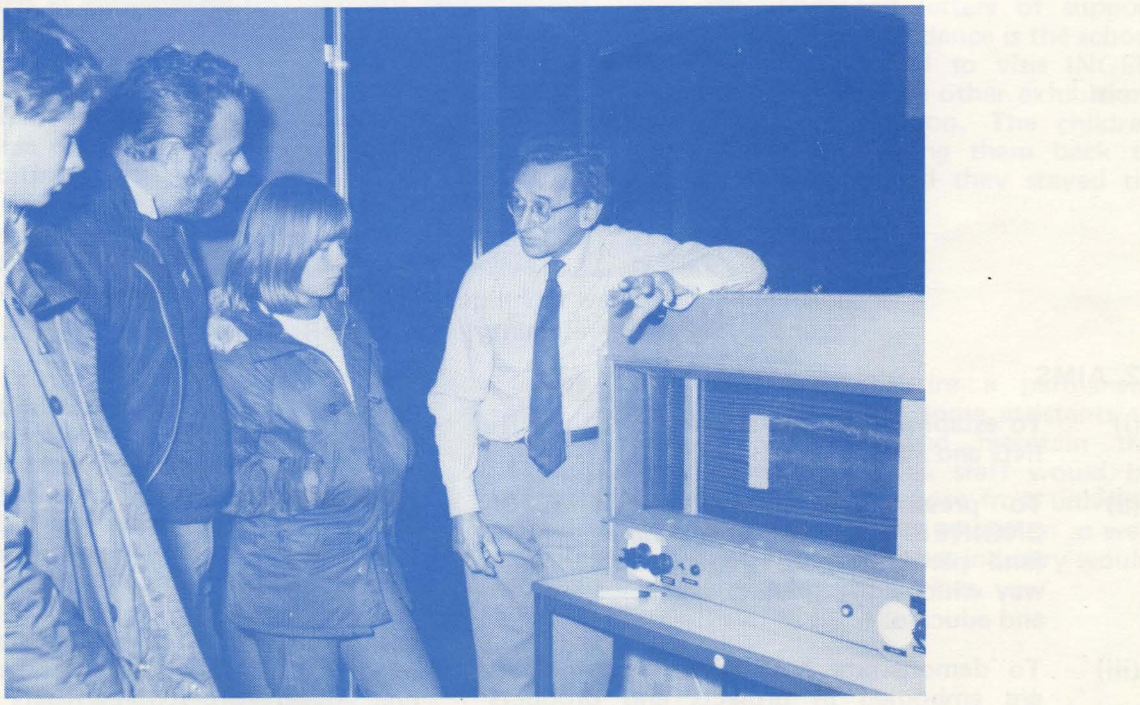
1. INTRODUCTION

We live in an age dominated by the fruits of scientific advances and their applications, together with their exploitation in many technological fields. It is here that ENGINEERING begins. ENGINEERING comprises the design, manufacture and marketing of everything that is made and thereby covers all the products required by people to live, communicate and to defend their way of life. ENGINEERING is not distinct from science but interfaces and interacts with it. ENGINEERING cannot work without science but even science relies and feeds on ENGINEERING design and development. ENGINEERING involves the development of scientific ideas and principles and continually seeks new scientific solutions to problems which extend scientific thought and its horizons. ENGINEERING is exciting, demanding, difficult and always challenging - for it is the art of solving practical problems.

ENGINEERING today is dynamic. Many will look on the past with nostalgia but few will be prepared to give up what the ENGINEER has provided us with to live more effective lives in our places of work, in our homes, in our journeys and travel on land, sea and air, in our communications, and in all our leisure exploits. Yet with the products of ENGINEERING all around us, how many people really understand what ENGINEERING is and what it does? ENGINEERING does not just happen! It is the result of years of training, testing, experience and continuing development.

Many people in Britain today look down on ENGINEERING and the ENGINEER as simply a fitter or technician with a hammer and screwdriver in the rear pocket of his overalls. They fail to realise that without strength in ENGINEERING British Industry and the British economy would be in an even sorrier position than it finds itself today. Britain's future prosperity lies in the strength of its industry and that involves good productivity coupled with an excellence in its ENGINEERING to face up to the growing challenge of our overseas competitors. Britian's dominance of overseas markets such as we enjoyed 100 years ago has now largely disappeared and unless we reverse the process of years of decay and lost opportunities, the future is bleak. Britain needs injection into all branches of its manufacturing industries and its associated research and development centres of the best trained and the best motivated young people that the universities, polytechnics and technical colleges can produce. How can we convince young people and their parents that a career in ENGINEERING is a career demanding high (but not exclusively high) academic standards for a challenging and highly rewarding structured training in industry where many of the world's problems are encountered and solved? Clearly there is no one simple route or solution but it is our belief that attitudes towards ENGINEERING and the ENGINEER can only change by making everyone more aware of what ENGINEERING is and does.



Flow in fluids is important in the understanding of Aeronautics as well as the flight of birds.

It was in this spirit and to meet this demand that INGEN was formed from a group of ENGINEERS and INDUSTRIALISTS centred on the Southern Science and Technology Forum in association with Portsmouth Polytechnic and the University of Southampton. It is our earnest wish to see INGEN as a centre where both young and old alike can learn and see something of the nature of ENGINEERING, discover its stimulus and challenge, and so understand better the decisions which relate our society to technolgical change. Moreover this will encourage young people to seek more information about ENGINEERING and to accept it as a prime career to follow.

A recent report on the ENGINEERING profession by Sir Monty Finniston underlines these views in the following words:-

"Prosperity or decline?

Britain's economic health depends on successfully designing, making, marketing and using technologically-based products and processes. Since a modern industrial society of this sort is in essence an engineering society, its prosperity depends upon engineering excellence in its broadest sense, including design, production, marketing and servicing, but British industry's response to the growing challenge from its overseas competitors through the last century has been manifestly inadequate, and Britain has been outpaced in many areas where once it led the world.

The regeneration of United Kingdom manufacturing competitiveness must be given over-riding priority in national policies with the emphasis on developing market-orientated ENGINEERING EXCELLENCE in the products made by British industry and in the production of them".

An example of new techniques to simplify cable jointing and giving added reliability, as used by British Telecom.

2. AIMS

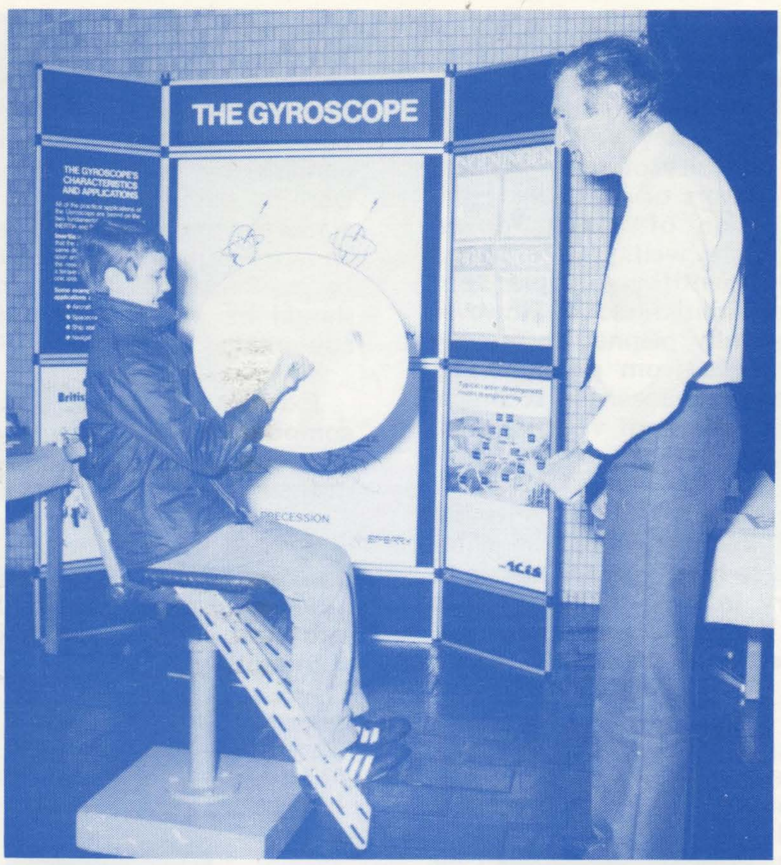
(i) To establish an exhibition for ENGINEERING and APPLIED SCIENCE.

(ii) To present the various disciplines of ENGINEERING to the general public (and particularly to young people) in a way which will stimulate, challenge, inform and educate.

(iii) To demonstrate how scientific principles are embodied in projects and products which greatly influence people at home, at work and in their leisure activities.

(iv) To provide an environment in which an understanding of important scientific and engineering princples can be demonstrated and experiments can be performed requiring the interaction and involvement of the visitor.

(v) To present the problem-solving nature of ENGINEERING. The exhibition will feature ENGINEERING solutions to well-posed practical problems but will also pose problems having open-ended solutions.



Gyroscope and their application in automatic control.

3. PROPOSAL

Many centres of engineering and applied science have been set up in recent years in a number of overseas cities, such as the "Palace of Discovery" in Paris and the "Science Centres" of Toronto and Tokyo.

We see a permanent exhibition having initially an exhibition floor area of between 5,000 and 10,000 sq. ft. The exhibition centre will require workshops, a lecture theatre, offices and a cafeteria, although perhaps not all of these would be needed initially. The total floor space for the complex would be between 8,000 and 20,000 sq. ft.

4. NEED

A pilot exhibition was arranged by INGEN in central Portsmouth in January, 1982, to gauge the support and interest such an innovative exhibition would attract from young people and their parents. About 2,500 visitors attended INGEN 82. Television and radio coverage towards the end of the exhibition brought INGEN to the notice of a much wider audience. The organisers were left in no doubt that the need is real - indeed, even more pressing than we imagined and that the public, especially the young, would come and would most certainly enjoy the experience of learning in a practical way.

There is available substantial evidence of the success of the pilot scheme in the form of photographs, video recordings and letters of support but perhaps the most telling evidence is the school party from Ryde who booked to visit INGEN during the morning and explore other exhibitions in Portsmouth in the afternoon. The children insisted that their teacher bring them back to INGEN after lunch instead and they stayed till closing time!

5. ORGANISATION

The exhibition would require a permanent staff, including a Director and some assistants to develop, design, construct and maintain the exhibits. The Director and his staff would be expected to receive technical advice from universities and other centres of higher education as well as industry. It would be hoped that industry would provide equipment and other services.

6. EXHIBITS

Exhibits will be designed to stimulate the technical interest of visitors using the well proven technique of participation. They will be aimed largely at arousing the curiosity of teenagers and will not underestimate powers of comprehension, thus avoiding the situation of 'talking down' to young people who may well have a sound understanding of some scientific principles, but perhaps within a rather limited scope. However exhibits will also be carefully planned to provide fascintation at many levels from purely visual attraction to the challenge of advanced technical implications so that the interest of visitors of all ages and backgrounds can be seized.

To some extent the character of exhibits has already been described in formulating the aims. The exhibition centre is to have a similar nature to the Palace of Discovery in Paris or the Science Centres in Tokyo and Toronto. Each exhibit will be designed around a particular scientific principle or set of principles.

The principle will be explained and demonstrated in as simple and lucid a manner as possible. This basic understanding will then be built upon — perhaps by a mathematical explanation (with working description where possible), perhaps by a more complex version and finally by showing an application or embodiment of the principle. It is considered most important that exhibits should be of a high standard, both of technical content and presentation.

Exhibits will range from gyroscopes to micro-computers, from hydraulics to on-line control, and it is proposed to provide exhibits from each of the major brances of engineering, for example

photoelasticity	holography
robotic devices	the microchip explained
survey equipment	hydraulic effects
aerofoil instability	building resonance

to name but a few.

Human power output can be measured.

7. LOCATION

Ideally, INGEN should have its permanent home in London or within easy travelling distance of the capital. It should have an associated travelling exhibition which would tour the regions at appropriate times during the year. Thus INGEN will not only be a central organisation but will have local organisations centred on universities, polytechnics and other centres of higher education. If for any reason it is found impossible to set up a permanent home for INGEN in or close to London, an alternative site could be on the south coast. This would have certain attractions due to its closeness to London, and to the high technology industry which has gravitated to the area. With holiday centres and enterprising Universities and Polytechnics in Southampton and Portsmouth these might be regarded at ideal locations for INGEN.

A moving machine can be 'frozen' with a stroboscope.

8. COST CONSIDERATIONS

The cost of building a suitable centre would of course be very substantial. It is hoped that a building can be found which already exists and which would not be too costly to adapt.

The cost of running the centre may be considered in three main parts:

(i) Salaries for personnel

(ii) Running costs

(iii) Acquisition costs

Many of the well established centres (Paris 1944, Tokyo 1964, Toronto 1969) have staff in the order of 200 members. Quite clearly a much more modest start can be made with a permanent director, two or three technical designers and a staff of eight members to act as guides and technicians. For secretarial support, two members would certainly suffice for everyday running, although a move towards the publication of journals would be more demanding.

The costs of heating and lighting would be small compared with the salary budget. The cost of turning over the range of exhibits would be diminished by the availability of technical staff.

The large initial cost of constructing exhibits can be eased by borrowing a proportion of existing units from other institutions, many of whom have one or two devices which accord with the interactive nature of the exhibition. By replacing these over a period of time the financial burden will be spread. In addition, industry can be relied upon to support the exhibition by building exhibits which promote industrial contents.

In the nature of the venture public money in one form or another is probably the only realistic possibility. Thus it is intended to approach every source of public funding which might be available. No doubt a certain amount of financial assistance would also be available from other sources such as:-

(a) Entry charges (if thought desirable)

(b) Industry - directly or indirectly

(c) Benefactors

(d) Voluntary help at least in the early days

9. BENEFITS

To instill into young people an awareness of engineering and scientific principles in an enjoyable way can only be to the long term economic good of the country.

Industry will see a tangible benefit in attracting brighter and more innovative young people to the Engineering profession, whilst the youngsters themselves will benefit from insight into the potential of such a career. The exhibition should prove to be of real value to careers advisors and to both schools and further education establishments.

Finally of course, the region in which the exhibition exists will, we believe, enjoy substantial benefits, such as come from any major public facility which attracts visitors from far afield.

Techniques for vibration measurement and mode shape are needed in many branches of engineering design.

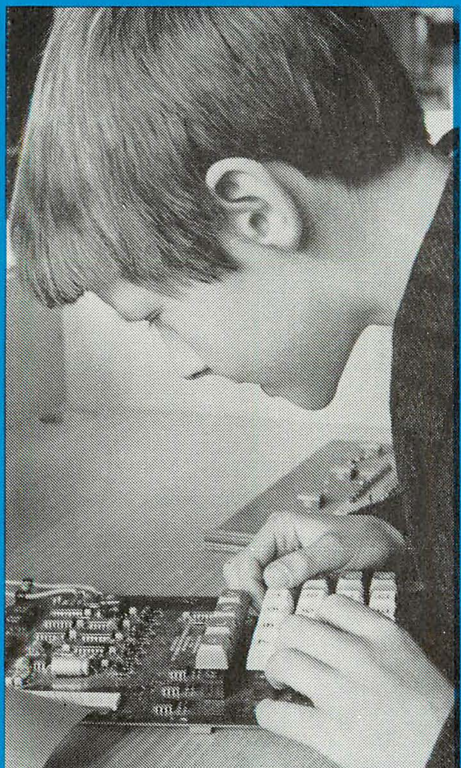
The INGEN Committee

Mr John Arnold	:	**Department of Mechanical Engineering Portsmouth Polytechnic**
Dr John Billingsley	:	**Department of Electrical Engineering Portsmouth Polytechnic**
Mr R H Gammon	:	**Southern Science and Technology Forum University of Southampton**
Mr John Gibbs	:	**Department of Civil Engineering Portsmouth Polytechnic**
Mr J Gorman	:	**Astronomical Society**
Mr D Jenkins	:	**Southern Gas**
Professor G M Lilley	:	**Department of Aeronautics and Astronautics University of Southampton**
Mr Harry Newman	:	**Department of Mechanical Engineering Portsmouth Polytechnic**
Mr Colin Peters	:	**Department of Civil Engineering Portsmouth Polytechnic**
Mr P Richmond	:	**Department of Education University of Southampton**
Mr C E Tate	:	**Plessey Ltd.**

INVENTIONGENIUSINGENUITYINNOVATINGENGINEERING

INGEN

A 'HANDS-ON' EXPERIENCE OF SCIENCE AND ENGINEERING

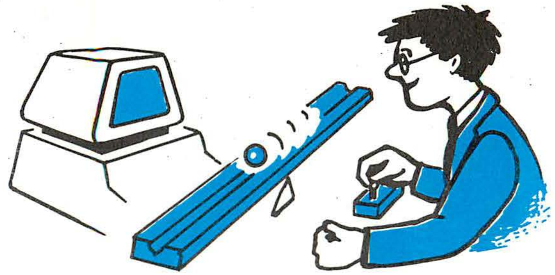


MOUNTBATTEN GALLERY

GUILDHALL,SQUARE, PORTSMOUTH

Friday, 1st January – Thursday, 7th January, 1982
(Except Sunday)
10 am to 4pm each day, Tuesday 10am to 8pm

CONTROL THE IMPOSSIBLE WITH THE HELP OF A COMPUTER – or see if you can succeed alone. To control a rolling ball in a tilting track requires enormous skill. With the help of a computer it is suddenly easy.



MEET THE CHAMPION EUROMOUSE – "THUMPER" THE TALKING MAZE–SOLVING ROBOT. With a microprocessor to work out the way, Thumper explores a wooden maze to find the shortest path to the centre.

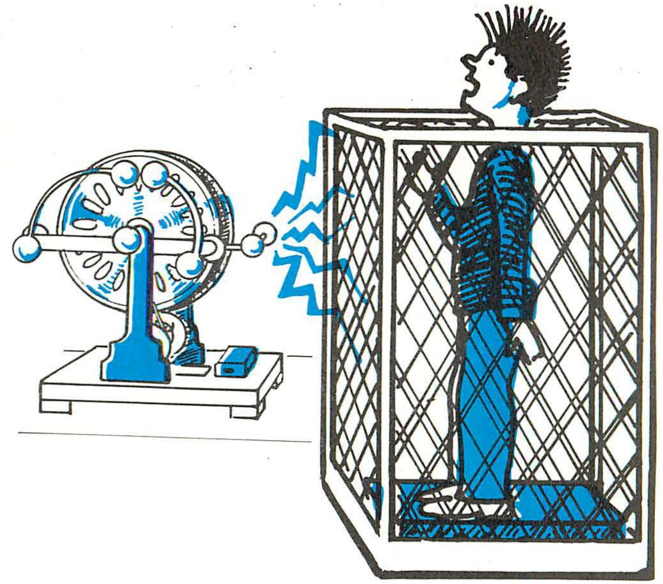
GYRATE WITH A GYROSCOPE.

MEET A HOLOGRAPHIC GHOST. In a hologram you see a full three-dimensional image.

SEE A SUPERSONIC SHOCKWAVE.

TEST YOUR STRENGTH WITH PHOTO–ELASTICITY. Polarising filters make it possible to see the forces inside a plastic block as bands of colour.

SEE THAT SOUND, HEAR THAT LIGHT.



50,000 VOLTS WILL MAKE YOUR HAIR STAND ON END. In the safety of a Faraday cage you can be charged to enormous voltages with no effect. But put your head out through the hole in the top and . . .

COME AND SEE many more exhibits – and work them yourself.

INGEN 82 is a pilot project paving the way for a permanent centre of Engineering Science in Portsmouth, where the visitor will interact with working displays to explore the fascinating world of Engineering Today.

INGEN is supported by the Southern Science and Technology Forum in association with Portsmouth Polytechnic and Southampton University.

INGEN, Southern Science and Technology Forum, Building 25, The University, Southampton SO9 5NH. Tel. (0703) 558379

EUROMOUSE MAZE CONTEST

EUROMICRO '86

Microprocessor controlled robot mice must find their way to the centre of the maze.

1. Maze Dimensions

The maze consists of 16 x 16 squares. The squares are based on a 18 cm (7 inch) matrix. The walls of the maze are 12 mm (½ inch) thick, and the passageways are thus 16.5 cm (6½ inch) wide. The walls are 5 cm (2 inch) high, painted white with red tops. The target post at the centre, 2.5 cm (1 inch) square, is 20 cm (8 inches) high, and can be removed if desired. The starting square is at the 'bottom left' corner of the maze, and the mouse is initially oriented so that the target is diagonally to its right. The running surface is chipboard, painted with black emulsion paint.

Dimensions should not be assumed to be more accurate than 5%: the maze may be made to metric or imperial dimensions, and quoted figures may be approximations (to 5%). Joins in the maze base will not involve steps of greater than 0.5 mm - possibly covered with tape. However, warping of the maze base during transport or storage may result in a change in gradient at a join of as much as 4°.

2. Mouse Restrictions

Although the superstructure of the mice may 'bulge' above the top of the maze walls, mice must be subject to the following size constraints - width 25 cm, length 25 cm. There is no height limit but beware of toppling! Mice must be completely self-contained and must receive no outside assistance. The method of wall sensing is at the discretion of the builder, however, the mouse must not exert a force on any wall likely to cause damage. The method of propulsion is at the discretion of the builder provided that the power source is non-polluting - internal combustion engines would probably be disqualified on this count. If the judges consider that a mouse has a high risk of damaging or sullying the maze they will not permit it to run. Nothing may be deposited in the maze. The mouse must negotiate the maze; it must not step over or otherwise illegally cross any maze wall. The means of locomotion of the mouse is again at the discretion of the designer.

3. Championship Rules

(a) Each mouse is allowed a maximum total of 15 minutes to perform. (With increasing numbers of mice, this may have to be reduced to 10 minutes in future). The judges have the discretion to request a mouse to retire early if by its lack of progress it has become boring, or if by erratic behaviour it is endangering the state of the maze.

(b) If the mouse can succeed in finding its way from the start to the maze centre the time is noted. The mouse can then make a second run, either by being lifted out and restarted or by making its way to the start square, perhaps by another exploratory route. Only "inward" times are noted, but as many runs are permitted as are possible within the time limit.

Scoring is designed to reward intelligence, efficiency of maze solving and self-reliance of the mouse. To the time of each run is added one thirtieth of the total time then elapsed. Thus a sixty second run achieved after five minutes "on stage" will score seventy seconds. Until the mouse is first touched, however, a ten second bonus will apply to each run. A mouse achieving a sixty second run after five minutes will score 60 + 2x5 - 10 = 60 seconds if it has not been handled, implying that it will have found its own way back to the start each time. Once touched, the subsequent runs are timed without bonus. The score of the mouse is taken as the score of its best run.

(c) If a mouse 'gets into trouble', the handlers can ask the judge for permission to abandon the run and restart the mouse at the beginning. A mouse may not be re-started merely because it has taken a wrong turning - the judges decision is final. The judges may add a time penalty for a restart.

(d) If any part of a mouse is replaced during its performance, such as batteries or EPROMs, or if any significant adjustment is made then the memory of the maze within the mouse must be erased before restarting. Slight manipulations of sensors will probably be condoned, but operation of speed or strategy controls is expressly forbidden without a memory erasure.

(e) If no successful run has been made, the judges will make a qualitative assessment of the mouse's performance, based on distance achieved, 'purposefulness' versus random behaviour and quality of control.

(f) If a mouse elects to retire because of technical problems, the judges may at their discretion permit it to perform again later in the contest. The mouse will be seemed to have taken an extra three minutes performance time (i.e. if a mouse retires after four minutes, then when restarting it is counted as having taken seven minutes and will have only eight more minutes to run). This permission is likely to be withdrawn if the programme is full or behind schedule.

(g) The judges will use their discretion to award the prizes, which in addition to the major prize may include prizes for specific classes of mouse - perhaps lowest cost, most ingenious, best presented, etc.

(h) Before the maze is unveiled the mice must be accepted and caged by the contest officials. The handlers will place the mice at the start under the officials' instructions.

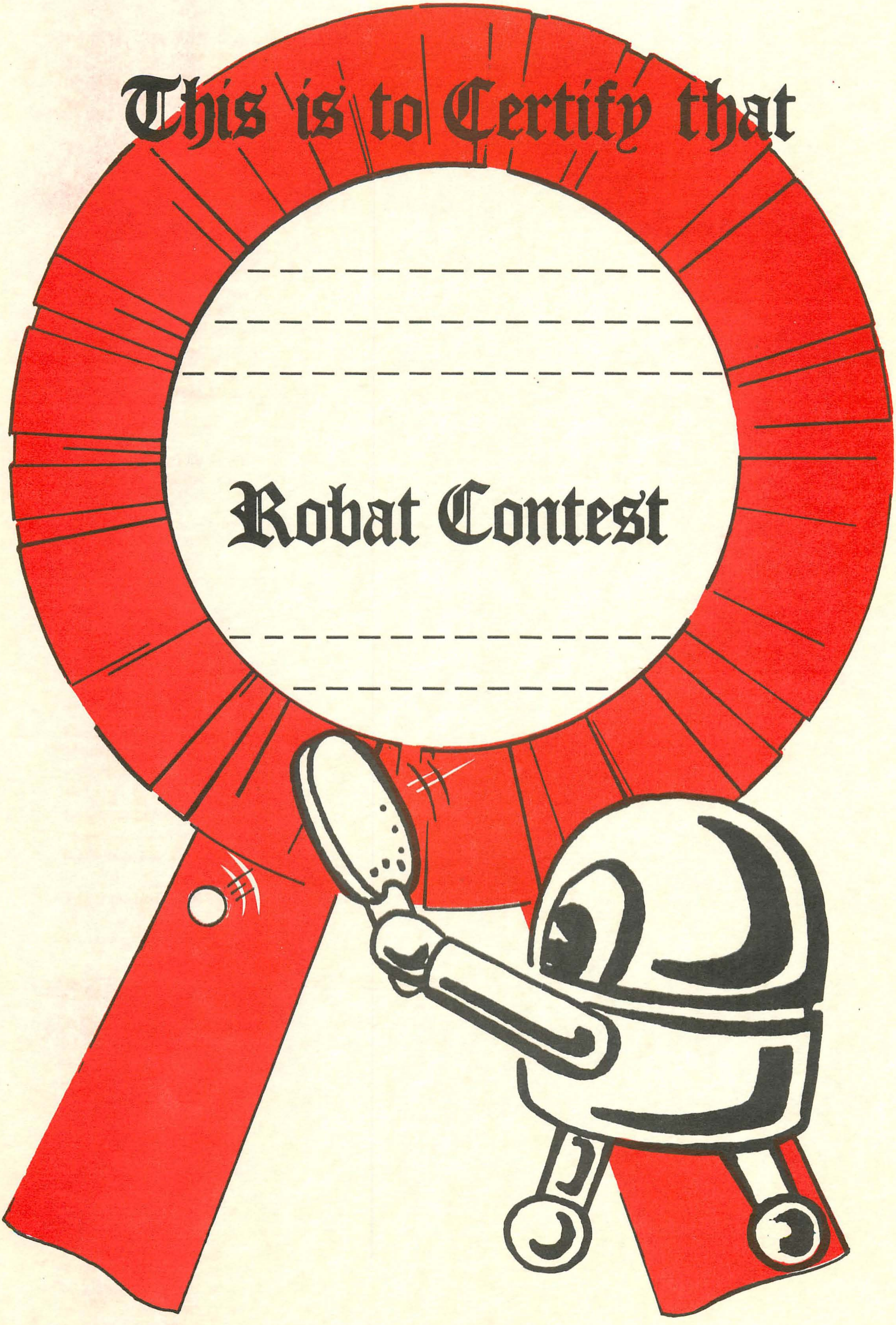
(i) The starting procedure of the mouse should be simple and must not offer a choice of strategies to the handler. For example, a decision to make a fast run to the centre as time runs out must be made by the mouse itself.

(j) No part of the mouse (with the possible exception of batteries) may be transferred to another mouse. Thus if one chassis is used with two alternative controllers then they are the same mouse and must perform within a single 15 minute allocation. The memory must be cleared with the change of controller.

The Micromouse Maze Contest was first held in the USA by IEEE Spectrum.

November, 1985.


This is to Certify that
Euromouse Maze Contest
TIG


This is to Certify that
Robat Contest

vol. 9
Jul. 1985

MOUSE

JOURNAL of The JAPAN MICROMOUSE ASSOCIATION

日本マイクロマウス協会
JAPAN MICROMOUSE ASSOCIATION

'85 WORLD MICROMOUSE CONTEST

'85マイクロマウス世界大会

'85 WORLD MICROMOUSE CONTEST

EXPO'85

GENERAL INFORMATION

Name:	'85 WORLD MICROMOUSE CONTEST
Date:	August 23 (Fri.) - 25 (Sun.), 1985 Preliminary Match : August 23, 24 Final Match : August 25
Venue:	The Site of Tsukuba Expo '85 Expo Hall, Capacity 600
Sponsor:	The Japan Association for the International Exposition, Tsukuba, 1985 Japan Science Foundation Japan Micromouse Association
Support:	Science and Technology Agency, Ministry of Foreign Affairs, Ministry of Education, Ministry of International Trade and Industry, Embassy of the United States of America, British Embassy, Embassy of the Republic of Korea, Embassy of the Federal Republic of Germany, Embassy of Finland, Japan Electronic Industry Development Association, Japan Industrial Robot Association, Information Processing Society of Japan, The Japan Society of Precision Engineering, Japan Microcomputer Club, Robotics Society of Japan, IEEE Computer Society, Euromicro, Seoul National University
Special Collaborator:	Namco Limited
The Event:	The '85 Micromouse Contest Conducted in accordance with the Micromouse Contest Rules as set down by the Japan Micromouse Association.
Number of Contestants:	Approximately 15 from 5 overseas, and 120 from Japan

MICE FROM ALL OVER THE WORLD HAVE GATHERED AT TSUKUBA

Brains from every country have come from near and far to Tsukuba seeking the micromouse world crown:

Japan

The Fukuyama chapter of the Hiroshima microcomputer club, who beginning with the Second All Japan Tournament have won first prize for four consecutive years, as they did in the 5th annual tournament, will introduce 2 micromice, the first one a gyro-equipped mouse (NAZCA). It seems certain that they, along with Mr. Isao Yoshii who is competing well in the Kanto Region, will participate in the finals.

Korea

In Korea, where last year the first micromouse contest was held, with Seoul University's engineering department in the forefront, efforts at expansion are being made. Although the history of their participation in the event is little more than one year long, a good fight is expected this year from the two demonstration mice Korea has entered.

Europe

The countries of Europe who have been participating in the event for as many as six years, the same as Japan, this year will send five guest teams from three countries. Among these will be England's three wheel super light mouse that won last year's first prize. This mouse's extraordinary speed is a thing to watch. The other European contestants as well are fully capable of moving into the winner circle and one can expect some unique designs from the European teams.

The United States

As for the birthplace of the micromouse, the United States, after having cancelled their National American Tournament at one point, this year have decided to reopen the American tournament in accordance with the international contest rules. This year the University of California's Berkeley team will attend the Tsukuba contest. With plans for the 2nd American National Tournament concluded, the United States plans to make a comeback and is determined not to be out-moused by Japan or Europe.

THE LIST OF INVITED MICROMICE

Country	Name of micromouse	Name of contestant	Age	Remarks
England	Enterprise	David Woodfield	37	Euromicro '84 First Place
	T-5	Alan L.S. Dibley	47	Euromicro '84 Third Place
Finland	Manu	Hannu-Matti, and others	26	Euromicro '84 Second Place
	Tellu	Hannu-Matti, and others	26	Euromicro '84 Fourth Place
F.R.G.	Speedy Gonzales	Ralf Hinkel	26	Entry mouse for Euromicro '84
U.S.A.	Moon Knight Delight	Baxter Cheung, and others	26	'85 United States Micromouse Contest First Place
Korea	GOCHOO 2HO	Hyeok Lee, and others	22	'85 Korean Micromouse Contest First Place
	SAPIENCE	Kim Kee Hee	21	'85 Korean Micromouse Contest Second Place
Japan	NAZCA	Masanori Nomura Masaru Itani	32 26	'84 Japan Micromouse Contest First Place
	LABO-2	Isao Yoshii	42	'84 Japan Micromouse Contest Second Place
	Puzilism	Takayuki Uehiro	29	'84 Japan Micromouse Contest Third Place

MICROMOUSE IS .....

The object of the micromouse contest, much like this maze puzzle, is to be the first to get ones robot (mouse) through a complex maze using the robots own judgement and memory. The mouse must be completely self sufficient, its brain computer, sensors gauging the conditions of the outer environment, functions for movement and batteries etc. must all be contained within the robot body and neither wired nor wireless exterior manipulation is allowed.

Put simply, we are looking for the complete mecatronic integration of amateur mechanical, electronic and computer skills.

EXPLANATION OF CONTEST RULES

Within the contest time limit of 15 minutes, each contestant is allowed to run his or her mouse through the course up to 10 times. The contestant who has the shortest course time from start to finish wins. The object is to reach the goal at the center of the 3 × 3 meter maze, made up of 16 × 16 compartments. In the first course run the mouse must explore the whole maze and with this memory stored in its "brain", must figure out for itself the shortest possible passage to the goal. After this is completed the mouse is set free to run the course it has come up with. The superior mouse will be able to cut down its course time by speeding up or employing "slalom" techniques. It is a real test of brain power.

THE MICROMOUSE'S MERITS

Point 1

— Can he really reach the goal? —

For the mouse who knows only that the goal is at the center of the maze, it is a task to decide which road to take at every fork in the path.

There are mice with algorithms instructing them to always choose roads leading to the center (centripetal law), to go always to the left or just to turn when encountering a curve.

Point 2

— Which course is really the shortest? —

The mouse covers the whole maze and constructs a map of it in his brain, then from all of the possible courses calculates the one he feels to be the fastest.

It is not just length, but the number of corners taken is also a big factor going just a little bit farther in order to make a straight course can save considerable time. There are instances when in order to succeed "time must be taken" and patience is necessary.

Point 3

— Speed is the mouse's life. —

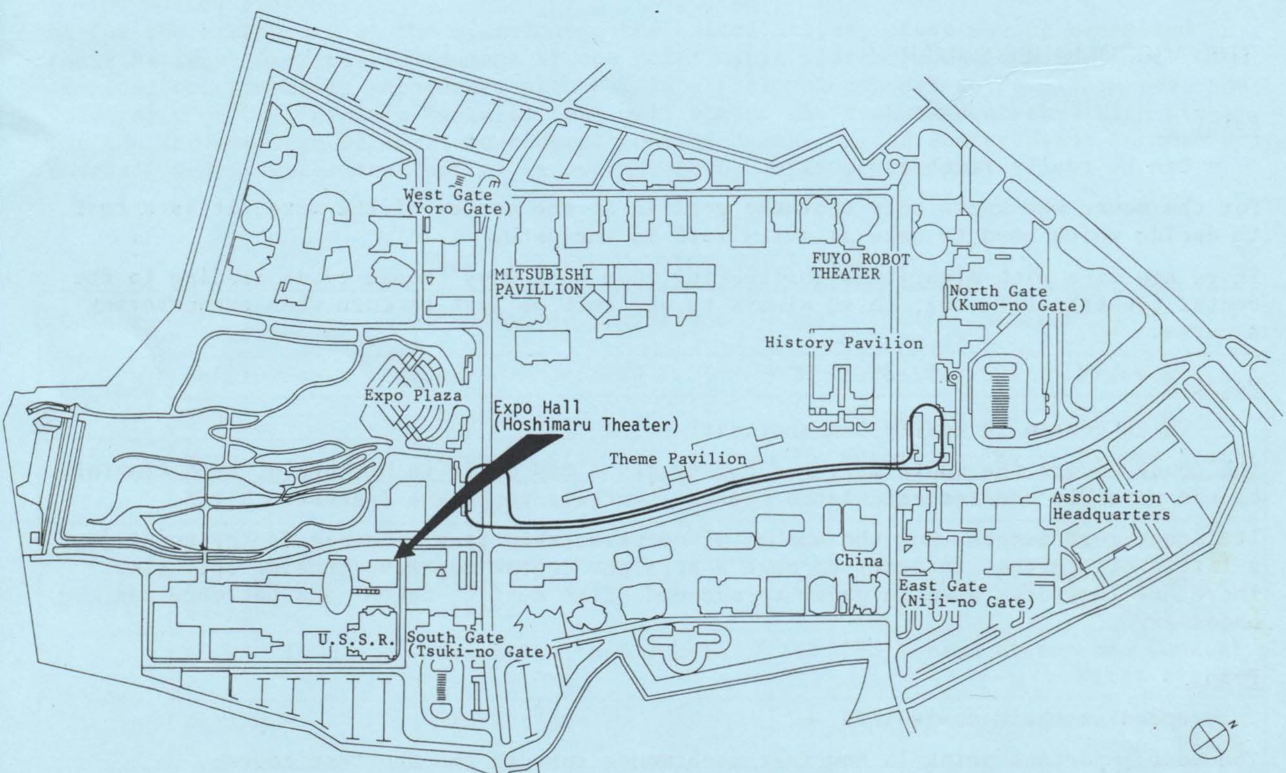
The most important point is how fast each mouse runs in the shortest course.

The same as with the operation of a racing car, as speed increases it becomes extremely difficult to maintain control. One slight miscalculation and the crash wall awaits. This is the thrill of the micromouse contest.

SCHEDULE

August 23 (Fri.)	August 24 (Sat.)	August 25 (Sun.)
		9:30 Opning Show
10:00 Opening Show	10:00 Opening Show	10:00 Final Match (Approx. 31 contestants)
10:30 Preliminary Match (Approx. 60 contestants)	10:30 Preliminary Match (Approx. 60 contestants)	
12:00 Demonstration	12:00 Demonstration	
13:00 Preliminary Match 17:00 (Tentative)	13:00 Preliminary Match 17:00 (Tentative)	
		18:00 Award Ceremony 18:30

LOCATION MAP



Materials reproduced under the supervision of the Japan Association for the International Science Exposition, Tsukuba, 1985

Note: This contest was made possible with the special cooperation of Namco, Ltd.

Japan Science Foundation
Secretariat of
'85 World Micromouse Contest
2-1, Kitanomaru Koen, Chiyoda-ku
Tokyo 102, Japan

(承) V－A－0023

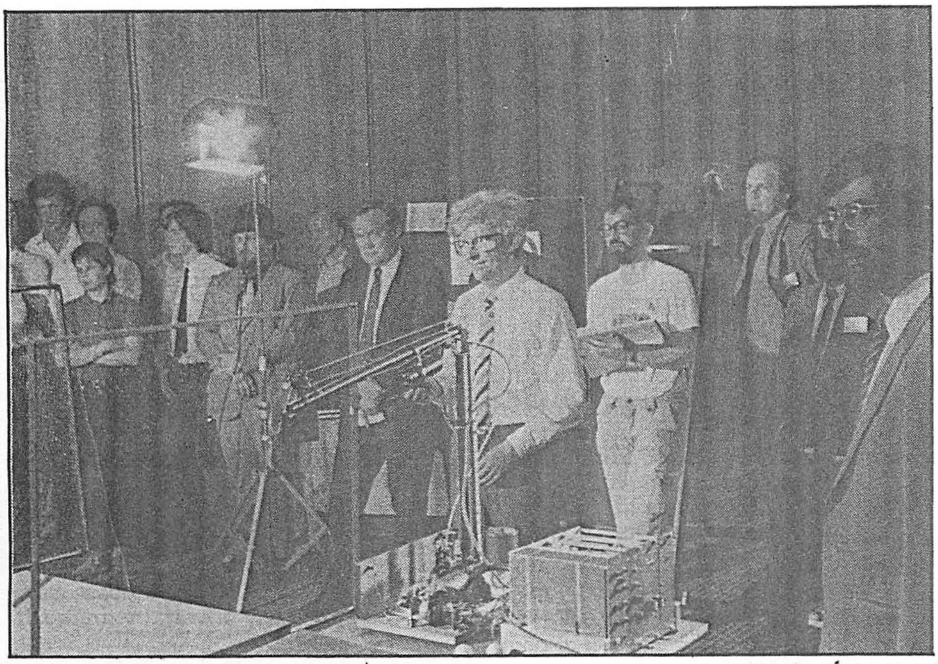


Fig. 2 Robat

control, and a new mouse, Ancomical, was entered by ICL's amateur computer club. Technology ranged from Brainy Bricks, made from Lego, to Pascal, sawn down from a toy car and struggling to clear the corners with three-point turns. Lami was marvellously engineered with tyres made of crossmounted micro-wheels. These allowed it to perform a virtuoso display of driving in a circle while pointing north. The novel wheels unfortunately demanded an absolutely flat surface, and an uneven joint in the maze base marred Lami's contest performance.

One mouse was built around a CMOS processor. The body of aluminium had been carved out with tin snips, and the wall sensors were metal flaps which closed contacts salvaged from a relay. With no previous electronic experience, Nick Smith had put together Sterling Mouse, the first mouse to reach the centre and 'know' it had succeeded. The strategy had its roots in dynamic programming, but was so simple in essence that the calculations could be carried out as a delay routine between motor steps.

An Easter workshop was organised by the ICL computer club, where ideas were exchanged and advances were made. Thezeus and Thumper appeared at Wembley in 1981, founding a dynasty of winners. David Woodfield's Thumper combined ingenuity with superb craftsmanship, using four swivelling wheels which allowed it to manoeuvre without rotating. In Thezeus, Alan Dibley established the practice of building a small personal computer into the Micromouse—albeit with sawn-off keyboard. 15 mice took part in the Paris Euromicro finals, and Thumper became the new European champion. The rules had again been changed slightly, giving each mouse 15 min in which to perform, the best run being counted. This put a premium on learning ability, and the time achieved for the best run had by now been cut to below a minute.

The 1982 British finals were held at the Computer Fair, Earls Court—the first of three such years. Two new Thezei beat Thumper into third place, but all three times were below one minute. The University of Tampere in Finland played host to the 1982 European finals; they snatched victory from Thezeus-4 by a mere two seconds margin, taking 40 s, and retained the title the next year in Madrid.

At last, in Copenhagen, at Euromicro 1984, Britain won the title back through the efforts of Enterprise, grandson of Thumper. The shortest path was 70 squares in length, covered in an amazing 27 s. David Woodfield and Alan Dibley will now join teams from Finland and Germany in the Japanese All World contest in Tsukuba. Even more contestants are expected from South Korea and the United States, and of course Japan.

Robot ping-pong

In November 1981, a microrobotics conference was held at Imperial College. Someone asked the question: 'What can follow Micromouse when solving the maze is seen as easy?' Three-dimensional mazes were suggested, along with noncartesian shapes and walls which move. All these are possibilities, although there are still plenty of challenges in the contest as it is. A contest of a different type was needed, and I suggested robot ping-pong. Playing very safe, I named a date five years off for the first heat—but it has arrived in less than four.

A group of entrants met in Portsmouth on 19th January 1985 to exchange ideas and polish up the rules. Three very primitive pieces of machinery arrived: two bat mechanisms and a vision system. Nothing really worked, although an oscilloscope trace showed a peak where the ball might just possibly be. Less than two months later, the contest was introduced on BBC's Micro Live. One of the mechanisms now leaped about, threatening mayhem to the presenter who stood too close. The vision system put up an excellent screen display of the track of a real bouncing ball, and a completely new arm succeeded in taking a swipe at the ball.

By the time this article reaches print, you will have seen the Robats doing battle in earnest at the European Personal Robotics Congress, and more recently they will have met again to challenge the European contestants at the Euromicro Conference in Brussels, 3rd–6th September 1985 (where Euromouse will also be held). I suspect that the flight of the ball will at first be erratic, to say the least. But from the first few tentative efforts, a whole new technique of dynamic robot response and interception will emerge.

Conclusion

Micromouse has grown up here on a shoestring budget, begging space at annual British exhibitions and scrounging prizes from the exhibitors. It is none the worse for that. In Japan, however, there is a permanent Micromouse Secretariat. They were present at last year's Euromicro finals in Copenhagen, and awarded nine free air flights to European participants to take part in this year's Japanese finals. The maze used at the European Personal Robot Congress has been flown here by the Japanese Science Foundation, so that any incompatibilities can be sorted out beforehand, and mazes have been sent to South Korea and the United States. Could the importance which the Japanese obviously give to such contests be linked with their industrial success, both resulting from it and resulting in further success?

Micromouse and Robat will continue to give qualified and unqualified engineers alike the opportunity to innovate. Their ideas may at times spin off into industrial applications; the contestants themselves may be recruited by marketers of new robotic products. In all events, they enhance the awareness and ability of the country as a whole to ride on the rushing tide of technology.

Details of the Micromouse and robot ping-pong (Robat) contests can be obtained from Dr. John Billingsley, Department of Electrical & Electronic Engineering, Portsmouth Polytechnic, Anglesea Building, Anglesea Road, Portsmouth PO1 3DJ.

This paper is a revised version of a paper presented at the European Personal Robotics Conference, London, July 1985.

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THE INSTITUTE OF
ELECTRICAL AND
ELECTRONICS
ENGINEERS, INC.

SECTION DE MONTRÉAL SECTION

Montreal, August 1st, 1988

A few months ago, **IEEE MONTREAL** announced that the ***1st Contest MicroMouse MONTREAL International*** will be held in Montreal next October. The Contest is the first of its kind in Canada.

This Contest is sponsored by **IEEE MONTREAL** and it is jointly organized with the **SALON EDUCATION SCIENCE TECHNOLOGIE** with the participation of **Hydro-Quebec.**

The ***Contest MicroMouse MONTREAL International*** will be held at the Hydro-Quebec Pavillion of the Salon from October 13 to 19. ***MicroMouse MONTREAL International*** is billed to be a fun event for one and all. The enclosed documents show the activities being planned for this week long event. Please note that the Qualifying runs and the Competition itself will be held October 18 and 19.

MicroMouse MONTREAL International will be a most entertaining event and I urge you strongly to participate actively in it!

Very sincerely yours,

Michel Fortier, eng.
Président

N.B.: The best Canadian participant will be automatically qualified to participate in the ***World MicroMouse Contest 1989 (USA).***

IEEE MONTREAL

is pleased to announce the organization of the

1st MicroMouse MONTREAL International Contest

on October 19, 1988

at the

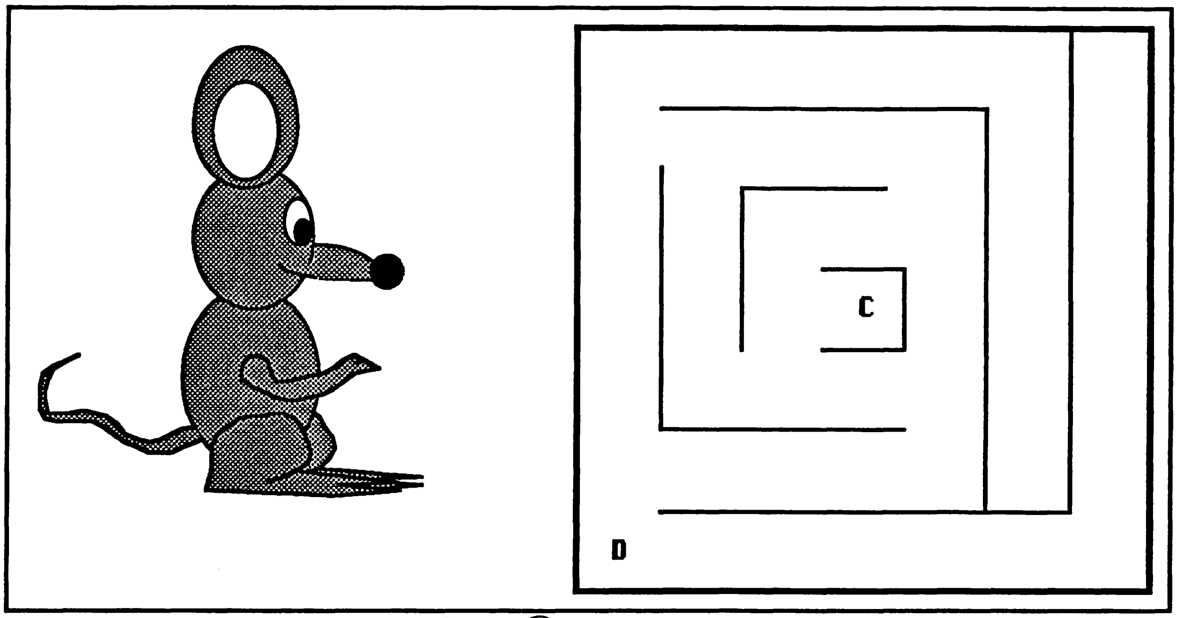
SALON EDUCATION SCIENCE TECHNOLOGIE

being held October 13 to 19 1988 at the

Olympic Velodrome of Montreal

with the participation of

Hydro-Québec



1st Contest
MicroMouse MONTREAL International

The contest is coming fast.

The **MicroMouse MONTREAL International** event,
the first MicroMouse contest of its kind in Canada,
sponsored by **IEEE MONTREAL**
and jointly established by
Salon Education Science Technologie and **Hydro-Québec**
will be held
at the *Olympic Vélodrome of Montreal.*

A whole week where people can see MicroMice.

From October 13 to 19 we will have ...
- Demonstrations, explanations, mini-competitions, ...
- **Qualifying runs** on **October 18 1988**
- The **Competition** on **October 19, 1988.**

Prizes of the Competition:
1st, 2nd and 3rd place prizes for the best runs (300$, 200$, 100$)
MicroFinish Prizes for each MicroMouse finishing a run on the maze (250$).

This competition is open to anyone who wishes to participate — without restriction except that participants must abide by the rules set forth (enclosed).
If you wish to participate in the contest,
help us prepare for the competition by filling the enclosed *PINK* form
and return it at the specified address.

For information:

Michel Fortier
Chairman
IEEE Montreal
Tel: 514-765-7822
FAX: 765-8785

François Rocque
Special Projects Coord.
Salon Education
Science Technologie
Tel: 514-861-8241

MicroMouse MONTREAL International

Rule book

Part I - Rules particular to MicroMouse MONTREAL International

Part II - General rules

Rule book
PART I

Rules particular to MicroMouse MONTREAL International

1. Registrations

(a) A registration consists of a MicroMouse and its team (captain and teammates). This registration is valid only for the duration of the competition (different than the duration of the event). All registration are handed over to the judge supervisor.

(b) To participate in the contest, the MicroMouse must have been registered before the beginning of the contest.

(c) A MicroMouse registered in a competition cannot undergo any changes after the beginning of the contest without the judging committee's authorization.

2. Maze configuration

The maze's configuration will be made public just before the beginning of each trial of the competition.

3. Competition format

(a) Only two (2) persons are allowed to handle the mouse inside the designated perimeter of the maze. The team captain must indicate to the head Official the name of these two persons.

(b) It is anticipated that the competition's format will use fixed starting times.

4. Competition and Prizes

(a) The **MicroMouse MONTREAL International Contest** admits any team wishing to participate in the event. All teams must abide by the rules contained in the rule book herein (parts I and II). The competition's prize is given to the team captain.

(b) The team must represent only one country and at least one team member must be a citizen of that country (unless a proxy is in effect - see point "(e)"

(c) The team captain must indicate to the judge supervisor under which context (Canadian/International, which country, etc...) he is participating, either in his registration or in writing if submitting a modification).

(d) *Proxy* – A MicroMouse may be entered into any one of the competitions without the team being present; in that case, the captain designates his representatives who are be on location and who then acquire the same distinctions of the original team.

(e) *Prizes and Awards* – The following *Prizes* will be given at the Competition:

One **First Place Prize** of 300$
One **Second Place Prize** of 200$
One **Third Place Prize** of 100$
A **MicroFinish Prize** of 250$ to any MicroMouse completing a run (one prize per MicroMouse)

The following *Awards* will be given at the Competition:

An Award for the **Canadian Champion** to the best Canadian team
An Award for the Best Hardware in **MicroMechanics**
An Award for the Best Software in **MicroIntelligence**
The Judges' Choice Award for Best **MicroDesign**

Rules particular to MicroMouse MONTREAL International (continued)

5. Jury and rule interpretations

(a) A jury will be appointed to apply the rules contained in this book, parts I and II, and will be the only one empowered to attribute points to the competition participants. This jury will be formed by **IEEE Montreal** and will be composed of one Head Official and, at least, two other Officials, their total number being odd.

(b) In case of a problem in interpretation or for any other case not covered by these rules, in parts I and II, the jury will consider the request or the situation and will render a decision. This decision will be without appeal.

Rule book
PART II

General rules for the MicroMouse MONTREAL International

1. MicroMouse specifications

(a) A MicroMouse will be self-contained.

(b) A MicroMouse cannot use an energy source employing a combustion process.

(c) A MicroMouse cannot leave any part of its body behind while negotiating the maze.

(d) A MicroMouse cannot jump over, climb, scratch, damage, or destroy the walls that constitute the maze.

(e) A MicroMouse cannot be larger, either in length or in width, than 25 centimeters. The dimensions of a MicroMouse which changes its geometry during a run will never be greater than 25 cm X 25 cm. There are no height restrictions for a MicroMouse .

2. Maze specifications

(a) The maze is square, composed of 16 by 16, or 256, unit squares. Each unit is 18 cm X 18 cm. The entire maze is enclosed by maze walls.

(b) The **start** square is a unit square that is located at one of the four corners of the maze.

(c) The four unit squares in the center of the maze form the **goal** square.

(d) The sides of the maze walls are white; the top of the wall is red; the floor is made of wood and is covered with nongloss black paint.

(e) Each wall is 1.2 cm wide by 5 cm high.

(f) A square zone at each of the four corners of a unit square is called a **lattice point.** Each lattice point is 1.2 cm X 1.2 cm.

(g) There is a goal post at each lattice point. The post in the center of the maze, i.e., in the center of the goal square, is called the **goal post.** It is 20 cm high and 2.5 cm X 2.5 cm square. The goal post is red. Each of the other posts is 5 cm high and 1.2 cm X 1.2 cm square; its top is red and its sides are white.

(h) The maze is configured such that there is at least one wall connected to each lattice point post. There is no wall connected to the goal post.

(i) The MicroMouse will begin negotiating the course in a clockwise direction.

3. Contest rules (general)

(a) Each official contesting MicroMouse is subject to a time limit of 15 minutes. Within this time limit, the MicroMouse may try to make up to 10 runs from the start square to the goal square.

(b) A run begins when an entrant leaves the start square and is successful if the entrant reaches the goal square.

(c) The red goal post will be removed from the maze by a Contest official for an entrant's allotted time if the entrant's operator so requests it prior to his starting time.

(d) A run is the sum of the time for a successful run and all bonuses and penalties for that run.

(e) The entrant with the minimum runtime is declared the winner.

Rule book
PART II
— CONTINUED —

General rules for the MicroMouse MONTREAL International (cont'd)

(f) The operator may abort a run at any time. If an operator touches its entrant after a run has begun, then the run is declared aborted. When an operator aborts a run, the team's people allowed inside the maze perimeter will remove their entrant as soon as possible.

(g) No information can be fed to the MicroMouse entrant from any source after the team has seen the maze configuration of the Contest.

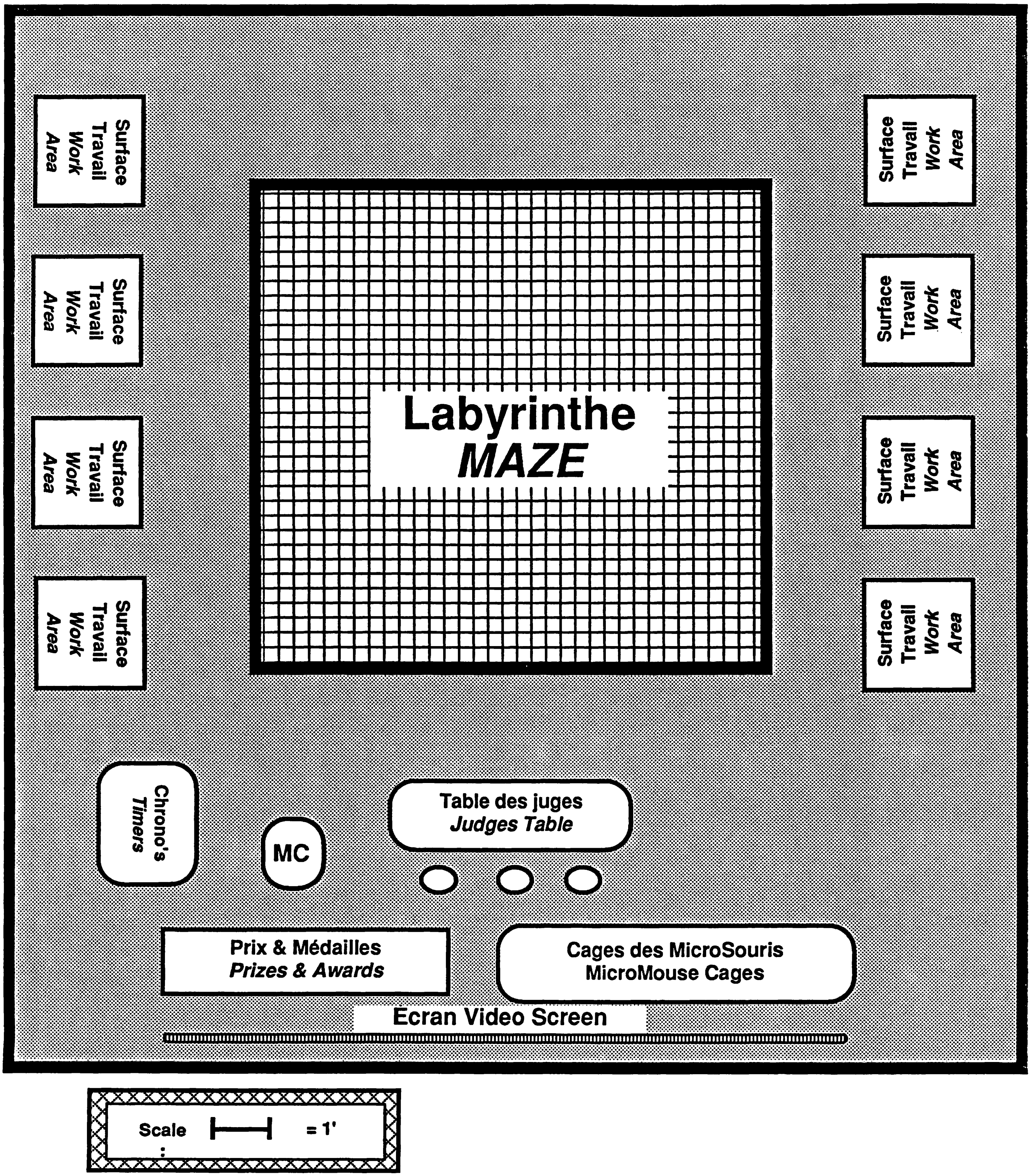
(h) The lighting in the room in which the Contest is held may be at a level suitable to support the use of video equipment. Adjustments of any of the environmental conditions may be requested but will be made only with the approval of the Contest officials.

(i) Contest officials have the right to ask an operator to describe his/her entrant.

(j) Contest officials may stop a run, disqualify an entrant, and/or give instructions as they deem appropriate.

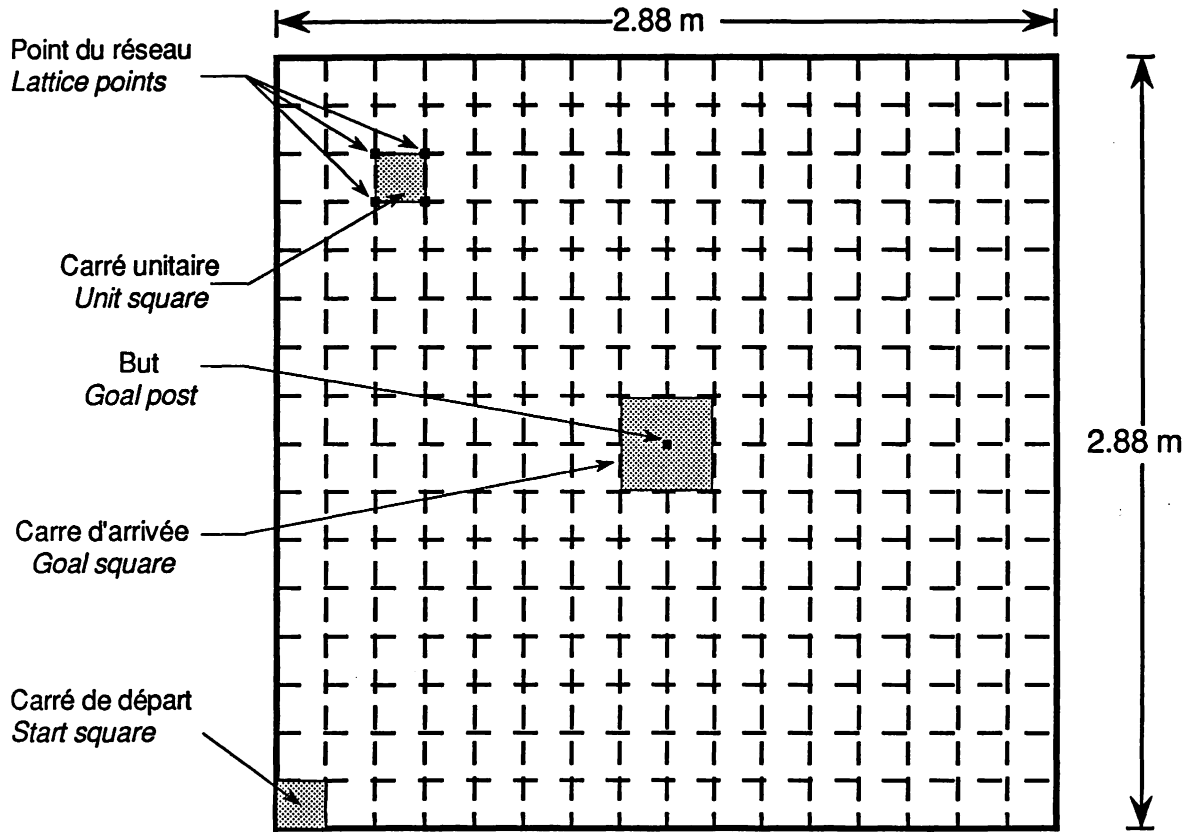
(k) Within an entrant's allotted time of 15 minutes, the operator may replace batteries and/or adjust sensors only.

(l) All other modifications to an entrant who has begun a run, e.g., ROM replacement, speed alterations, program loading, repair work, etc., may be requested by an operator if the Contest's rules permit. Such requests will be subject to any bonus and/or penalty points relevant to the rules in effect for that Contest.

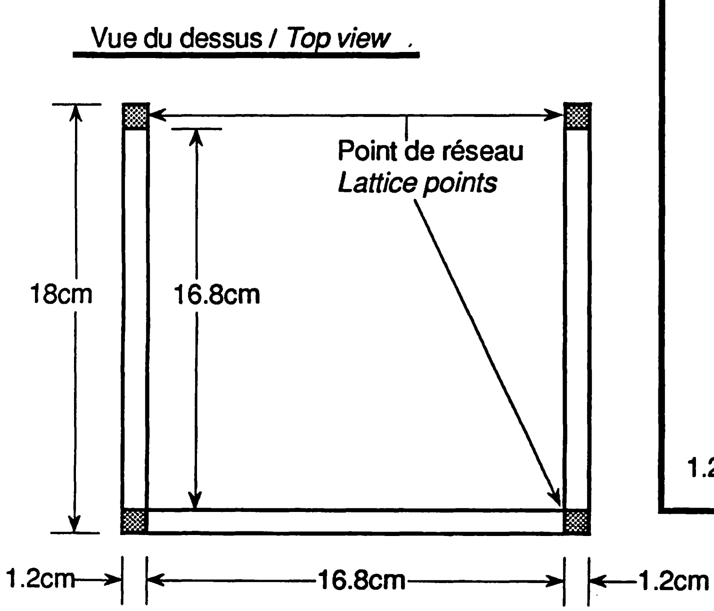


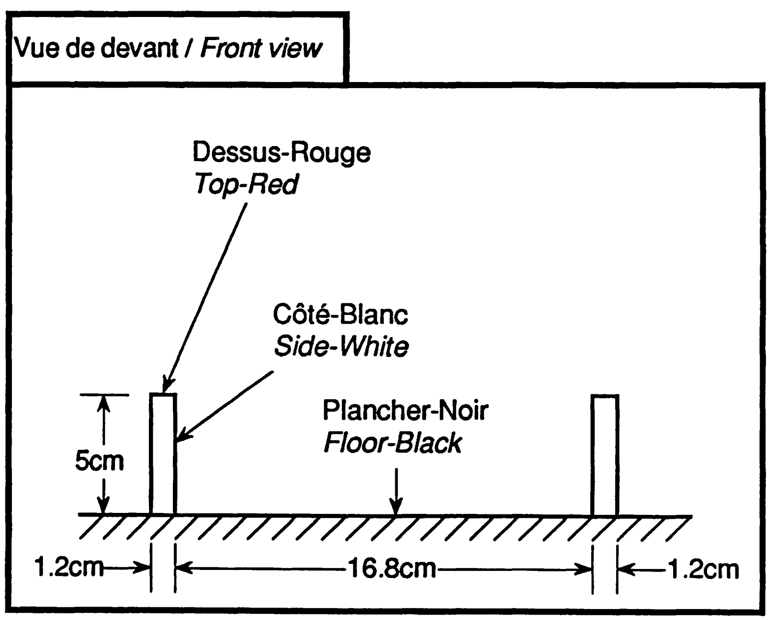
Disposition pour le Concours MicroSouris
MicroMouse Contest Layout

Labyrinthe — *Maze*



Carré unitaire • *Unit square*



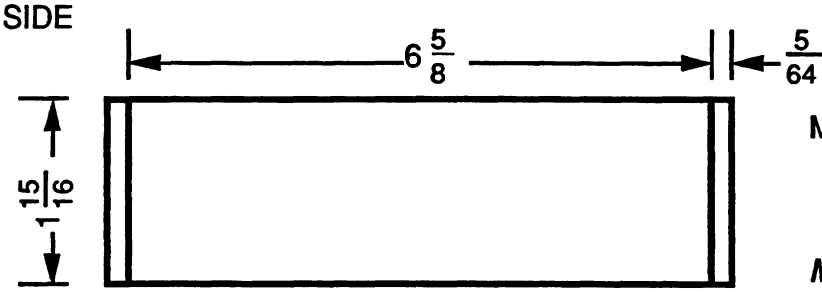


Labyrinthe MicroSouris
MicroMouse Maze Parts

LES DIMENSIONS SONT EN POUCES
ALL DIMENSIONS ARE IN INCHES

Mur du labyrinthe (les dimensions ne sont pas à l'échelle
Wall of maze *side and top views not shown to scale*)

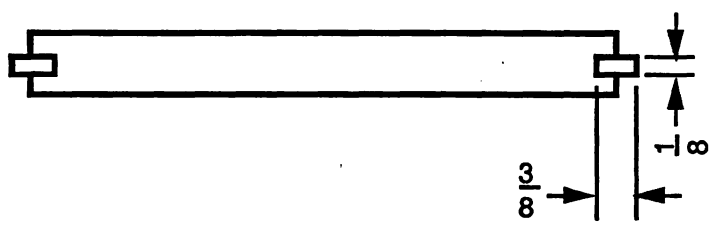
SIDE



Matériaux du mur:
- Press-wood couvert de mélamine
- Embouts fait au masonite
- Dessus peint en rouge

Material for wall:
- *Melamine covered press-wood*
- *Inserts made with masonite slats*
- *Top is painted red*

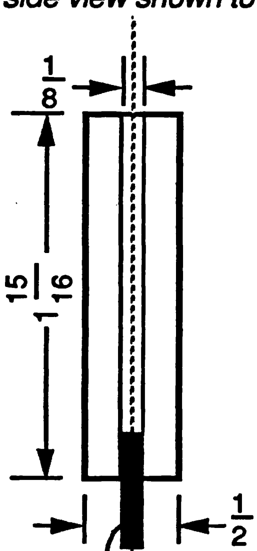
DESSUS
TOP



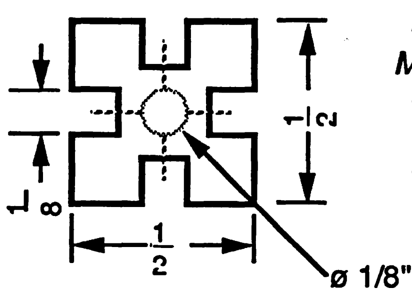
Poteau du labyrinthe
Post for maze

(vue de côté montrée à l'échelle; vue du dessus à 2x
side view shown to scale; top view shown 2 x side view scale)

COTE
SIDE



DESSUS
TOP



Matériau pour les poteaux:
- Bois dur de 0.5 x 0.5"
- Rainure faite à la toupie
- Clou coupé inséré au bout

Material for post:
- *Hardwood 0.5 x 0.5" stick*
- *Grooves made with router*
- *Nail inserted in hole at bottom*

Le clou dépasse du bas d'un demi pouce et a un diamètre d'un huitième de pouce.
Nail one-eighth inch thick inserted into hole projects out less than half an inch.

MicroMouse MONTREAL Information and Registration Form

Name of MicroMouse
and MasterMind ______________________________

Home address ______________________________

____
(City, Town, Country, POSTAL CODE)

Work address ______________________________
(Company name)
____

____
(City, Town, Country, POSTAL CODE)

School address ______________________________
(University/school name)
____

____
(City, Town, Country, POSTAL CODE)

I work full time ☐ part time ☐ and/or go to school full time ☐ or part time ☐.
Mailing address: ☐ HOME ☐ WORK ☐ SCHOOL

Please indicate if member/grade of IEEE or IEEE Computer Society
or one of the IEEE Societies
or a Society outside of IEEE ______________________________

Telephone number(s) and calling hours ( ) ______________________________

LOCAL INFORMATION

Name, address and telephone of Local Newspaper or University/School paper

____

My MicroMouse plans to sompete in the **IEEE MicroMouse MONTREAL International Contest** - 1988 and will represent (university/country): ______________________________

Please return to one of the following

For the IEEE Montreal MicroMouse International Contest

Michel Fortier, chairman
IEEE Montréal
3, Place duCommerce
Verdun, PQ (CANADA)
H3E 1H6
Tel: 514-765-7822 / FAX: 765-8785

François Rocque, Special Projects Coord.
Salon Educ. Science Technologie
435, rue de l'Inspecteur
Montréal, PQ (CANADA)
H3C 2K8
Tel: 514-861-8241


WHAT ARE YOU PREPARING... FOR THE YEAR 2000?
NEWTON.
Sir Isaac Newton (1642-1727)

SALON ÉDUCATION SCIENCE TECHNOLOGIE

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NEW DATES:

OCTOBER 13 TO 19 '88

OLYMPIC VELODROME

The Salon Éducation Science et Technologie arouses a strong interest in the sectors it wants to reach.

However, because of the scope of their projects, participants require more time to carry them out successfully. Consequently, we have brought two major changes to our program:

- New exhibition dates:
  October 13 to 19, 1988.
- Shorter exhibition period:
  7 days instead of 10

This decision has been made in order to allow all participants to give this event the importance and prestige it deserves.

Jacqueline Vézina

Jacqueline Vézina
President

SOUS LE HAUT PATRONAGE
Ministère de l'Éducation
AVEC LA COLLABORATION
Ministère de l'Enseignement supérieur et de la Science

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SALON ÉDUCATION SCIENCE TECHNOLOGIE

100,000 people from all over the province are expected to attend

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EXHIBITORS CAN BE:

- Educational Institutions - schools, colleges, CEGEPs, universities
- School Boards
- Industries
- Groups - federations, associations, corporations, institutions
- Research Centres
- Arts Centres and Cultural Centres
- Specialized Firms
- Governmental Services
- Special Project Sponsors
- Suppliers of Goods and Services
- The Media
- etc...

PRESENTATIONS, DEMONSTRATIONS OR SHOWS CAN BE PUT ON BY:

- Students from all levels
- Teachers and Educators
- School Board Administrators and Staff
- Parents
- Professionals
- Research Technicians
- Industrialists
- Employers
- Specialists - in communications, in educational and social services
- Producers of educational material
- Artists
- etc...

RESERVE NOW. Our team is at your disposal to answer any questions you may have and to help you plan your dynamic participation in this event.

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'85 WORLD MICROMOUSE CONTEST

May 25, 1984

With the remarkable advances in the performance of personal computers, the number of amateurs using these computers according to their individual needs is increasing rapidly. One of the purposes of this micromouse contest is to demonstrate the more sophysticated applications of microcomputers to general amateurs.

The World Micromouse Contest will be held concurrently with EXPO '85 in Tsukuba City and is open to micromice from all over the world.

In this contest, the contestants design and build small selfcontained robots to negotiate a complicated maze in the shortest possible time. A microcomputer must be incorporated into the design to control the sensors and drive motors, to memorize the progress of the mouse through the maze and to calculate the shortest path to the destination. Knowledge of computer hardware as well as software is required to apply the microcomputer. In other words, a micromouse is a typical application of mechatronics, encompassing sensor and motor controller technologies. Hence, a micromouse is a product of a great deal of mental agility and persistence. The creator, however, is more than compensated for his efforts by the satisfaction gained in producing a functioning micromouse.

Looking back over the history of the micromouse, the plan for the first contest was announced by the IEEE of the United States in 1977, and the final held in New York City was very successful. In 1984, COMPCON of IEEE is planning to stage a micromouse contest. Euromicro, an academic society in Europe, has held the Euromouse Contest annually since 1980.

In Japan, the All Japan Micromouse Contest has been held in the Science and Technology Museum every autumn since 1980, at which superior technologies have been demonstrated in dramatic contests.

Considering the lively micromouse contests held in many countries throughout the world, we believe that the time is ripe to hold a world micromouse contest. A common bond of microcomputer technology between people throughout the world is strengthened by their enthusiasm for the micromouse.

Japan Science Foundation

Japan Micromouse Association

'85 WORLD MICROMOUSE CONTEST

Official Rules of the Contest Prepared by

JAPAN MICROMOUSE ASSOCIATION

Effective from April 1984

Contestants in the MICROMOUSE CONTEST are required to build a robot which can negotiate a specified maze, the winner being the robot negotiating the maze in the shortest time. A robot participating in this contest is termed a micromouse.

1. Rules for the Micromouse

1-1 A micromouse shall be selfcontained.
A micromouse shall not use an energy source employing a combustion process.

1-2 A micromouse shall not leave part of its body behind while negotiating the maze.

1-3 A micromouse shall not jump over, climb, scratch, damage or destroy the walls that constitute the maze.

1-4 A micromouse shall not be larger, either in length or in width, than 25 centimeters. The dimensions of a micromouse, which changes its geometry during a run, shall not be greater than 25 cm x 25 cm.
There are no restrictions on the height of a micromouse.

2. Rules for the Maze

2-1 The sides of the maze walls shall be white, and the top of the walls shall be red. The floor shall be black. The track of the maze shall be made of wood finished with non-gloss black paint.

2-2 The maze shall be composed of multiples of an 18 cm x 18 cm unit square. The maze shall comprise 16 x 16 unit squares. The walls constituting the maze shall be 5cm high and 1.2 cm thick. The outside wall encloses the entire maze. (Refer to Figure 1.)

2-3 The start of the maze shall be located at one of the four corners. The mouse shall begin negotiating the course in a clockwise direction. At the center of the maze, there shall be a central square which is composed of 4 unit squares. This central square shall be the destination. At the center of the square shall be a red post, 20 cm high and each side 2.5 cm.

2-4 Small square zones, each 1.2 cm x 1.2 cm, at the four corners of each unit square are called lattice points. The maze is so constituted that there is at least one wall at a lattice point, except for the destination square. (Refer to Figure 1.)

3. Rules for the Contest

3-1 Each contesting micromouse shall be subject to a time limit of 15 minutes. Within this time limit, the micromouse may try to make up to 10 runs.
The minimum time recorded to negotiate the maze shall be the official time.

3-2 The time taken to negotiate the maze shall be measured by infrared sensors set at the start and destination.

3-3 Each run shall be made from the start. The operator may abort a run at any time.
If an operator touches his micromouse during a run, it is deemed to be aborted.
When an operator aborts a run, he shall remove the micromouse from the maze immediately.

3-4 After the maze is disclosed, the operator shall not feed information on the maze into the micromouse.

3-5 The illumination, temperature and humidity of the room in which the maze is located shall be those of an ambient environment. Requests to adjust the illumination shall not be accepted.

3-6 The Referee reserves the right to ask, as he deems it appropriate, the operator for an explanation of his micromouse. The Referee also reserves the right to stop a run, declare disqualification, or give instructions as he deems appropriate.

Appendices

(1) Dimensions of Micromouse

The size of the lower structure of a micromouse is constrained by the size of the maze and the provisions of Article 1-4.

(2) Structure of Maze

The precision with which the maze is made is that commonly used for similar structures, and there may be an element of error in the dimensions. As the maze is designed to be flexible, the design may produce gaps of approximately 1mm between sections of the walls.

(3) Adjustments to the Mouse During the Contest

Within the time limit of 15 minutes, the operator may replace batteries, adjust sensors, change speed, repair, load programs and replace ROM.
The operator may not, however, tamper with the micro-mouse in a manner which alters its weight.

(4) Positions of Sensors

Start sensor: At the boundary between the starting unit square and the next unit square.

Destination sensor: At the entrance of the destination square.

The infrared beam of each sensor is horizontal and positioned 1 cm above the floor. (Illustrated in figures 2 and 3-(d).)

(5) The Red Post at Destination

The red post at the center of the destination square may be removed if the operator so requests before his run.

(6) Note:

a) Please note that the following rules are rigidly enforced.

1) A run becomes invalid the moment the mouse is touched.

2) No more than 10 runs are allowed during the time period of 15 minutes.

b) There may be unit squares which are not sided by walls. (Refer to figure 3-(c) and 3-(d).)

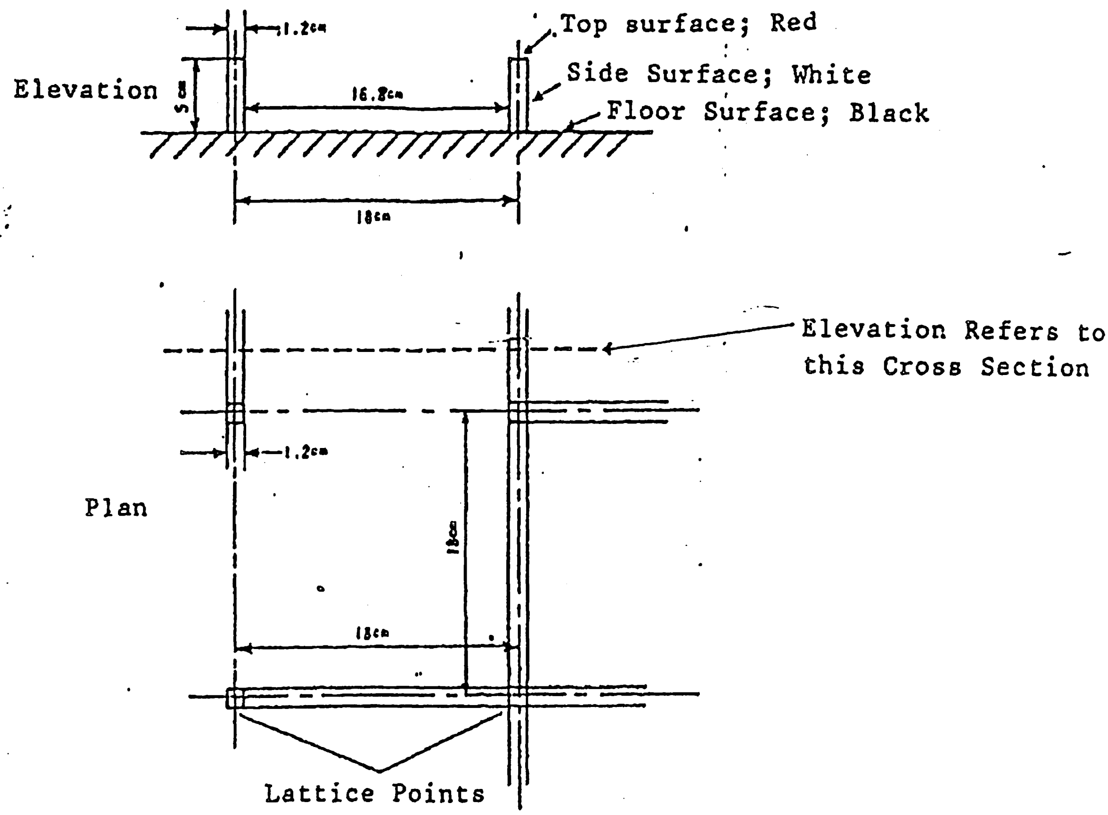


Figure 1 Structure of Maze

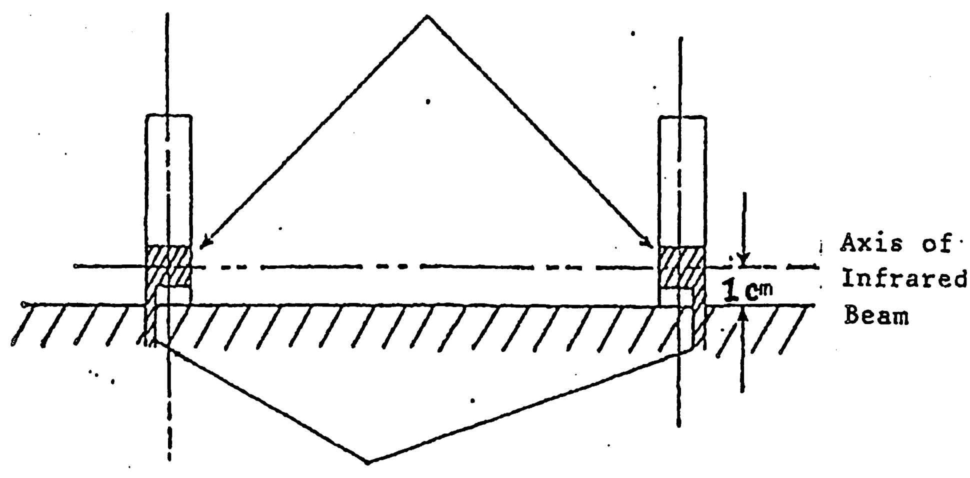
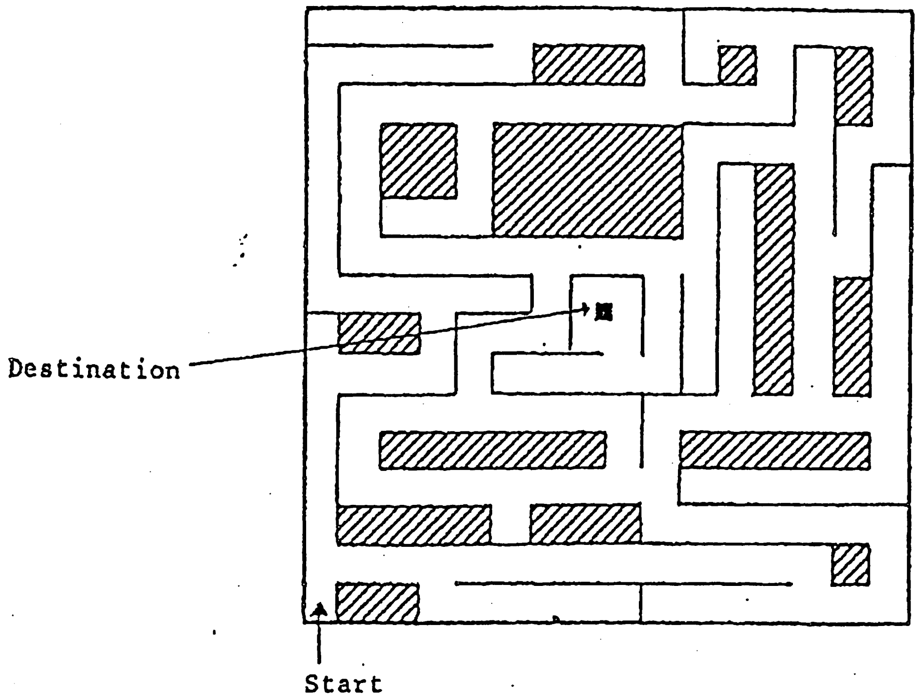
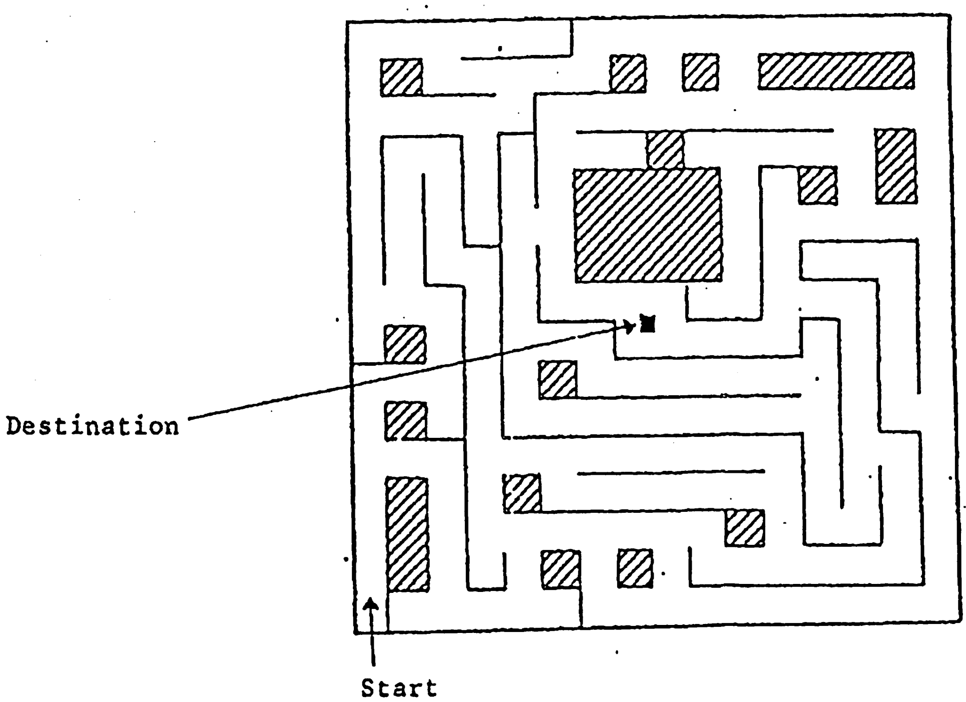


Figure 2 Cross Section of Sensor system

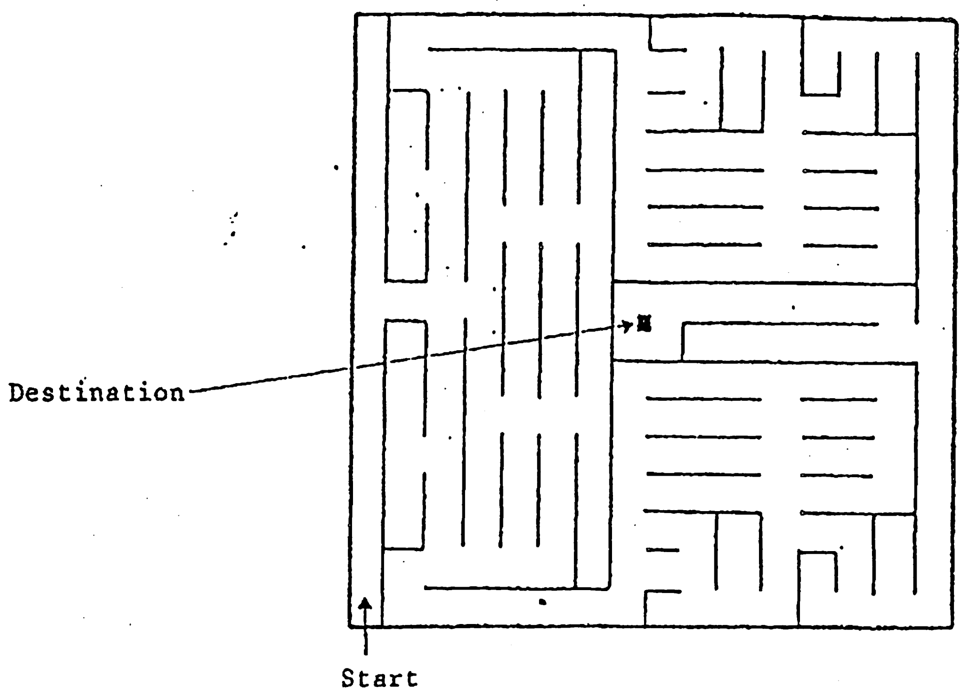


(a) Maze for the 1st Contest (1980)

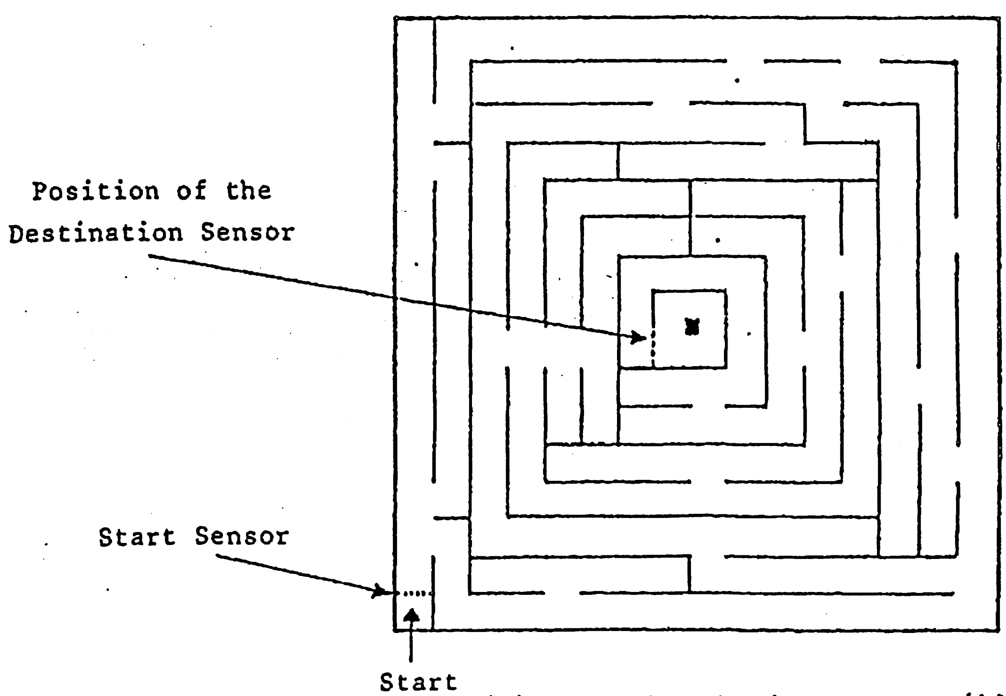


(b) Maze for the 2nd Contest (1981)

Figure 3 Examples of Mazes used in the All Japan Micromouse Contest (1/2)



(c) Maze for the 3rd Contest (1982)



(d) Maze for the 4th Contest (1983)

Figure 3 Examples of Mazes used in
the All Japan Micromouse Contest (2/2)

Secretary

Secretariat of The World Micromouse Contest
Japan Science Foundation
2-1, Kitanomaru Koen, Chiyoda-ku
Tokyo 102, Japan

Phone: 03-212-8471 (private exchange)
03-212-2670 (direct)
Fax: 03-201-3030
Telex: 2228209 KAGAKUKAN

'85 WORLD MICROMOUSE CONTEST

FIRST OFFICIAL ANNOUNCEMENT

1985 WORLD MICROMOUSE CONTEST

The electronics, the most rapidly advancing technologies in the vanguard science and technologies of the world, are forming a great pillar to support the modern society of mankind.

The applicability of micro-processors has been broadened through the remarkable progress of micro-processors and microcomputers, each of which has an ability comparable to a large scale computer of only a few decades ago, have made a debut in succession.

A robot system is an integration of the rapidly advancing computer technologies and mechanism, and great hopes are entertained of the robot technologies to making substantial contribution to the human societies in the coming 21st century.

Robots are being studied and developed by many research laboratories, colleges and private enterprises all over the world. Among these robots, a micromouse which is a micro-robot equipped with microcomputers, is an intelligent

Secretariat of The Micromouse Contest
c/o Japan Science Foundation, Science Museum, 2-1, Kitanomaru-Koen, Chiyoda-ku, 102 Tokyo, Japan.
TEL:03(212)8471, 03(212)2670 TELEX:02228209 JSF FAX:03(201)3030

robot that has the abilities of memory, arithmetic calculation and controlling the motor and sensor. It is a typical product of the mechatronics which is a portmanteau world of mechanism and electronics.

Needless to say, well-balanced technologies of the hardware and software are essential as an application of microcomputer technologies in order to realize a micromouse contest in which micromice compete each other how quickly they reach the final goal set in a complicated maze.

A micromouse was announced in 1977 by IEEE of the United States and a final contest was held in 1979. In Europe, EUROMICRO is opening an EUROMOUSE contest every year since 1980. In Japan, an All Japan Micromouse Contest is opened every year since 1980 under the sponsorship of the Japan Science Foundation, and the Japan Micromouse Association was established in 1983.

We are very much desirous to broaden the network of research and development of micromouse, which is an application of the microcomputer technologies, based on the history and actual situation of micromouse. We are buoyant with expectations of realizing a highly intelligent independent robot and firmly believe that such a development will make a great contribution to the mankind that is entering the 21st century.

Fortunately, the Japan Association for The International Exposition, Tsukuba, 1985 has a positive policy to the plan of our 1985 World Micromouse Contest and it is determined that a micromouse contest is held in the EXPO hall in the period of August 23 to 25 of 1985.

We feel greatly honoured by the determination of EUROMICRO to sending its excellent EUROMOUSE to the '85 World Micromouse Contest and would like to express our sincere gratitude to all parties of EUROMICRO for complying with our plan and accepting our invitation.

We are also very desirous that international communication through micromouse as microcomputer application technologies is further deepened upon this opportunity of the world micromouse contest.

Yoshihiro Inayama
Chairman
Japan Science Foundation

Toshihiko Kubo
Chairman
Japan Micromouse Association

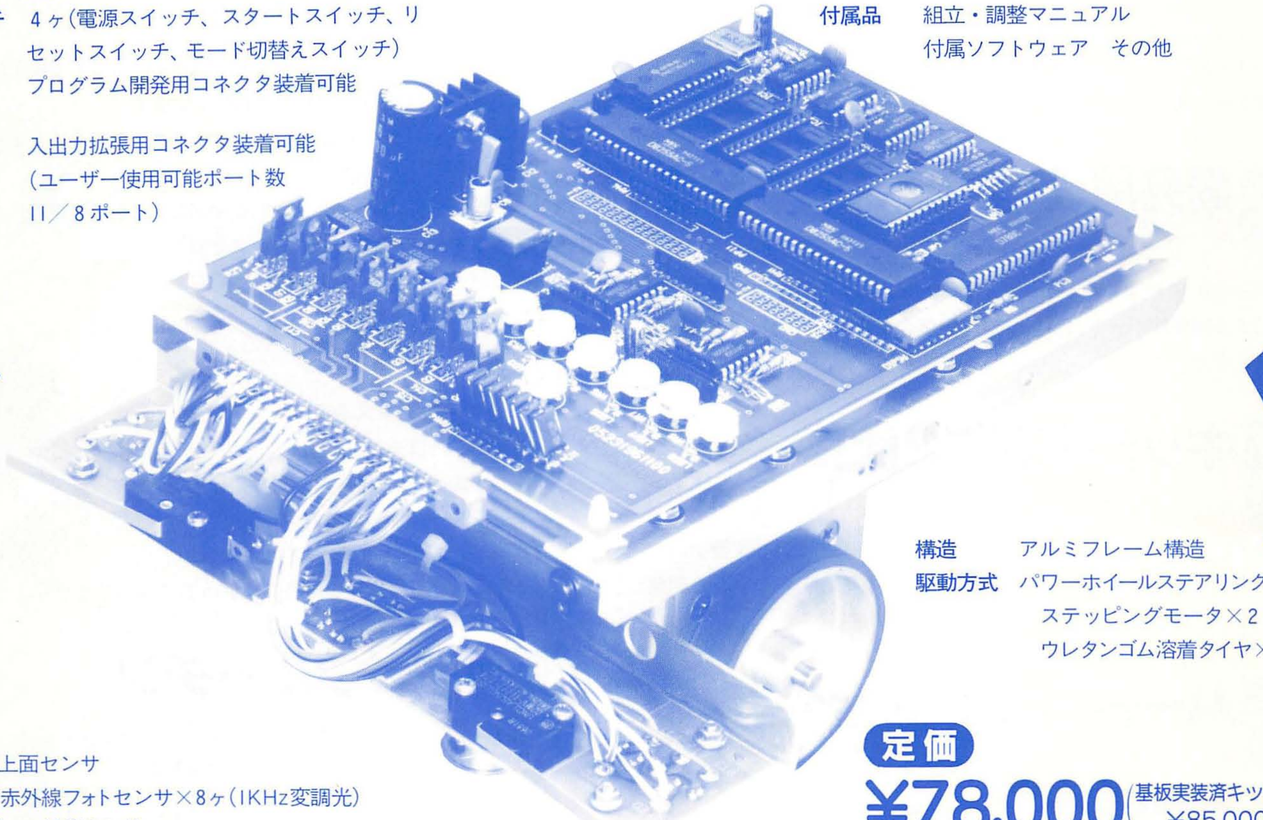
namcot

あのマッピーの頭脳がキットに！

マイクロマウス マッピーキット

CPU	Z80
ROM	2732×１（最大16Kバイト実装可能）
RAM	M58725×１（6242実装可能）
I／O	8255×２
モニタ	LED×８（センサ情報等の表示可能）
スイッチ	４ヶ（電源スイッチ、スタートスイッチ、リセットスイッチ、モード切替えスイッチ）
開発用ポート	プログラム開発用コネクタ装着可能
拡張用ポート	入出力拡張用コネクタ装着可能（ユーザー使用可能ポート数11／８ポート）

電源	ラジコン用ニッカド電池６Ｖ×２ヶ（商品には含まれません）
言語	アセンブラ言語
外形寸法	225×245×160㎜
重量	1.56㎏（電池を除く）
付属品	組立・調整マニュアル 付属ソフトウェア　その他

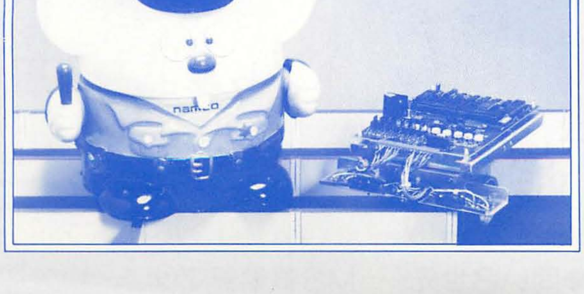


構造	アルミフレーム構造
駆動方式	パワーホイールステアリング方式 ステッピングモータ×２ヶ ウレタンゴム溶着タイヤ×２ヶ

センサ　壁上面センサ
　赤外線フォトセンサ×８ヶ（1KHz変調光）
　ゴール検出センサ
　マイクロスイッチ×２ヶ
　※センサユニットは上下２段切替え式
　（競技用迷路とランドマーク走行の両センス方式に対応）

定価
¥78,000（基板実装済キットは¥85,000）

マイクロマウス協会会員は
特別価格　¥73,000（基板実装済キットは¥79,500）
※クレジットも御利用になれます。



センサで感知し、マイコンで判断し、迷路を自走するロボット、マイクロマウス。第２回全日本マイクロマウス大会（1981年）で登場するやいなや全世界で注目のまとになったナムコのマッピーが、ついにキットになりました。

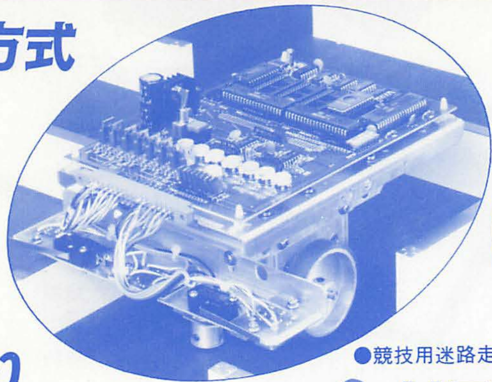
高い走行精度と定評ある安定性を実現した「マイクロポリスのマッピー君」は、全国各地10,000回を越えるデモ走行で信頼性は実証ずみであり、そのハードウェアをベースに、当時のマッピー開発スタッフ自ら再設計したマイクロマウスキットが「マッピーキット」です。

マイクロマウス マッピーキット 7つの特徴

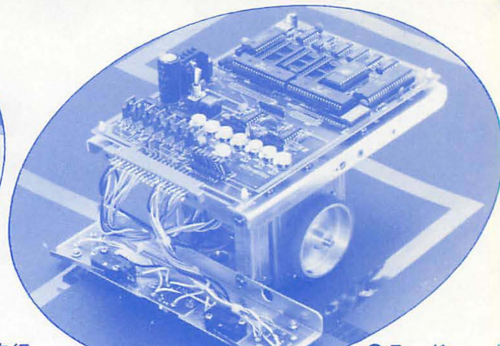
namcot

1 2Wayセンス方式

センサ取付け位置が上下２段切替え式ですから、上段で競技用迷路走行、下段で床面ランドマークセンス走行ができます。専用迷路がなくても、家庭内で手軽に走行実験ができます。



●競技用迷路走行



●ランドマークセンス走行

2 信頼の足まわり

タイヤには、スリップ、変形、経年変化に強いウレタンゴム溶着タイヤを使用。さらに、その径はモータ信号１パルスで１㎜進む設計です。高精度走行、高耐久性を約束する足まわりです。

3 開発用・拡張用ポートを設定

手持ちのホストコンピュータの入出力ポートに接続してプログラム開発ができる開発用ポートと、オリジナル機能を追加して楽しめる拡張用ポートを設定しました。

4 キット状態に2仕様

すべてのパーツを自分で組み上げるタイプと、基板部品が実装済のタイプの２仕様を設けました。ハンダ付けから楽しむか、プログラム開発に徹するか、目的に合せて選べます。

5 ハード・ソフトを全公開

組立、調整から拡張までに必要なキットのハード・ソフト資料は、付属マニュアルに全公開されています。

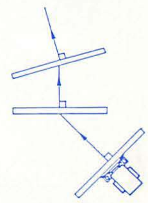
6 付属ソフト

デバイスチェックプログラムに加え、組み上げればすぐにその場で走らせて楽しめるデモ走行ソフトが付属しています。

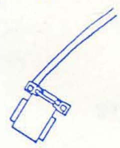
ⓐデバイスチェック　モニタＬＥＤ、センサ、スイッチ、モータの機能チェック。

ⓑノーセンス走行　センサには無関係に直線上を往復走行します。

ⓒ銀テープ走行（ランドマークセンス走行）
床面に貼った銀テープに対し常に垂直に姿勢制御しながら走行します。



ⓓ沿線走行
（ランドマークセンス走行）
床面に貼った銀テープに沿って走行します。

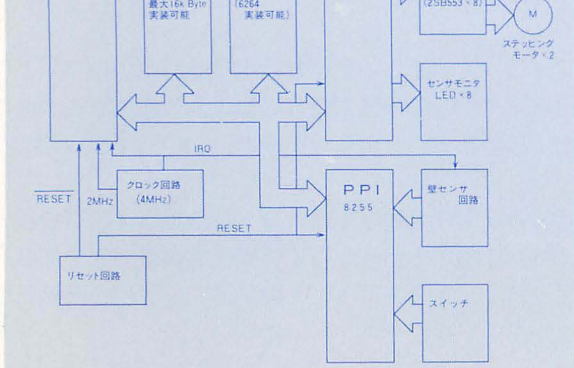


ⓔ迷路左手走行（競技用迷路センス走行、ランドマークセンス走行どちらでも可）
迷路中を左手法で走行します。
※マイクロマウス競技会用のプログラムではありません。

7 付属サブルーチン

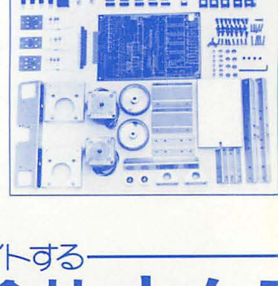
MATU	レジスタ入力値分、インタラプトを待つ。
KAITEN	モータの回転方向を制御。
HOT	インタラプトを400回待つ。
BARA	左右の車輪を異なるスピードで回転。
ZENSIN	壁をセンスして位置修正

ブロックダイヤグラム



アフターサービス

組立・調整のご相談から、キットの修理、部品の販売まで致します。
また、マッピーキットの講習会も実施予定です。



「遊び」をクリエイトする――
株式会社 ナムコ
本社　〒144 東京都大田区蒲田5-38-3 朝日ビル　TEL03（736）1211（大代）
●問い合せ先……MS事業部マッピーキット係

'85 WORLD MICROMOUSE CONTEST

HISTORY

OF

ALL JAPAN MICROMOUSE CONTENTS

(SUMMARY)

Secretariat of The Micromouse Contest
c/o Japan Science Foundation, Science Museum, 2-1, Kitanomaru-Koen, Chiyoda-ku, 102 Tokyo, Japan.
TEL:03(212)8471, 03(212)2670 TELEX:02228209 JSF FAX:03(201)3030

THE FIRST ALL JAPAN MICROMOUSE CONTEST

Period	November 1 ∿ 9, 1980		
Place	Science Museum		
Sponsor	Japan Science Foundation		
Special Collaborator	Namco Limited		
Number of Contestants	Micromouse	18 units	
	Microcat	9 units	

Final Results

Micromouse

		Contestants
Winner	No appropriate unit	
Second Place	DENKEN No. 1	Musashi Institute of Technology Electrical Society
Third Place	KSS-01	KSS-01 Making Group
Technology Prize	AKEMI No. 1	Nihon Business Automation Co.
Design Prize	GONSU	Ohashi Workshop
Compact Prize	POCHI	Osaka Uni.

Microcat

			Time
Winner	MISTY 3	The Foundation of Chubu Science & Technology Center Microcomputer Club	2'26" (No other records are kept.)
Second Place	Electric Cockroach No. 3	Shizuoka Uni. Electric Cockroach Production Team	

Third Place	CAT-EX-5	Japan Microcomputer Club
Idea Prize	CAT-EX-5	Japan Microcomputer Club
Design Prize	Daybreak Super-Express-1	Kenji Hirohka
Special Prize	Logical Cat	Toyoharu Kuroda

THE SECOND ALL JAPAN MICROMOUSE CONTEST

Period	October 30 ∿ November 8, 1981		
Place	Science Museum		
Sponsor	Japan Science Foundation		
Planning Collaborator	Namco Limited		
Number of Contestants	Micromouse	55 units	
		(Entered contestants:	108 units)
		Contestants completing the route:	9 units
	Microcat	30 units	
		(Entered contestants:	48 units)
		Contestants completing the route:	11 units

Final Results

Micromouse		Contestants	Time
Winner	NORIKO-3	Kenji Mugita	37"2
Second Place	Trinity	Kenichi Yajima	1'15"5
Third Place	KSS-01M	Shzuo Saito	1'21"5
Fourth Place	TU-2	Takayuki Uehiro	1'22"9
Fifth Place	NORIKO-2	Kenji Mugita	1'40"2
Sixth Place	FUZUKI	Kohji Yamana	1'43"9
Special Prize	MASA-1	Masahiro Shiomi	3'37"6 (7th)
Technology Prize	NA-1	Nobuyuki Taira	4'42"8 (8th)
"	KAKO	Masayuki Sudoh	-
Idea Prize	M-1	Keiichi Konno	5'57"1 (9th)
"	FUKUI·MC-1	Fukuimicro Computer Club	-
Design Prize	NEZUMISAN	Toshihide Obara	-

Reference exhibit

MICROPOLICE "MAPPY"
(Exhibited for the first time in Japan)

Planned and manufactured by:
NAMCO LTD.

Microcat		Contestants	Time
Winner	MECHA	Makoto Iwahara	41"8
Second Place	MIMIC CAT-II	Joji Andoh	1'13"2
Third Place	MECHA-DORYU	Hiroshi Wakao	1'26"9
Technology Prize	REIJIROH	Toyoharu Kuroda	1'27"0
"	MIKA CHAN	Masao Kobayashi	1'37"6
Prize for Greatest Potential	ODDITY-1	Osamu Kurachi	1'58"1
Fighting Spirit Prize	JIRADH	Kenji Hirohka	2'10"9
Originality Prize	MIKATAN	Mikio Mimura	5'37"2
Prize for Most Interest	COSMOS SHOW	Masahiro Shoji	

Reference			
8th	MIMIC CAT-I	Joji Andoh	3'56"4
9th	NAOTA-I	Naotaka Yokoyama	5'23"6
11th	SPANK	Sakae Mochizuki	6'25"4
12th	CAT EX-10	Hiromasa Hayashi	13'39"2

Reference exhibits

NYAMUCO — Planned and manufactured by: NAMCO LTD.

PUTAN

THE THIRD ALL JAPAN MICROMOUSE CONTEST

Period	October 29 ∿ November 7, 1982		
Place	Science Museum		
Sponsor	Japan Science Foundation		
Planning Collaborator	Namco Limited		
Number of Contestants	Micromouse	100 units	
		(Entered contestants:	165 units)
		Contestants completing the route:	24 units
	Microcat	24 units	
		(Entered contestants:	37 units)
		Contestants completing the route:	12 units

Final Results

Micromouse

		Contestants	Time
Winner	NORIKO-7	Kenji Mugita	26"5
Second Place	TU-3	Takayuki Uehiro	44"1
Third Place	MASA-I-A	Masahiro Shomi	44"6
Fourth Place	CAP-11-Z	Hisakazu Kakeba	44"8
Fifth Place	NORIKO-3	Kenji Mugita	46"4
Sixth Place	M-No. 1 (Rev.)	Keiichi Konno	46"7
Technology Prize	MIMIC-MOUSE-1	Mitsubishi Heavy Industry, Ltd. Head Office Microcomputer Club	59"8
	TZ-80	Shigeru Higasa	52"1
Design Prize	NAKA	Yamanashi Uni. Group "NABE"	10'32"5
	NEZUMISAN-IInd	Toshihide Obara	Retire
Idea Prize	TSUBASA-No. 2	Hidehiko Kamimura	1'09"3
Special Prize	MEISHODEN IV INROUSE	Tokai Gakuen High School Microcomputer Group	Retire
NAMCO Special Prize	M-No. 1 (Rev.)	Keiichi Konno	46"7

Reference exhibits

MICROPOLICE "MAPPY" Manufactured by: NAMCO LTD.

Microat		Contestants	Time
Winner	MIMIC CAT-3	Mitsubishi Heavy Industry, Ltd. Head Office Microcomputer Club	22"8
Second Place	FUZUKI	Kohji Yamana	48"9
Third Place	YMCAT	Hiroshi Obana	59"0
Fourth Place	RAY-01	Rei Honma	1'08"0
Fifth Place	YOUJI	Yuji Yamashita	1'08"7
Sixth Place	HIROMI-01	Rei Honma	2'02"3
Prize for Greatest Technical Potential	GIANT-TAMA	Akio Nakamura	Retire
Design Prize	AO-II	Akihito Ohta	2'28"9
Fighting Spirit Prize	HM-Z	Hiroshi Hosoda	2'38"5
Prize for Greatest Potential	YOUJI	Yuji Yamashita	1'08"7
NAMCO Special Prize	RAY-01	Rei Honma	1'08"0

Reference exhibits

NYAMCO — Manufactured by: NAMCO LTD.

PUTAN

THE FOURTH ALL JAPAN MICROMOUSE CONTEST

Period	October 28 ∿ November 6, 1983		
Place	Science Museum		
Sponsor	Japan Science Foundation		
	Japan Micromouse Association		
Special Collaborator	Namco Limited		
Number of Contestants	Micromouse	70 units (Entered contestants: Contestants completing the route:	 126 units) 20 units
	Microcat	23 units (Entered contestants: Contestants completing the route:	 33 units) 8 units

Final Results

Micromouse

		Contestants	Time
Winner	TU-27	Takayuki Uehiro	33"84
Second Place	MEISHODEN IV ICROUSE	Tokai Gakuen High School Microcomputer Group	43"79
Third Place	NEZUMISAN :IIIrd	Toshihide Obara	45"28
Fourth Place	D-70	Yohichi Kawaguchi	52"37
Fifth Place	YZR 80A	Yachiyo Microcomputer Club	55"25
Sixth Place	KEIKO	Group "NABE"	57"66
JMMA Prize	MEISHODEN VI TSURUHIME	Tokai Gakuen High School Micro Computer Group	1'06"64
Science Museum Prize	S.I.T.-VI	Shibaura Institute of Technology	1'59"34
NAMCO Prize	KEIKO	Group "NABE"	57"66
Fighting Spirit Prize	D-70	Yohichi Kawaguchi	52"37
"	YZR 80A	Yachiyo Microcomputer Club	55"25

Reference exhibit

MICROPOLICE "MAPPY": Manufactured by: NAMCO LTD.

Microcat		Contestants	Time
Winner	HYAO	Tokyo Institute of Technology Precision Instrument, System B	35"59
Second Place	BUCHI	Tokyo Institute of Technology Precision Instrument, System A	36"21
Third Place	ZOHSAN-I	Shimokawabe Group	1'09"48
Fourth Place	T-3	Hisashi Ito	1'11"17
Fifth Place	AO-CHIBI	Akihito Ohta	1'41"32
Six Place	AO-No. 3	"	1'57"25
JMMA Prize	Rika	The Society of Technomerriment	2'16"52
"	RUKUSUKEMARU	Norio Mizutani, Keiko Hoshi	3'41"45
Science Museum Prize	GIANT-TAMA	Nagano Microcomputer Coterie + α	Retire
NAMCO Prize	AO-CHIBI	Akihito Ohta	1'41"32
Fighting Spirit Prize	T-3	Hisashi Ito	1'11"17
Prize for Greatest Potential	Désordre 6 Vert Blaireau	Osamu Kurachi	Retire
"	HC-XII	Tokyo Uni. The Society for Data Processing	Retire

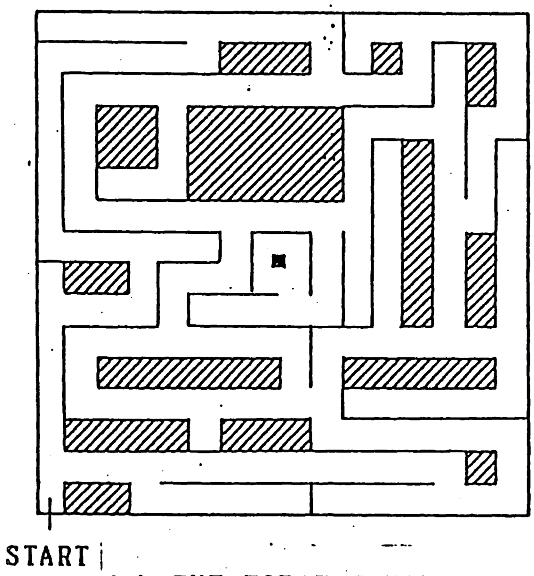
Reference exhibits

NYAMCO — Manufactured by: NAMCO LTD.

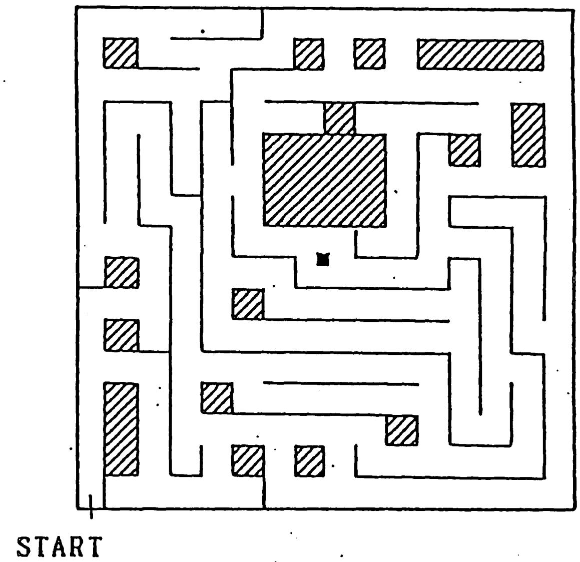
PUTAN

ALL JAPAN MICROMOUSE CONTESTS PAST MAZES

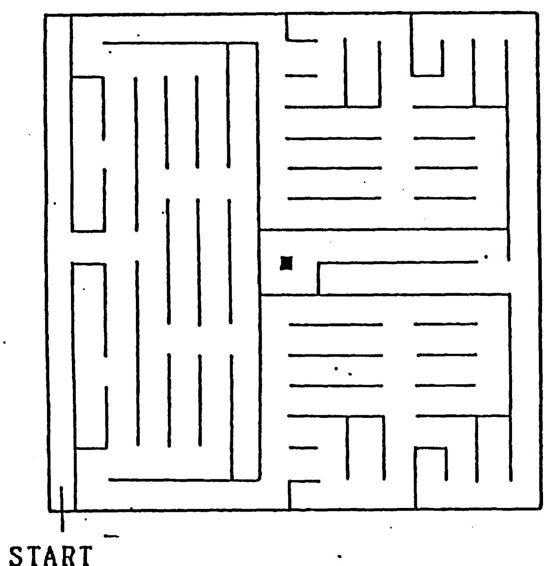
MICROMOUSE



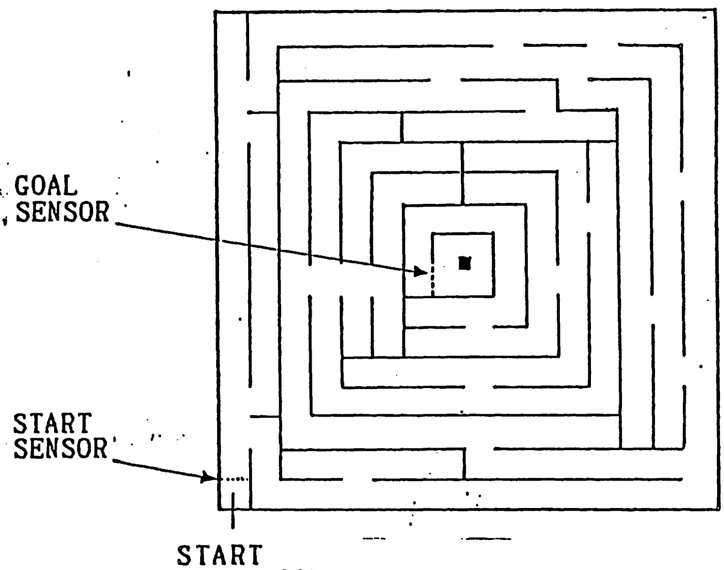
(a) THE FIRST CONTEST



(b) THE SECOND CONTEST

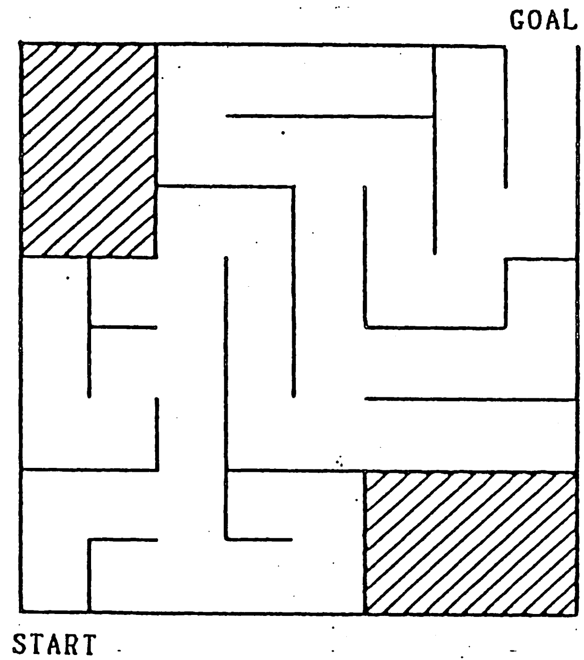


(c) THE THIRD CONTEST

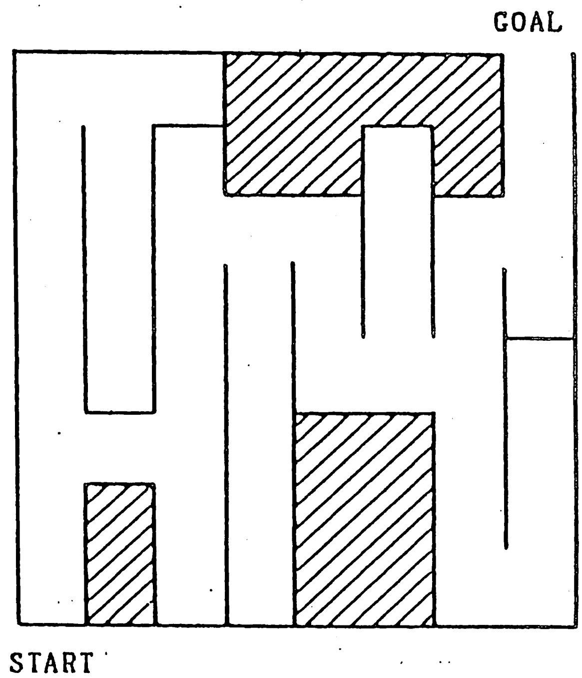


(d) THE FOURTH CONTEST

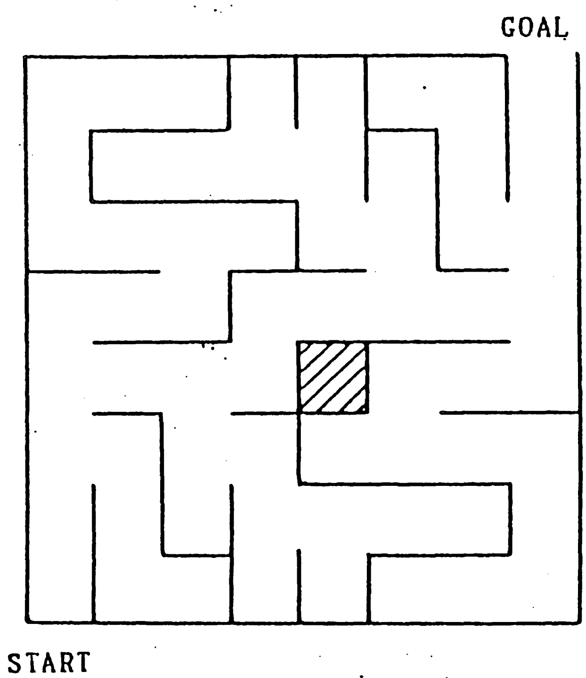
MICROCAT



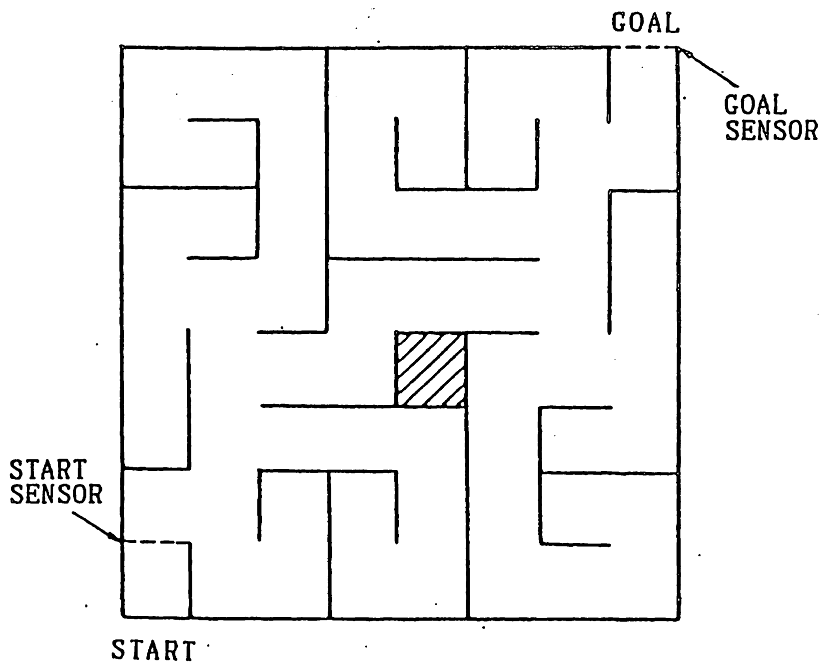
(a) THE FIRST CONTEST



(b) THE SECOND CONTEST



(c) THE THIRD CONTEST



(d) THE FOURTH CONTEST

ARTICLES

OF

THE JAPAN MICROMOUSE ASSOCIATION

JAPAN MICROMOUSE ASSOCIATION

ARTICLE OF JAPAN MICROMOUSE ASSOCIATION

(Laid down as of March 1, 1983)

CHAPTER 1. GENERAL PROVISIONS

(Name)

Article 1.

This association shall be named as "Japan Micromouse Association".

(Purpose)

Article 2.

The purpose of this association shall be to promote the research and development of microrobots on an amateur level and to contribute eventually to the promotion of scientific technology. Especially, this association shall have the purpose of developing microcomputer technology, electronic technology and also mechanical technology and to spread the relevant knowledge through contests for selfcontained robots and micromouse contest.

(Office)

Article 3.

The headquarters of this association shall be located in Chiyoda-ku, Tokyo.

2. This association may have subsidiary offices of any necessary sites in accordance with resolutions adopted in board of directors' meeting.

3. This association may have an executive office to manage and perform the business, and it may have a general manager appointed by its Chairman of the board and also necessary staffs.

Mr. Hiroshi Kanayama	Professor on the Electronics and Information Engineering Faculty, Tsukuba University
Mr. Muneo Sakita	Director, Namco Limited
Mr. Hirobumi Miura	Professor of Mechanical Engineering, Tokyo University
Mr. Hiromitsu Miyamoto	Assistant Manager in charge of public relations, Japan Science Technology Promotion Foundation
Mr. Ryoichi Mori	Professor on the Electronics and Information Engineering Faculty, Tsukuba University
Mr. Tadataka Yanagidaira	Director, Mamco Limited
Mr. Shinichi Yuda	Assistant Professor on the Electronics and Information Engineering Faculty, Tsukuba University
Mr. Tadashi Yoshioka	Senior Managing Director, Japan Electronics Industry Promotion Association
Mr. Hiroyuki Yoshikawa	Professor of Precision Machinery Engineering, Tokyo University

Supervisor

Mr. Eiichiro Nagasawa	Certified Public Accountant and Licenced Tax Accountant, Nagasawa Public Accountant Office
Mr. Hajime Yamauchi	Certified Public Accountant and Registered Accountant, Statutory Auditor, Namco Limited

(3) Patronage Member
Legal entities such as corporations or bodies which endorse the purposes of this association and that entered in it in accordance with the approval of its board of directors.

(4) Honorary Member
Persons selected and recommended by the board of directors among those who have sufficient knowledge and experience concerning micromouse and who have rendered distinguished services to this association.

(Admission)

Article 6.

Admission to this association shall be completed by filing a fixed application form together with an admission fee and membership fee to be determined separately.

(Withdrawal)

Article 7.

Any member may withdraw from this association by taking a fixed procedure.

2. For the following reasons members may be deemed as withdrawn from this association:

(1) death, adjudication of disappearance, winding-up of group or body;

(2) declaration of incompetency and/or quasi-incompetency;

(3) dismissal;

(4) any member whose membership fee is in arrears for more than one (1) year.

(Dismissal)

Article 8.

This association may, by the resolution of its board of directors' meeting, dismiss any of its members who has impaired the honor of this association, or who has conducted any act contrary to the purposes of this association.

(Non-refund of Membership Fee)

Article 9.

Membership fees already paid shall not be refunded for any reason whatsoever.

CHAPTER 4. OFFICERS

(Number of Officers)

Article 10.

The following officers shall be appointed in this association.

Chairman of the board	One (1) person
Vice-Chairman of the board	Not more than three (3) persons
Senior Managing Director	One (1) person
Managing Director	One (1) person
Director	Not more than thirty (30) persons (including Chairman, Vice-Chairman, Senior Managing Director and Managing Director)
Auditor	Two (2) persons

(Election)

Article 11.

Chairman and Vice-Chairman(men) of the board and Senior Managing Director and Managing Director shall be elected at the board of directors' meeting.

2. Directors and Auditor shall be elected by the council.

(Term)

Article 12.

The term of office shall be for two (2) years, but any officer may be reelected.

2. Officers shall, even after the expiration of their terms, carry out their duties until their successors assume their posts.

3. In the event any director or auditor elected among the patronage members resign during the term of their directorship or supervisorship from the representative posts in their own corporation or body, then their successors representing the said corporations or bodies shall assume their predecessors' post as director or supervisor.

4. The term of any officers filling a vacancy shall be the remaining period of their predecessor's term.

(Duties)

Article 13.

The Chairman of the Board shall represent this association and shall manage the business of this association.

2. The Vice-Chairman(men) of the Board shall assist the Chairman and shall act for Chairman if he is incapacitated.

3. Senior Managing Director and Managing Director shall aasist the Chairman and Vice-Chairman(men) of the Board, and shall deal with the matters resolved by the board of directors' meeting and the business of this association. Besides that, they shall act for the Chairman or Vice-Chairman(men) of the Board if they receive such instruction by the Chairman or Vice-Chairman of the Board.

4. Directors shall attend the board of directors' meetings to discuss and determine important matters concerning the business of this association.

5. Supervisors shall inspect the assets and accounts of this association and also inspect the execution of the business of this association.

CHAPTER 5. BOARD OF DIRECTORS

(Formation)

Article 14.

In this association the board of directors shall be formed and shall be organized with the Chairman and Vice-Chairman(men) of the Board, Senior Managing Director, Managing Director and Directors.

2. Supervisors may attend the board of directors' meetings to express their opinions.

(Convocation of Board of Directors' Meeting)

Article 15.

Board of directors' meetings shall be of two (2) types consisting of ordinary board of directors' meetings and extraordinary board of directors' meetings.

2. The ordinary board of directors' meetings shall be convened by the Chairman of the Board within three(3) months from the end of each business year.

3. The extraordinary board of directors' meetings shall be convened by Chairman of the Board whenever necessary.

(Method of Convocation)

Article 16.

All officers must be notified of the date and time, place and agenda of the board of directors' meeting.

(Presiding Chairman)

Article 17.

The Chairman of the Board shall act as the presiding Chairman at the board of directors' meeting.

(Method of Resolution)

Article 18.

Resolutions of the board of directors' meetings shall be decided by a majority vote of the directors including proxy voting, but in the case of a tie, the presiding chairman shall decide the said issue.

(Matters of Resolution)

Article 19.

The following matters shall be decided by the resolution of ordinary board of directors' meeting:

(1) Alteration of Articles of this association;

(2) Business plan and budget for income and expenditure;

(3) Business reports, statement of accounts, balance sheet and list of properties;

(4) Dissolution and disposition of remaining properties;

(5) Any other important matters which the Chairman of the Board may deem necessary.

(Minutes)

Article 20.

The substance of the proceedings at board of directors' meetings and the results thereof shall be recorded in the minutes when the meeting is held and the presiding chairman and more than two (2) persons present shall sign on and affix their seals to it.

CHAPTER 6. COUNCILLORS

(Election)

Article 21.

Councillors shall be elected by the board of directors.

(Number of Councillors)

Article 22.

Councillors shall be within thirty (30) persons.

(Term)

Article 23.

The provision of Article 12 shall also apply to the term of councillors.

(Meeting of Councillors)

Article 24.

Meeting of councillors shall be formed to resolve the following matters:

(1) Election of officers;

(2) Approval of business plans;

(3) Any other matters which the board of directors may deem necessary.

2. Rules concerning the management of meetings of councillors shall be determined separately.

CHAPTER 7. COMMITTEE

(Establishment)

Article 25.

In case it is required in the management of this association and in the execution of its business, a permanent or provisional committee may be established in accordance with the resolution of the board of directors' meeting.

2. The Chief of the committee and its members shall be nominated by the Chairman of the Board.

3. Rules concerning the management of the committee shall be determined separately.

CHAPTER 8. ASSETS AND ACCOUNTS

(Assets)

Article 26.

The assets of this association shall consist of the followings:

(1) Admission fees and membership fees;

(2) Contributions and other various revenues;

(3) Fruits derived from the assets.

2. Expenditures in this association shall be defrayed out of its assets.

(Control)

Article 27.

The control and operation of the assets of this association and any fund borrowing shall be conducted by the Chairman of the Board in accordance with the resolutions of the board of directors' meetings.

(Business Year)

Article 28.

The business year of this association shall begin on January 1 and shall end on December 31 of each year.

(Disposition of Surplus)

Article 29.

Any surplus yielded at the end of any business year shall be carried forward to the following year in accordance with the resolutions of the board of directors' meetings.

CHAPTER 9. SUNDRY PROVISIONS

(Rules)

Article 30.

Various rules necessary for executing the business of this association under these Articles shall be established separately in accordance with the resolutions of the board of directors' meetings.

SUPPLEMENTARY PROVISIONS

(Election of Officers at the Initial Stage of Establishment)

1. The election of officers at the initial stage of the establishment of this association shall be made at the general meeting of promotors.

2. The term of those officers and councillors who have taken office at the initial stage of establishment of this association shall end on December 31, 1983.

ARTICLES

OF

THE JAPAN MICROMOUSE ASSOCIATION

JAPAN MICROMOUSE ASSOCIATION

ARTICLE OF JAPAN MICROMOUSE ASSOCIATION

(Laid down as of March 1, 1983)

CHAPTER 1. GENERAL PROVISIONS

(Name)

Article 1.

This association shall be named as "Japan Micromouse Association".

(Purpose)

Article 2.

The purpose of this association shall be to promote the research and development of microrobots on an amateur level and to contribute eventually to the promotion of scientific technology. Especially, this association shall have the purpose of developing microcomputer technology, electronic technology and also mechanical technology and to spread the relevant knowledge through contests for selfcontained robots and micromouse contest.

(Office)

Article 3.

The headquarters of this association shall be located in Chiyoda-ku, Tokyo.

2. This association may have subsidiary offices of any necessary sites in accordance with resolutions adopted in board of directors' meeting.

3. This association may have an executive office to manage and perform the business, and it may have a general manager appointed by its Chairman of the board and also necessary staffs.

CHAPTER 2. BUSINESS

(Business)

Article 4.

This association shall promote the following business to accomplish the purposes specified in Article 2 above:

(1) to hold All Japan Micromouse Contests (including local contests) and relevant events, and to keep records of such events;

(2) to hold the lectures and seminars concerning micromouse;

(3) to exchange both domestic and overseas information concerning micromouse;

(4) to collect and study data concerning micromouse;

(5) to perform any other business necessary for accomplishing the purposes specified in Article 2 above.

CHAPTER 3. MEMBERSHIP AND FEE

(Types of Membership)

Article 5.

Members in this association shall be classified as follows:

(1) Individual Member
Individuals entered in this association by endorsing its purposes.

(2) Group Member
Groups entered in this association by endorsing its purposes.

(3) Patronage Member

Legal entities such as corporations or bodies which endorse the purposes of this association and that entered in it in accordance with the approval of its board of directors.

(4) Honorary Member

Persons selected and recommended by the board of directors among those who have sufficient knowledge and experience concerning micromouse and who have rendered distinguished services to this association.

(Admission)

Article 6.

Admission to this association shall be completed by filing a fixed application form together with an admission fee and membership fee to be determined separately.

(Withdrawal)

Article 7.

Any member may withdraw from this association by taking a fixed procedure.

2. For the following reasons members may be deemed as withdrawn from this association:

(1) death, adjudication of disappearance, winding-up of group or body;

(2) declaration of incompetency and/or quasi-incompetency;

(3) dismissal;

(4) any member whose membership fee is in arrears for more than one (1) year.

(Dismissal)

Article 8.

This association may, by the resolution of its board of directors' meeting, dismiss any of its members who has impaired the honor of this association, or who has conducted any act contrary to the purposes of this association.

(Non-refund of Membership Fee)

Article 9.

Membership fees already paid shall not be refunded for any reason whatsoever.

CHAPTER 4. OFFICERS

(Number of Officers)

Article 10.

The following officers shall be appointed in this association.

Chairman of the board	One (1) person
Vice-Chairman of the board	Not more than three (3) persons
Senior Managing Director	One (1) person
Managing Director	One (1) person
Director	Not more than thirty (30) persons (including Chairman, Vice-Chairman, Senior Managing Director and Managing Director)
Auditor	Two (2) persons

(Election)

Article 11.

Chairman and Vice-Chairman(men) of the board and Senior Managing Director and Managing Director shall be elected at the board of directors' meeting.

2. Directors and Auditor shall be elected by the council.

(Term)

Article 12.

The term of office shall be for two (2) years, but any officer may be reelected.

2. Officers shall, even after the expiration of their terms, carry out their duties until their successors assume their posts.

3. In the event any director or auditor elected among the patronage members resign during the term of their directorship or supervisorship from the representative posts in their own corporation or body, then their successors representing the said corporations or bodies shall assume their predecessors' post as director or supervisor.

4. The term of any officers filling a vacancy shall be the remaining period of their predecessor's term.

(Duties)

Article 13.

The Chairman of the Board shall represent this association and shall manage the business of this association.

2. The Vice-Chairman(men) of the Board shall assist the Chairman and shall act for Chairman if he is incapacitated.

3. Senior Managing Director and Managing Director shall aasist the Chairman and Vice-Chairman(men) of the Board, and shall deal with the matters resolved by the board of directors' meeting and the business of this association. Besides that, they shall act for the Chairman or Vice-Chairman(men) of the Board if they receive such instruction by the Chairman or Vice-Chairman of the Board.

4. Directors shall attend the board of directors' meetings to discuss and determine important matters concerning the business of this association.

5. Supervisors shall inspect the assets and accounts of this association and also inspect the execution of the business of this association.

CHAPTER 5. BOARD OF DIRECTORS

(Formation)

Article 14.

In this association the board of directors shall be formed and shall be organized with the Chairman and Vice-Chairman(men) of the Board, Senior Managing Director, Managing Director and Directors.

2. Supervisors may attend the board of directors' meetings to express their opinions.

(Convocation of Board of Directors' Meeting)

Article 15.

Board of directors' meetings shall be of two (2) types consisting of ordinary board of directors' meetings and extraordinary board of directors' meetings.

2. The ordinary board of directors' meetings shall be convened by the Chairman of the Board within three(3) months from the end of each business year.

3. The extraordinary board of directors' meetings shall be convened by Chairman of the Board whenever necessary.

(Method of Convocation)

Article 16.

All officers must be notified of the date and time, place and agenda of the board of directors' meeting.

(Presiding Chairman)

Article 17.

The Chairman of the Board shall act as the presiding Chairman at the board of directors' meeting.

(Method of Resolution)

Article 18.

Resolutions of the board of directors' meetings shall be decided by a majority vote of the directors including proxy voting, but in the case of a tie, the presiding chairman shall decide the said issue.

(Matters of Resolution)

Article 19.

The following matters shall be decided by the resolution of ordinary board of directors' meeting:

(1) Alteration of Articles of this association;

(2) Business plan and budget for income and expenditure;

(3) Business reports, statement of accounts, balance sheet and list of properties;

(4) Dissolution and disposition of remaining properties;

(5) Any other important matters which the Chairman of the Board may deem necessary.

(Minutes)

Article 20.

The substance of the proceedings at board of directors' meetings and the results thereof shall be recorded in the minutes when the meeting is held and the presiding chairman and more than two (2) persons present shall sign on and affix their seals to it.

CHAPTER 6. COUNCILLORS

(Election)

Article 21.

Councillors shall be elected by the board of directors.

(Number of Councillors)

Article 22.

Councillors shall be within thirty (30) persons.

(Term)

Article 23.

The provision of Article 12 shall also apply to the term of councillors.

(Meeting of Councillors)

Article 24.

Meeting of councillors shall be formed to resolve the following matters:

(1) Election of officers;

(2) Approval of business plans;

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LIST OF OFFICERS
IN THE SECOND PERIOD OF
THE JAPAN MICROMOUSE ASSOCIATION

Chairman of the Board

Mr. Toshihiko Kubo	President of Science and Technology Museum Japan Science Foundation

Vice-Chairmen of the Board

Mr. Hidetoshi Takahashi	Emeritus Professor at Tokyo University and Guest Professor at Keio University
Mr. Masaya Nakamura	President and Representative Director, Namco Limited

Senior Managing Director

Mr. Mitsuo Ueda	Managing Director, Japan Science Technology Promotion Foundation

Managing Director

Mr. Namio Ichikawa	Managing Director, Namco Limited

Director

Mr. Junichi Iijima	Assistant in Computer Science Department, Electricity and Communication University
Mr. Masao Iwasaki	General Manager of Project Department in Science and Technology Museum, Japan Science Technology Promotion Foundation
Mr. Ichiro Kato	Professor of Science and Engineering, Waseda University

Mr. Hiroshi Kanayama	Professor on the Electronics and Information Engineering Faculty, Tsukuba University
Mr. Muneo Sakita	Director, Namco Limited
Mr. Hirobumi Miura	Professor of Mechanical Engineering, Tokyo University
Mr. Hiromitsu Miyamoto	Assistant Manager in charge of public relations, Japan Science Technology Promotion Foundation
Mr. Ryoichi Mori	Professor on the Electronics and Information Engineering Faculty, Tsukuba University
Mr. Tadataka Yanagidaira	Director, Mamco Limited
Mr. Shinichi Yuda	Assistant Professor on the Electronics and Information Engineering Faculty, Tsukuba University
Mr. Tadashi Yoshioka	Senior Managing Director, Japan Electronics Industry Promotion Association
Mr. Hiroyuki Yoshikawa	Professor of Precision Machinery Engineering, Tokyo University

Supervisor

Mr. Eiichiro Nagasawa	Certified Public Accountant and Licenced Tax Accountant, Nagasawa Public Accountant Office
Mr. Hajime Yamauchi	Certified Public Accountant and Registered Accountant, Statutory Auditor, Namco Limited

<PHOTO>

No.

1. 「NORIKO X-1」
2. FUKUYAMA MICRO COMPUTER CLUB L;Mr.Kenji Mugita,R;Mr.Masalu Itani
3. 「NORIKO X-2」
4. 「EMI」
5. Mr.Takayuki Uehiro
6. 「S.I.T. XIII」
7. L;Mr.Masaki Nishimura
8. 「Enterprise」(GB)
9. Mr.David Woodfield (GB)
10. 「LABO-2」 & Mr.Isao Yoshii
11. 「TZ80b」 & Mr.Shigeru Higasa
12. 「TZ80b」
13. 「SAPIENCE」 & Mr.Kim (KOREA)
14. 「SAPIENCE」(KOREA)
15. 「Tellu」(Finland)
16. Finland Team
17. 「Micro Gonzales」(WG)
18. Mr.Ralf Hinkel (WG)
19. 「LABO-3」
20. 「T-5」(GB)
21. Mr.Alan L.S.Dibley (GB)
22. 「MAY-ROSE」
23. 「Moon Night Delight」(USA)
24. Mr.Baxter Cheung (USA)
25. Mr.Masanori Nomura
26. EXPO HALL (Vunue of '85World Micromouse Contest)
27. Contest Stage
28. 〃
29. Mr.Ichiro Kato (Contest Chairman)
30. Award Ceremony
31. 〃
32. 〃
33. 〃
34. 〃

写真説明

No.	内　　　　　　容
１．	優勝マウス「ＮＯＲＩＫＯ　Ｘ－１」
２．	優勝チーム「福山マイコンクラブ（左：麦田憲司氏、右：井谷優氏）」
３．	２位マウス「ＮＯＲＩＫＯ　Ｘ－２」
４．	３位マウス「ＥＭＩ」
５．	ＥＭＩ製作者「上広孝幸氏」
６．	５位マウス「Ｓ．Ｉ．Ｔ．ＸⅢ号」
７．	S.I.T.XⅢ号製作者「芝浦工業大学（左：西村昌樹氏）」
８．	科学技術館賞「Enterprise（英国招待マウス）」
９．	Enterprise製作者「David Woodfield 氏」
10.	日本マイクロマウス協会賞「ＬＡＢＯ－２号」吉井功氏
11.	ナムコ賞「ＴＺ８０ｂ」八千代マイコンクラブ（日笠繁氏）
12.	「ＴＺ８０ｂ」
13.	特別賞「ＳＡＰＩＥＮＣＥ（韓国招待マウス）」金基　氏
14.	「ＳＡＰＩＥＮＣＥ」
15.	特別賞「Ｔｅｌｌｕ（フィンランド招待マウス）」
16.	フィンランドチーム
17.	特別賞「Micro Gonzales（西ドイツ）」
18.	西ドイツ招待選手「Ralf Hinkel 氏」
19.	「ＬＡＢＯ－３号」吉井功氏製作
20.	英国招待マウス「Ｔ－５」 Alan L.S. Dibley 氏製作
21.	Alan L.S. Dibley氏
22.	「ＭＡＹ－ＲＯＳＥ」山名宏治氏製作
23.	米国招待マウス「Moon Knight Delight 」
24.	米国選手「Baxter Cheung 氏」
25.	選手宣誓、昨年度全日本大会優勝者「野村正則氏」
26.	「'85マイクロマウス世界大会」会場“エキスポホール”
27.	大会会場舞台風景
28.	大会会場舞台風景
29.	加藤一郎競技委員長（早稲田大学理工学部長）
30.	表彰風景
31.	表彰風景
32.	表彰風景
33.	表彰風景
34.	表彰風景

以上

※写真 No.は、写真裏面に付記してあります。

速報

MOUSE

JOURNAL of The JAPAN MICROMOUSE ASSOCIATION

vol.10

Sep. 1985

'85マイクロマウス世界大会

—'85 WORLD MICROMOUSE CONTEST—

開催要項

〈名　　称〉'85マイクロマウス世界大会
（'85 WORLD MICROMOUSE CONTEST）

〈会　　期〉1985年8月23日(金)～25日(日)の3日間
8月23日，24日　予　選
8月25日　　　　決　勝

〈会　　場〉「科学万博—つくば'85」会場内
エキスポホール（星丸シアター）　固定席600

〈主　　催〉財団法人国際科学技術博覧会協会　財団法人日本科学技術振興財団　日本マイクロマウス協会

〈後　　援〉科学技術庁，外務省，文部省，通商産業省，アメリカ合衆国大使館，英国大使館，大韓民国大使館，ドイツ連邦共和国大使館，フィンランド大使館，(社)日本電子工業振興協会，(社)日本産業用ロボット工業会，(社)情報処理学会，(社)精機学会，日本ロボット学会，日本マイコンクラブ，IEEE COMPUTER SOCIETY，EUROMICRO，SEOUL NATIONAL UNIVERSITY

〈特別協力〉株式会社ナムコ

〈競技種目〉マイクロマウス競技
日本マイクロマウス協会制定マイクロマウス競技規定により運営

〈参加国数〉6カ国（フィンランド，韓国，英国，米国，西独，日本）

〈参加台数〉126台（海外15台，国内111台）

1977年米国I.E.E.E.でマイクロマウスが提案されて以来，初の世界大会が「科学万博——つくば'85」の会場内において開催されました。

初の世界大会ながら，内外6カ国から総計126台（うち海外15台）がエントリーし，8月23日から25日の3日間熱戦が繰り広げられました。

大会の会場となった「エキスポホール」では最高1時間待ちの行列ができるほどで，3日間で延べ1万2千人の方がたが熱心に観戦されました。

競技の内容も昨年の記録を半分近くに縮めるマウスが登場するなど，世界大会だけあって技術的にも高度なものになり，関係者を驚かせました。また，本大会の開催により，参加者，各国の主催者が一堂に会し，技術情報の交換や，今後の計画について語り合うなど，意義ある大会となりました。

決　勝　8月25日(日)

予選を見事通過した20台のマウスと過去の大会からの招待マウス11台，合計31台のマイクロマウスにより，熱戦が繰り広げられました。この日，会場であるエキスポホールに入場した観客数も，万博始まって以来の入場者があり，最高で1時間待ちの行列ができたほどでした。

開会式では，主催団体の挨拶のあと，来賓代表として国務大臣・科学技術庁竹内黎一長官の祝辞に続き，世界大会のために作ったマイクロマウスのテーマ曲に合わせて選手入場を行い，「'85マイクロマウス世界大会」決勝へ進出した全チームの代表者がステージ上に勢揃いしました。ここで選手を代表して昨年度全日本大会の覇者野村正則氏による選手宣誓が行われ，競技開始となりました。

決勝の出走順は，予選タイムの20位から出走，途中に11台のシードマウスが登場しました。

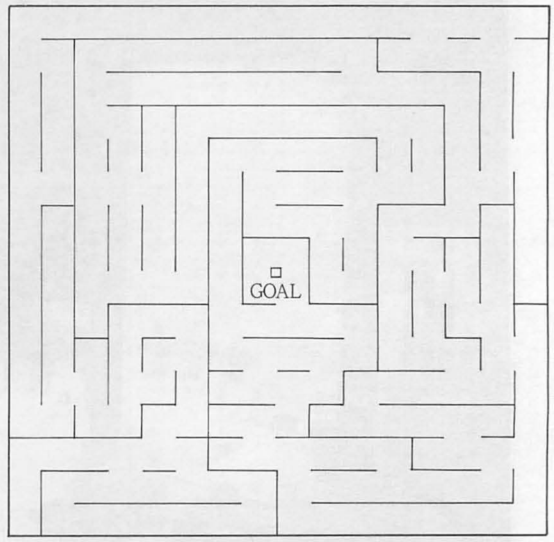
決勝迷路は，開催年度に因んで最短歩数85歩の設定。……聞くところによると，迷路設計をした競技委員の先生方は，85歩の迷路を設計するために徹夜までされたとか。

競技前半は，迷路探索はできていながらも最短速コースでの完走をするマウスが少なく，50秒の壁をどのマウスが破るかに注目されましたが，山田氏の「Champ」が49秒58で壁を突破。その後シードマウスが続々登場し，吉井氏の「LABO 2 号」が41秒76，昨年度全日本大会優勝の「NAZCA」が31秒68と次々に記録を更新しました。

ただ残念なことに海外からのシードマウスは，長旅のためかリタイア続出，なかなか完走することができませんでした。

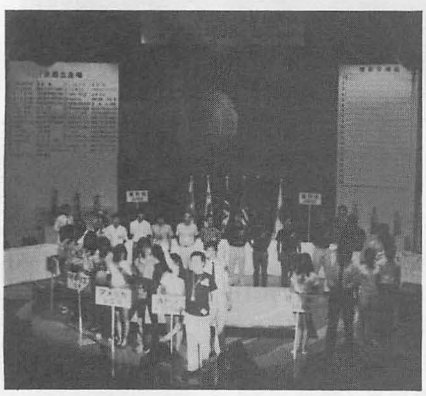
後半，予選のトップグループが出走し，さらにタイムを縮めて行きましたが，予選第6位の芝浦工業大学「S.I.T. XIII号」が28秒36のタイムで5位入賞を果しました。過去全日本大会連続優勝している福山マイコンクラブからは，「NORIKO-Xシリーズ」5台を決勝に進出させ，「NORIKO-X2」が第2位，そして「NORIKO-X1」が見事優勝を果し，3位には福山マイコンクラブ上広氏の「EMI」が入賞しました。海外からのマウスで完走を果した英国David-Woodfield氏の「Enterprise」は7位と，おしくも6位入賞は果せなかったものの，大変素晴しい優雅な走行をして高い評価を得ました。

結局，決勝進出31台中，28台出走，21台完走，1位から6位の入賞のほかに，6つの特別賞が授与されました。



START

代表的短路85歩42折，87歩40折
89歩38折，101歩30折



選手宣誓をする野村正則氏

午前9時30分，競技に先がけてオープニングセレモニーが開催されました。

万博開門直後にもかかわらず会場には多数の観客がつめかけました。開会宣言に続いて(財)国際科学技術博覧会協会井原義徳事務総長，(財)日本科学技術振興財団猪狩則男副会長および日本マイクロマウス協会中村雅哉副会長（(株)ナムコ社長）より挨拶のあったあと，来賓を代表して国務大臣・科学技術庁竹内黎一長官より「高度な技術が一体となり，また科学する心と創造する喜びが理想的に結合したマイクロマウスの世界大会が，科学万博において初めて開催されることは，誠に時宜を得た極めて意義あることであり，本事業が技術教育の場として，さらに発展することを期待します。（要旨のみ）」（科学技術庁普及啓発課田中正則課長代読）とのご祝辞をいただきました。

〈審査員紹介〉（写真左から）

(財)日本科学技術振興財団宮沢昭夫理事，(株)ナムコ木下次男開発二部長，韓国ソウル大学高明三教授，アメリカ I.E.E.E. Mrs.スーザン・ローゼンバーム理事，早稲田大学教授加藤一郎理工学部長（審査委員長），イギリスポーツマス工科大学ジョンビリングスレー教授，筑波大学油田信一助教授，電気通信大学飯島純一助手。

優勝トロフィーを受けとる井谷優氏

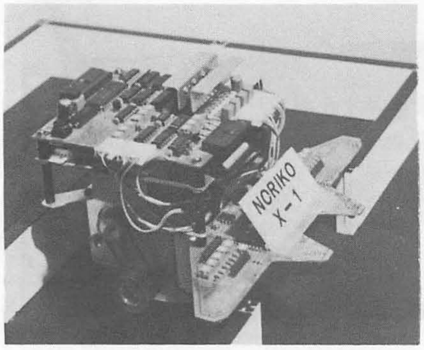
表彰式では，加藤一郎審査委員長の講評のあと，1位から6位までの表彰が行われました。各入賞者には表彰状のほか，メダル，トロフィーの授与があり，さらに1位から3位までの入賞者には研究奨励金が贈られました。

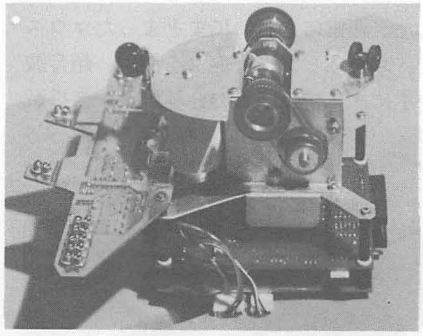
最後に科学万博日本政府館福島公夫総館長の挨拶に続き，(財)日本科学技術振興財団常務理事上田満男氏から謝辞および閉会の宣言があり，"'85マイクロマウス世界大会"は無事幕を閉じました。

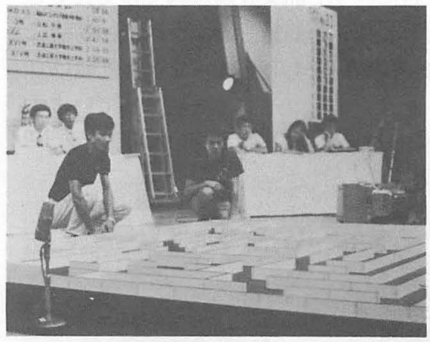
入賞マウス紹介

〈優　勝〉 19秒83

「NORIKO-X1」：福山マイコンクラブ（麦田憲司・井谷優・野村正則）





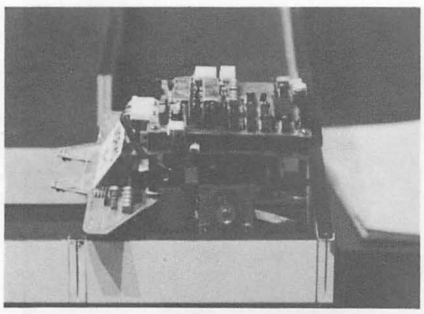


福山マイコンクラブのメンバー井谷氏，麦田氏，野村氏によるNORIKO-Xシリーズ，見事優勝を勝ち得たのはNORIKO-X1でした。ソフト：井谷，ハード：麦田・井谷，メカ：麦田・井谷・野村という担当で，昨年実績のあるジャイロ搭載，ステッピングモータ使用の2輪マウスです。

写真から分るように，2つの動輪の間に1つの従輪を設け，動輪がスリップしても正確な距離のデータがとれるようになっています。重さはバッテリーなしで980g，けっして軽量とは言えませんが，パワーと高速スラロームでカバーしています。探索アルゴリズムは，福山マイコンクラブ自慢の「足立理論」さらに井谷氏が手を加えて改良してあります。見事なコーナリング，直線でのスピードと昨年全日本大会であっと言わせた「NAZCA」が遅く感じられるほどでした。

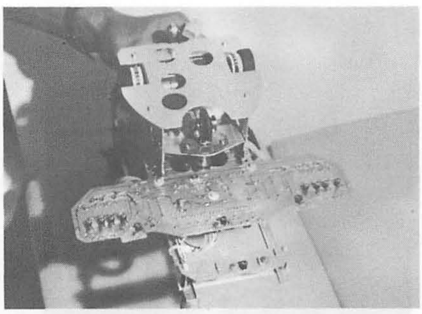
〈２　位〉 20秒05

「NORIKO-X2」：福山マイコンクラブ（麦田憲司・井谷優・野村正則）



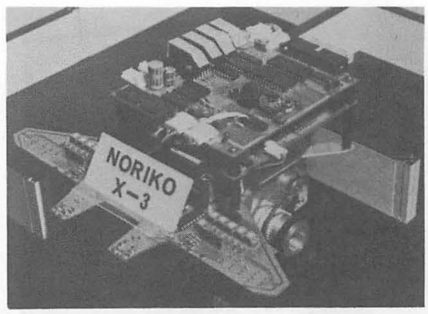
〈３　位〉 20秒36

「EMI」：福山マイコンクラブ（上広孝幸）



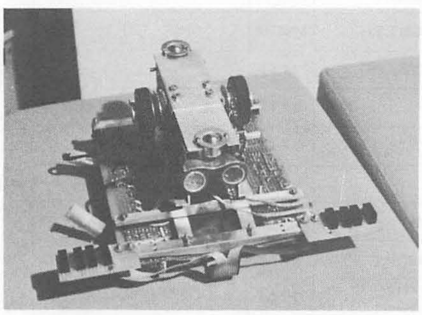
〈４　位〉 22秒83

「NORIKO-X3」：福山マイコンクラブ（麦田憲司・井谷優・野村正則）



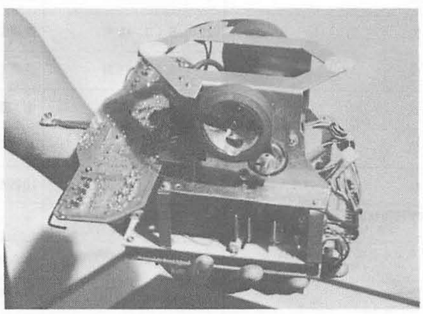
〈５　位〉 28秒36

「S.I.T. XIII号」：芝浦工業大学（西村昌樹）



〈６　位〉 31秒68

「NAZCA」：福山マイコンクラブ（井谷優・野村正則）



1位から3位までの記録の差は100分の53秒しかありませんでした。どのマウスが優勝しても不思議ではありません。同じ福山マイコンクラブのマウスではありますが1台1台がそれぞれに工夫されたマウスですので，この決勝迷路での極限のスピードではなかったかと思われます。

2位と4位は「NORIKO-X」シリーズの2台で，2位のX2はステッピングモータ，4位のX3はDCモータを使用しています。

3位の「EMI」は福山マイコンクラブの上広氏の製作で，動輪二輪はステッピングモータ，操舵輪一輪はDCモータを使用し，操舵輪に回転カウンタが組み込まれていて走行距離のデータを取っているようです。マウスの重量は1600gとこれもけっして軽量とは言えませんが，スピードは，X1，X2ともに平均で秒速約80cm程度でているようです。

5位のマウスは，芝浦工業大学電気工学科春日智恵先生の研究室の「S.I.T.XIII号」。製作は，西村昌樹氏。昨年の12月から製作を始めて世界大会予選前日の8月22日に完成。ステッピングモータを使用し，横壁は赤外線センサ，前壁は超音波センサを使用しています。前壁検出に超音波を使用することにより，かなり手前から前壁の情報が得られ，探索時には非常に有効な方法といえます。

6位に入賞したのは，昨年度全日本大会の優勝マウス「NAZCA」でした。製作者の井谷氏と野村氏は，新作マウスの製作に忙しく，「NAZCA」にはほとんど手をつけていなかったらしく，「本当によく走ってくれた」と自らのマウスに感激していました。

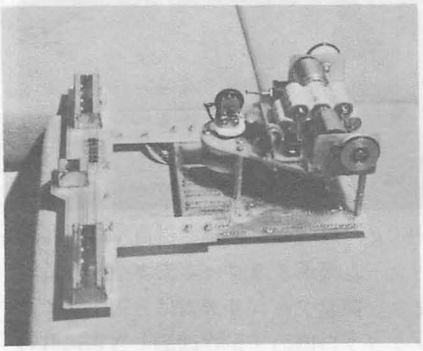
入賞したマウスはもちろん，決勝へ進めなかったマウスも，1台1台に製作者の工夫と努力の跡が感じられ，それらのマウスが一堂に会し，競い合ったこの「'85マイクロマウス世界大会」は本当に素晴しい大会となりました。

〈科学技術館賞〉

「Enterprise」：40秒91

David Woodfield（英国）

特にハード面を評価されての受賞でした。580gの軽量三輪マウスで，動輪二輪，操舵輪ともDCモータ，操舵輪はロータリーエンコーダに直結されています。

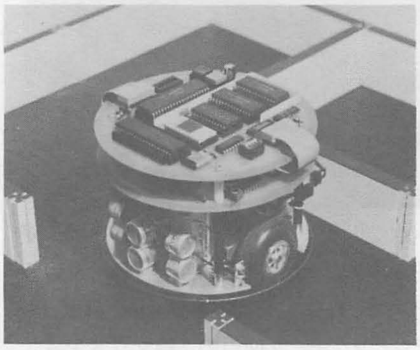


〈日本マイクロマウス協会賞〉

「LABO－2号」：41秒76

吉井　功

協会賞は技術奨励賞として授与されました。非常にきれいにまとまったマウスで，ステッピングモータを使用。超音波を主に赤外線，メカの3種のセンサ搭載。

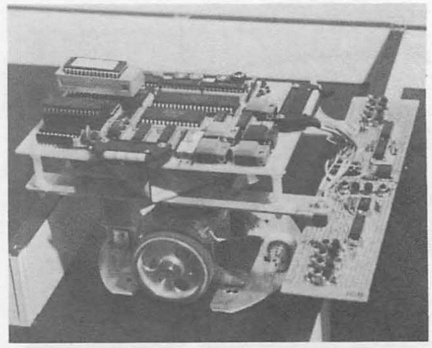


〈ナムコ賞〉

「TZ80b」：46秒35

八千代マイコンクラブ（日笠 繁）

ナムコ賞はソフト面での評価でした。Z80Aを搭載し，プログラム開発にはPC9801F2を使用。「TZ80b」はシンプルな構造が特徴となっているそうです。

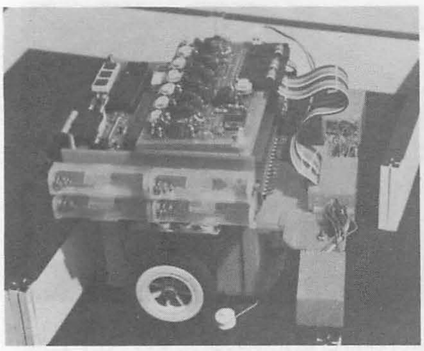


〈特別賞〉

「SAPIENCE」

金 基熙（韓国）

ドライブモータにはDCモータを使用し，赤外線センサとリトライ用メカセンサを使用しています。一番の苦労はやはりソフト面だったそうです。

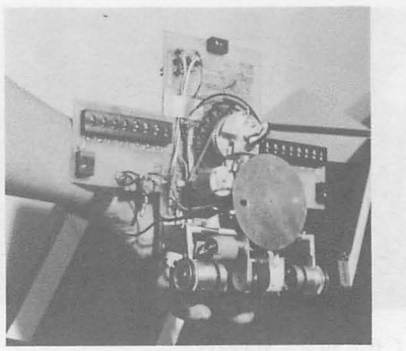


〈特別賞〉

「Tellu」

Hannu-Matti ほか（フィンランド）

上から見ると十字型をしたマウスで自国の国旗を表現しているようです。CPUは6809を使用し，動輪二輪，操舵輪一輪の三輪マウスでした。

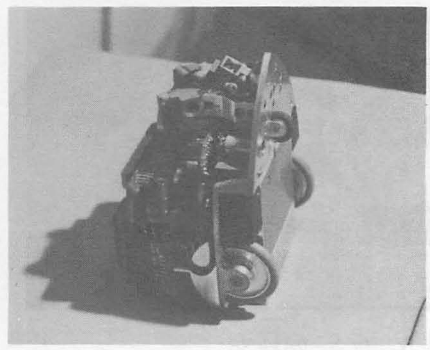


〈特別賞〉

「Micro Gonzales」

Ralf Hinkel（西独）

450gと非常に軽いマウスで，センサには，CCDカメラを3個搭載し，動輪二輪，操舵輪一輪の三輪マウスでした。可愛らしいねずみの外装も印象的でした。



順位	マウス名	エントリー者名	記録	備考
1	NORIKO-X1	福山マイコンクラブ（麦田憲司・井谷優・野村正則）	19″83	優勝
2	NORIKO-X2	福山マイコンクラブ（麦田憲司・井谷優・野村正則）	20″05	2位
3	EMI	福山マイコンクラブ(上広孝幸)	20″36	3位
4	NORIKO-X3	福山マイコンクラブ（麦田憲司・井谷優・野村正則）	22″83	4位
5	S.I.T. XIII号	芝浦工業大学電気工学科	28″36	5位
6	NAZCA	福山マイコンクラブ（井谷優・野村正則）	31″68	6位（※'84全日本大会優勝）
7	Enterprise	David Woodfield（英国）	40″91	科学技術館賞（※'84ヨーロッパ大会優勝）
8	LABO-2号	吉井　功	41″76	日本マイクロマウス協会賞（※'84全日本大会2位）
9	LABO-3号	吉井　功	46″35	
10	TZ80b	八千代マイコンクラブ(日笠繁)	47″91	ナムコ賞
11	Champ	山田達司	49″58	
12	BLACK BOX	西岡隆美	51″05	
13	NORIKO-X4	福山マイコンクラブ（麦田憲司・井谷優・野村正則）	59″83	
14	NANACY-M	福山マイコンクラブ(大塚正則)	59″90	
15	KOJOKAN	福山マイコンクラブ(片山　勲)	1′04″61	
16	NNH 1号改	林　佳夫	1′09″56	
17	NORIKO-X5	福山マイコンクラブ（麦田憲司・井谷優・野村正則）	1′40″91	
18	けんじ－3号	立松千尋	2′03″38	
19	ブジリズム	上広孝幸	2′41″58	（※'84全日本大会3位）
20	S.I.T. XVI号	芝浦工業大学電気工学科	2′59″35	
21	S.I.T. XIV号	芝浦工業大学電気工学科	3′06″68	
	S.I.T. XV号	芝浦工業大学電気工学科	リタイア	
	SAPIENCE	金　基熙（韓国）	リタイア	特別賞（※'85韓国大会2位）
	Tellu	Hannu-Matti ほか（フィンランド）	リタイア	特別賞(※'84ヨーロッパ大会4位)
	MAY-ROSE	山名宏治	リタイア	
	COCHOO-2HO（とうがらし2号）	李　爀 ほか（韓国）	リタイア	（※'85韓国大会優勝）
	Moon Knight Delight	Baxter Cheung ほか（米国）	リタイア	（※'85米国大会優勝）
	Manu	Hannu-Matti ほか（フィンランド）	リタイア	（※'84ヨーロッパ大会2位）
	Speedy Gonzales	Ralf Hinkel（西独）	—	特別賞(注1)（※'84ヨーロッパ大会）
	T－5	Alan L. S. Dibley（英国）	—	（※'84ヨーロッパ大会3位）
	GREEN PEAS	渡辺　勝	—	

備考欄（※）の記入のあるマウスはシードマウス

注1：予選参加のMicro Gonzalesを参考出走

〈予　選〉　1985. 8. 23, 24

〈決　勝〉　1985. 8. 25

総エントリー台数……126台(シードマウス11台を含む)

参加国……………………6カ国(フィンランド，韓国，英国，米国，西独，日本)

予選総エントリー数……115台(国内108台，海外7台)

予選総出走数…………74台(国内 71台，海外3台)

予選完走数……………27台(国内 27台，海外0台)

予選通過台数…………20台(国内 20台，海外0台)

シード台数……………11台(国内 3台，海外8台)

決勝エントリー数……31台(国内 23台，海外8台)

決勝出走数……………28台(国内 22台，海外6台)

決勝完走数……………21台(国内 20台，海外1台)

予選第1日目　8月23日(金)

"'85マイクロマウス世界大会" の予選が，２日間に渡り決勝会場と同じエキスポホールにおいて開催されました。

115台と多数のエントリーがあり，両日の予選はステージ上に２台の迷路を設け，２チームごとの出走で予選が進められました。

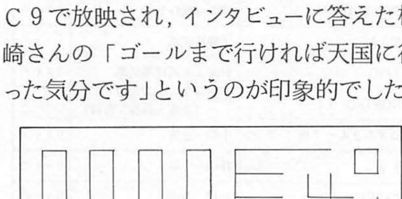
第１日目の23日はつくば近県参加者による予選でこの日の参加台数は53台のうち39台が出走,15台が完走しました。しかし,決勝へ進めるのは，２日間の予選を通して上位20台となっているため，完走したからと言って必ずしも安心はできません。

前日から宿舎では，いくつかのグループが徹夜で調整をして，大会にいどみましたが，中には全く動く気配を見せないマウスや，ゴール手前でおしくもリタイアしてしまうマウスなど半数以上のマウスが完走できませんでした。しかし39台中15台が完走というのは，率からすると非常に高いと言えます。世界大会に向けての参加者の努力が窺えました。

午前中のトップの記録は「BLACK BOX」の38秒40。千葉県君津市から参加した西岡さんはまずは一安心されたことでしょう。

午後に入って最初のうちはリタイアが続出しましたが,山名氏の「MAY-ROSE」が27秒86という好タイムを最後の10回目の走行で記録しました。山名さんは,「自分でも信じられない」と少し上ずったように語っていました。

エントリーNo.50の芝浦工大の「S.I.T.XⅢ号」は，この日の最高タイムである20秒88という記録を持ち時間ぎりぎりで出して，最後の盛り上げを見せてくれました。この日の模様は，その日のＮＨＫテレビＮＣ９で放映され，インタビューに答えた松崎さんの「ゴールまで行ければ天国に行った気分です」というのが印象的でした。



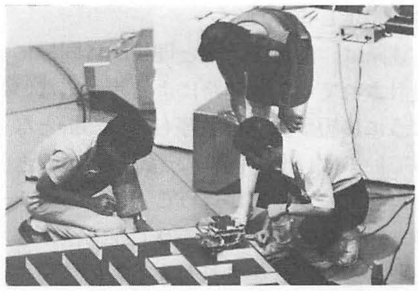
代表的短路69歩25折

涙をのんだマウスたち

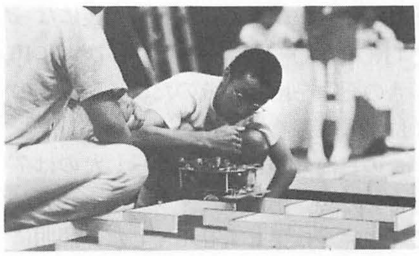
惜しくも決勝へ進出できなかったマウス。それぞれにドラマがありました。

右のマウスは,今回の大会で最年少のグループ，中学３年の横山君と高校１年の岩崎君が製作した「MA-Ⅱ "OKAPI"」。自分達の技術力を試してみたかったとのことですが残念ながらリタイアしてしまいました。

上の写真は，山下さんの「M−3」３分53秒80で完走しましたが，上位20位には残れませんでした。ＵＦＯ型のとてもユニークなマウスで，メカニカルセンサを用いクルクル回転しながら壁にそって進むマウスでした。



下のマウスは，早大理工機友会の「γ-Kraken」快調にスタートしたのですが，途中で文字どおり"火"を吹いてリタイアしてしまいました。



No.	ロボット名	エントリー者名	公式記録	No.	ロボット名	エントリー者名	公式記録
1	MAZE ACCIDENT	東京理科大学 無線研自動制御班	—	28	MAY−ROSE	山名 宏治	27″86
2	N·I·T−α	青木 智仁	—	29	TZ80b	八千代マイコンクラブ	33″53
3	進々堂直行	渡辺 勝	リタイア	30	マッハ2号	半田 邦之	リタイア
4	㊙	東君チーム	5′39″81	31	S·I·T XⅥ号	芝浦工業大学電気工学科	1′30″13
5	β−Kraken	早大理工機友会 マイクロマウスクラブ	リタイア	32	M−3	山下 伸逸	3′53″80
6		藤記 拓也 他	—	33	GOKKU 1	加藤 隆 他	リタイア
7	PETPE−3	井沢 隆	リタイア	34	COALA−M3MKⅡ	COALA	リタイア
8	金太郎C	上尾金属工業協会組合 マイコン研究会	リタイア	35	エントリー号	佐藤 孝治	—
9	Champ	山田 達司	40″21	36	PETPE−2	井沢 隆	リタイア
10	AMI 3号	高澤研究室	リタイア	37	MIMIC MOUSE 3	三菱重工本社 マイコンクラブ	リタイア
11	GREEN PEAS	渡辺 勝	2′03″70	38	ケッタⅡ	早大理工機友会 マイクロマウスクラブ	—
12	S·I·T XⅣ号	芝浦工業大学電気工学科	1′32″83	39	N·I·T−γⅡ	勝田 重男，平松 邦仁	—
13	N·I·T−γ（ガンマ）	平松 邦仁	5′19″70	40	S·I·T XⅡ号 (ASTRON)	芝浦工業大学電気工学科	4′51″50
14	NMA	間瀬 康夫，安達 雅春	リタイア	41	γ−Kraken	早大理工機友会 マイクロマウスクラブ	リタイア
15	BLACK BOX	西岡 隆美	38″40	42	SHUNⅡ	西村 輝一	リタイア
16	Ninja	八千代マイコンクラブ	リタイア	43	COALA−R1	COALA	—
17	NMK	中野 健一，木津川直樹	—	44	NNH 1号改	林 佳夫 他	49″96
18	HAM−STER	青山 敦	—	45	J−1	阿部，宮崎	リタイア
19	Kerel 0.0	中尾 武典，林 佳夫	リタイア	46	109	渡辺 克之	—
20	YOMISU−Ⅲ	保延 保	—	47		早稲田高校物理部	—
21	むうあ	山本 巌 他	リタイア	48	MIMIC MOUSE 2B	三菱重工本社 マイコンクラブ	リタイア
22	ORANGE−2	浅野 健一	—	49	MA−Ⅱ "OKAPI"	μ54543L	リタイア
23	JUNK−X2	JUNK	リタイア	50	S·I·T XⅢ号	芝浦工業大学電気工学科	20″88
24	かめさん	桐陰学園高校 電気工作同好会	—	51	GMM−1	角屋 良樹	リタイア
25	JUNK−X1	JUNK	リタイア	52	LABO−3	吉井 功	34″56
26	YUKIYO	押川憲一郎	—	53	MYDA−2	松崎 誠	リタイア
27	S·I·T XⅤ号	芝浦工業大学電気工学科	1′38″50				

予選第2日目　8月24日(土)

予選第２日目は，地方参加者および海外からのエントリー者によって行われ，エントリー62台のうち35台が出走し，12台が完走しました。

迷路は，前日の予選と理論的に同様に設計されていて，迷路による差が出ないように最短歩数，折数等も69歩25折となっています。全く同一の迷路で行うことが理想ですが，日が違うことによるハンディーをなくすためにこうした方法がとられ，迷路設計をされた先生方の苦労されたところです。

トップバッターの福山マイコンクラブの「NORIKO-X2」が，4回目の走行で16秒03を記録し，会場を沸かせました。その後リタイアが続きましたが，午後になって「NORIKO-Xシリーズ」が，次々に10秒台の記録を出し，そのたびに順位表の１位が入れ替りました。

この日海外からエントリーしたのは7台でしたが，出走したマウス達も残念なことに完走は果せませんでした。照明に対する調整がまだ充分できていなかったらしく，傘をさしたり照明を落したりしての走行も行われましたが，不調に終わりました。しかし西独から参加のRALF HINKEL氏の「MICRO GONZALES」は，センサにCCDカメラを用い，たいへんコンパクトにでき上っていて，完走こそできませんでしたが，高水準の技術に対して会場からたくさんの注目を集めました。

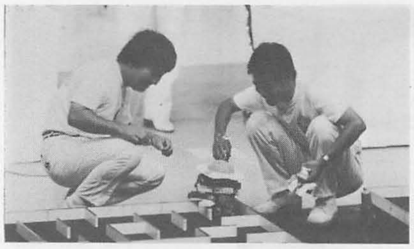
結局，前日の予選と合わせて27台のマウスが完走し，７台のマウスが残念ながら，決勝進出は果せず，20台の予選通過マウスと11台のシードマウスによって明日，決勝大会が行われることになりました。

START　　代表的短路69歩25折

涙をのんだマウスたち

遠方からはるばるマウスを胸に参加していただきましたが，旅の疲れが出たマウスが多かったようです。

山形県長井工業高校からは２台のマウスが参加しました。右のマウスは「袋小路長井線4号」10回の走行を試みましたがゴールへたどりつくことができませんでした。

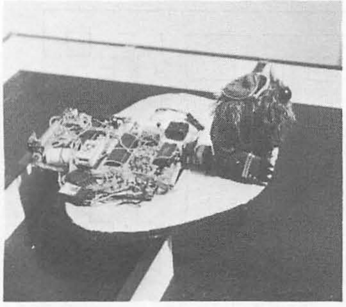


上の写真は名古屋 WHITE RABBITの「MAZE WALKER SEIKO I PLUS」コスモ星丸の外装で愛嬌を振りまきました。彼らのユニホームは世界大会のために，何とマウスよりも先に作ってしまったとか。

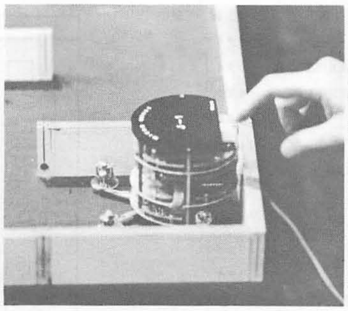
下の写真は韓国からの飛び入りチームの「SKYLINE Ⅱ」。10回の走行を終えてもそれに気づかず必死で頑張ってくれましたが，惜しくもリタイアでした。

№	ロボット名	エントリー者名	公式記録	№	ロボット名	エントリー者名	公式記録
1	NORIKO-X2	福山マイコンクラブ（麦田・井谷・野村）	16″03	32	いなほV2.0	新潟工業高校電気部	リタイア
2	スーパーマウス13	TEAN MICRO KIDS	—	33	NANACY-M	福山マイコンクラブ（大塚政則）	45″51
3	ARARAT	福山マイコンクラブ（足立芳彦）	リタイア	34	MAZE WALKER SEIKO I PLUS	WHITE RABBIT	リタイア
4		知能ロボット研究会	—	35	Gol Mok Dae Jang	李　鍚敏（韓国）	—
5	MASA 85M	加藤　正行	リタイア	36	MAZE RUNNER SEIKO TURBO	WHITE RABBIT	リタイア
6	N-1	西森　滋	リタイア	37	MI.MU.ME.MO-3	平野　康博	—
7	袋小路長井線4′号	長井工業高校	リタイア	38	NORIKO-X5	福山マイコンクラブ（麦田・井谷・野村）	15″68
8	TUN-1	知能ロボット研究会	—	39	チキチキ2号	村松　龍男	—
9	迷笑殿ⅡX	東海高校電研部マイコン班	リタイア	40	スーパーマウス12	TEAM MICRO KIDS	リタイア
10	T-164	田中　宏	—	41	NORIKO-X3	福山マイコンクラブ（麦田・井谷・野村）	15″80
11	MICRO GONZALES	RALF HINKEL（西独）	リタイア	42	マイケル	福山マイコンクラブ（八幡　聡）	2′23″53
12	K-2	高志高校物理部	—	43	まいこ	長野　昭博	2′28″86
13	KOJOKAN	福山マイコンクラブ（片山　勲）	1′48″20	44	MASAYO	グループ「なべ」	リタイア
14	KEIKO	グループ「なべ」	リタイア	45	セコマン	MAZDA ねずみの会	—
15	袋小路長井線3′号	長井工業高校	リタイア	46	NEZUMI	RALF HINKEL（西独）	—
16	MI.MU.ME.MO-4	平野　康博	—	47	THESEUS	東海高校ＯＢ会	リタイア
17	MBX50	新潟工業高校電気部	リタイア	48	T-4	伊藤比佐志	—
18	L. A. Express	BAXTER CHEUNG 他	—	49	JOG	新潟工業高校電気部	リタイア
19	ガーランドⅠ	角谷　良大　他	リタイア	50	NORIKO-X4	福山マイコンクラブ（麦田・井谷・野村）	48″70
20	May Show	勝股　義雅，鈴木　剛志	—	51	ねずみさん-7世	小原　敏秀	リタイア
21	マイクロチャレンジャーⅡ	畠山　幸義	—	52	§9	井口　寧	リタイア
22	NORIKO-X1	福山マイコンクラブ（麦田・井谷・野村）	14″88	53	ZERO	神村　英彦	リタイア
23	D-80	川口　洋一	リタイア	54	OSP 1	桂　寛	—
24	ねずみさんのタタキダイ	畑水練	—	55	EMI	福山マイコンクラブ（上広孝幸）	14″50
25	THEZEUS 6	ALAN L. S. DIBLEY（英）	リタイア	56	D-70	川口　洋一	4′46″20
26	NTB	佐藤　栄一，井上　猛	—	57	KEM-2	渋谷　俊晴	—
27	けんじ-3号	立松　千尋	52″65	58	KAPPEI-2	飼沼喜代和	リタイア
28	マウンテンドン	MAZDA ねずみの会	—	59	KNOWN AIM	DAVID WOODFIELD（英）	—
29	迷笑殿Ⅸ	東海高校電研部マイコン班	—	60	NA-3	福山マイコンクラブ（平　信之）	—
30	マイクロチャレンジャーⅠ	畠山　幸義	—	61	MIKA-4	権田　秀男	—
31	RYOKO-1	MAZDA ねずみの会	リタイア	62	スカイラインⅡ	Yong-Hoon Lee	リタイア

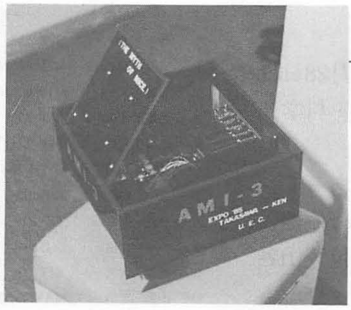
マウスアラカルト



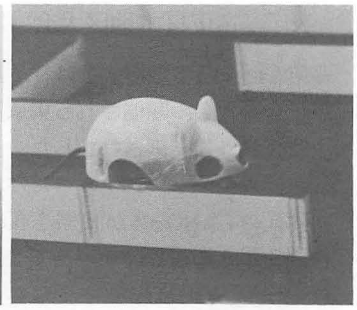
「T-5」



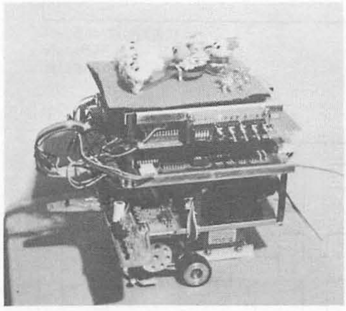
「J-1」



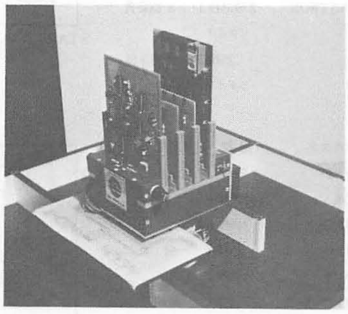
「AMI 3号」



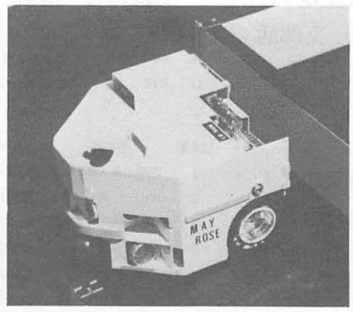
「LABO-3号」



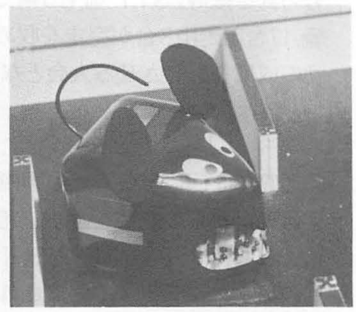
「MAZE RUNNER SEIKO TURBO」



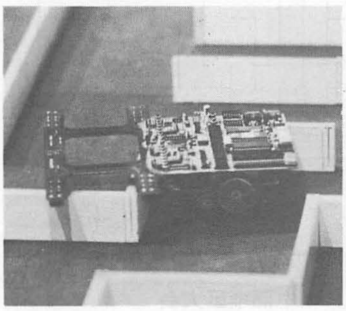
「Moon Knight Delight」



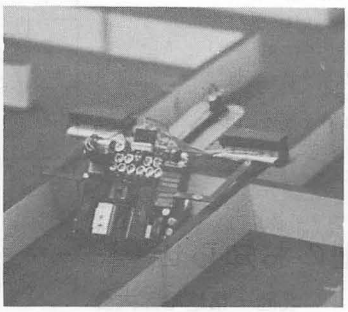
「MAY-ROSE」



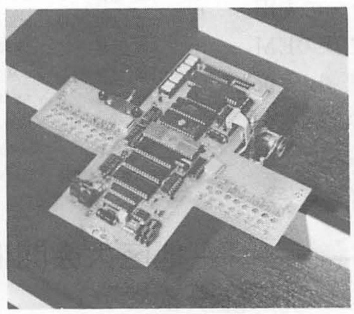
「Micro Gonzales」



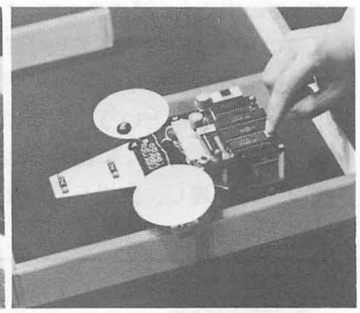
「S.I.T.XII号(ASTRON)」



「THEZEUS 6」



「Tellu」



「ねずみさん-7世」

マイクロマウスとは (MICROMOUSE)

マイクロマウスとは、自分自身の判断で複雑な迷路を脱出する自立型の知能ロボットです。

競技用迷路は、一辺18cmの正方形を一区画として、16×16区画(256区画)の大きさがあり、その中心にゴールがあります。

外側にある入口からスタートし、いかに速くゴールに到着するかを競う訳ですが、15分の持ち時間で10回までしか走行できないルールがあります。

そのため、最初の数回は、自分で走り回わりながら迷路を記憶(学習)し、その後に自分で最短コースを見つけて、一気にスピードアップをして通り抜け、最高タイムにチャレンジします。

外部からの操縦は一切許されていないため、マイクロマウスは、自分自身で壁の状況を認識し、一度通った所、まだ探索していない所などを判断して、そのロボットにとって最適なコースを見つけ出します。まさに頭脳の勝負といえます。

したがって、マイクロマウスにはコンピュータのハード技術、ソフト技術、そしてメカ的な技術といった総合技術が必要であり、さらに、0.1秒でも速く走るためには、まだまだ解決しなければならないこともたくさん残されていて、このマイクロマウスが「奥の深い知的ホビー」と言われる所以もそこにあるのです。

マイクロマウスの歴史と広がり

マイクロマウス競技の誕生は、1977年アメリカでのことでした。I.E.E.E.という電気電子学会のアトラクションとしてロボットに迷路を脱出させてみようというテーマで、この競技を発表したところ、大反響を呼び全米から何と6,000台もの申し込みがあったそうです。1979年6月にニューヨークで行った全米決勝大会には15台が勝ち進み、A・ボランド氏らの「ムーンライト・エクスプレス号」が29.78秒というタイムで優勝しました。これだけ盛り上ったアメリカの大会も、残念なことにその年で終わってしまい、その後ヨーロッパに引き継がれて行きます。

1980年、ヨーロッパのコンピュータ学会EUROMICROにより、ロンドンにおいて第1回大会が開催され、この地でも各方面から注目を集めました。以後毎年、学会が開かれる毎にヨーロッパ大会が開催されています。

一方日本でも、1980年10月に第1回全日本マイクロマウス大会が開催されています。アメリカ、ヨーロッパが学会内の活動であるのに対し、日本では広く一般のマニアを対象にしています。最初わずか9台だった参加も2年目には55台、3年目には100台と急激に増加し、延べ500台以上のマウスが現在までに参加しています。

そして、1984年アメリカ、韓国も加わった上で、ルールを統一し、このつくばでの世界初の「'85マイクロマウス世界大会」開催に至っています。

今後も、日本国内はもとより世界中でマニアが増大し、第2回、第3回の世界大会実現に向けてマイクロマウスの輪が広がっていくと思われます。

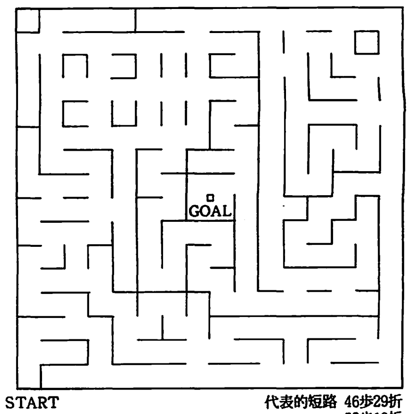
地区大会結果

東日本地区大会

第２回東日本地区大会は，７月28日(日)毎年全国大会の開催される東京・科学技術館２Ｆにて実施されました。

世界大会のシードマウスだけあって，吉井氏のLABO－2が優勝を収めた他，西岡氏が３年越しの初完走で２位。山名氏のMAYROSEもユニークなスラローム走行で３位入賞。また，松崎氏も初完走で努力賞を獲得。S.I.T.XIIIも３輪で完走する等，17台出走中８台が完走を収め，支部活動の成果を感じさせる大会となりました。

出走順	参加者	マウス名	記録	順位
1	芝浦工大チーム	SIT XVI	リタイア	
2	三菱重工チーム	MIMIC MOUSE 2B	リタイア	
3	三菱重工チーム	MIMIC MOUSE 3	リタイア	
4	芝浦工大チーム	SIT XIV	リタイア	
5	芝浦工大チーム	SIT XIII	1分22秒8	7
6	松崎　誠	MYDAちゃん－2	1分03秒1	6 努力賞
7	東　明洋	笑子の孫	58秒9	5
8	日笠　繁	TZ80b	30秒7	4 敢闘賞
9	角屋　良樹	GMM－1	リタイア	
10	芝浦工大チーム	SIT XV	リタイア	
11	山名　宏治	MAYROSE	30秒5	3 第3位
12	吉井　功	LABO－2	21秒9	1 優　勝
13	東　明洋	㊙	リタイア	
14	芝浦工大チーム	SIT XII ASTRON	2分31秒1	8 協会賞
15	吉井　功	LABO－3	リタイア	
16	西岡　隆美	ときわ2号	25秒5	2 第2位
17	井沢　隆	PETPE－2	リタイア	



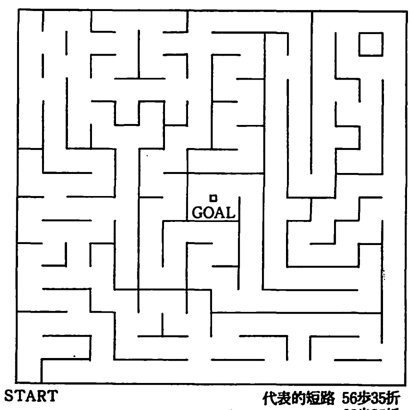
代表的短路 46歩29折
52歩19折
60歩11折

中・四国地区大会

通算で５回目となった中国四国地区大会は東京からの３台を含め，15台の参加によって，８月４日(日)，ＮＨＫ福山放送局の第１スタジオにて開催されました。

世界大会の優勝をねらう福山マイコンクラブの中でも，歴代チャンピオンの麦田氏等のNORIKOシリーズと，上広氏のEMIの一騎打ちとなり，X－2の優勝。上位５台が15～16秒という，昨年の全国大会優勝記録を半分近くに縮める猛スピードでゴールに達し，会場を沸かせました。

出走順	参加者	マウス名	記録	順位
1	芝浦工業大学	SIT－XII	リタイア	
2	片山　勲	KOJOKAN	1分00秒1	9
3	井谷・麦田・野村	NORIKO X－1	16秒8	5
4	〃	NORIKO X－3	15秒4	2
5	大塚　正則	NANACY	1分18秒4	10
6	井谷・麦田・野村	NORIKO X－2	15秒1	優勝
7	芝浦工業大学	SIT－XIII	33秒1	7
8	小原　敏秀	ねずみさん－7世	リタイア	
9	井谷・麦田・野村	NORIKO X－4	リタイア	
10	日笠　繁	TZ80b	38秒1	8
11	上広　孝幸	E.M.I.	15秒9	3
12	足立　芳彦	ARARAT	3分17秒5	12
13	井谷・麦田・野村	NORIKO X－5	16秒2	4
14	八幡　聡	マイケル	2分05秒7	11
15	井谷俊・野村正則	NAZCA	27秒2	6



代表的短路 56歩35折
62歩25折
74歩19折
76歩15折

地区大会開催のお知らせ

関西地区大会

〈日　時〉10月10日(木) 体育の日
12：00～17：00

〈場　所〉インテックス大阪2号館（大阪国際見本市新会場）'85ロボット・自動化機器展会場内

〈連絡先〉(財)大阪科学技術センター普及事業課
担当：宮上
☎06-443-5321(内)221

九州地区大会

〈日　時〉10月20日(日)
10：00～12：00 講演会
13：00～17：00 競技会

〈場　所〉熊本市立熊本博物館

〈連絡先〉(有)藤岡電気商会
担当：藤岡　勉
☎096-362-1218

北陸・信越地区大会

〈日　時〉11月３日(日) 文化の日
11：00～16：00

〈場　所〉新潟県立自然科学館
エントランスホール

〈連絡先〉新潟県立自然科学館
担当：日根
☎0252-83-3331

中部地区大会

〈日　時〉11月17日(日)

〈場　所〉犬山モンキーパークセンター

〈連絡先〉(株)ナムコ中部事業所
担当：南
☎052-231-6731

入　会　の　ご　案　内

日本マイクロマウス協会では、現在広く会員を募集しています。

当協会は、マイクロマウスをはじめとするマイクロロボット製作の技術向上、競技、作品発表の場を求めるアマチュアのための団体です。

【特　典】(1) 会員証の無料配布
(2) 協会が主催する競技会への無料エントリー
(3) 機関誌「ＭＯＵＳＥ」の無料配布
(4) 協会主催のセミナー等への優待サービス
(5) 科学技術館への優待サービス
(6) そ　の　他

【会　費】個人会員…………入会金 1,000円・年会費 1,000円
グループ会員……入会金 3,000円・年会費 3,000円（１口）

尚、グループ会員は、１口の加入に対して５人までを特典対象と致します。

入会希望の方は、下記事務局へご連絡下さい。

〒146 東京都大田区多摩川２－８－５
(株)ナムコ内　日本マイクロマウス協会事務局　☎03-756-3538

日本マイクロマウス協会
本部　(財)日本科学技術振興財団
科学技術館内

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