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The Status of Japan's Participation in Science and Technology Contests

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9.1 Introduction

A variety of science and technology contests are currently held in Japan. International science and technical contests began in the 1950s, and have developed by adding new fields such as Informatics. In Japan, mathematical, scientific research, technology, and other competitions are held, some of which include participants from overseas. Their existence, however, is not widely known.

In this article, therefore, we will present an overview of science and technology contests held on an international scale and describe Japanese participation in them. We will report on the following contests.

- **Contests related to science and technology education**
  International Science Olympiad (mathematics, physics, chemistry, informatics, biology, astronomy), International Science and Engineering Fair (ISEF)
- **Contests related to technology**
  ACM International Collegiate Programming Contest, Supercomputer Programming Contest, NHK Robocon (robot contest), RoboCup
- **Contests relating to skills**
  World Skills Competition

9.2 Overview of contests related to science and technology education.

9.2.1 International Science Olympiad

Targeting high school students (formally, students in secondary education), six Science Olympiads are held every year (Table 1). Each originated in Eastern Europe, and each has seen participation expand from the former communist bloc to include the West. With the exception of the Astronomy Olympiad, each Science Olympiad rotates among the participating countries, and each country is obligated to host the competition in the future. There is no unified governing body to oversee the different Science Olympiads.

The purposes of the competitions are to encourage learning by interested and talented young people, to foster originality and creativity, and to build international friendship through interaction among the participants. Overall, an Olympiad takes about 10 days, and in addition to the actual tests includes visits to relevant facilities, sightseeing, and social events.

To carry out the Olympiads, regulations and syllabi are determined and operating organizations are set. In the case of the Mathematical Olympiad, for example, a 10-member preparation committee including host country (previous, current, next) representatives is permanently in place. The committee provides information to participating countries, makes contact with and advises scheduled host countries, and exchanges information with relevant organizations such as UNESCO and the Science Olympiads. During the competition, the jury including the leaders of country delegations is formed and becomes the final decision making body. The selection of contest problems, the evaluation of answers, the determination of prizewinners, the revision of regulations, and the selection of future host countries are done there.

Following are overviews of the mathematics, physics, chemistry, and informatics Olympiads large enough to attract major international

Table 1: Overview of the International Science Olympiads for high school students

	Mathematical Olympiad	Physics Olympiad	Chemistry Olympiad	Olympiad in Informatics	Biology Olympiad	Astronomy Olympiad
Year/place 1st held	1959 Romania	1967 Poland	1968 Czechoslovakia	1989 Bulgaria	1990 Czechoslovakia	1996 Russia
Major participants and 1st year participating	1959: USSR 1967: France 1967: UK 1974: USA 1977: W.Germany 1985: China	1968: USSR 1972: France (non-participant since 1985) 1974: W.Germany 1984: UK 1986: USA 1987: China	1970: USSR 1975: W. Germany 1976: France 1983: UK 1984: USA 1987: China	1989: W. Germany, USSR, China 1990: UK 1992: USA 1996: France	1990: USSR 1990: Germany 1993: China 1998: UK	1996: Russia 1998: India 1999: Sweden 2001: Italy, S. Korea
Participating countries	84 (2002)	66 (2002)	57 (2002)	72 (2001)	40 (2002)	8 countries, 1 region (Moscow) (2001)
Team composition	6 or fewer contestants, 2 leaders	5 or fewer contestants, 2 leaders	4 or fewer contestants, 2 leaders	4 or fewer contestants, 2 leaders	4 or fewer contestants, 2 leaders	5 or fewer contestants, former prize winners, 2 leaders
Test problems and time to complete	6 problems (2 days, 9 hours total)	3 theoretical problems (1 day, 5 hrs., 30 points) 1-2 practical problems (1 day, 5 hrs, 20 points)	1 theoretical problem (1 day, 4-5 hrs., 60 points) 1 practical problem (1 day, 4-5 hrs. 40 points)	6 problems (2 days, 10 hrs. total)	1 theoretical problem (1 day, 4-6 hrs.) 1 practical problem (1 day, 4-6 hrs.) Weighted 1:1	4-6 theoretical problems (4 hrs., 60 points) 1-2 practical problems (3 hrs., 20 points) 1-2 observation problems (20 points)
Prizes	Gold Medal (top 1/12 of participants) Silver Medal (top 2/12) Bronze Medal (top 3/12) Honorable Mention (at least 1 problem correct)	Gold Medal (at least 90% of the average of the top 3 scores) Silver Medal (at least 78%) Bronze Medal (at least 65%) Honorable Mention (at least 50%)	Gold Medal (top 10% of participants) Silver Medal (top 20%) Bronze Medal (top 30%) Honorable Mention (at least 1 problem correct)	Gold Medal (top 1/12 of participants) Silver Medal (top 2/12) Bronze Medal (top 3/12)	Gold Medal (top 10% of participants) Silver Medal (top 20%) Bronze Medal (top 30%)	—
Recent results	1 China, 2 Russia, 3 USA, 4 Bulgaria, 5 Vietnam, 6 S. Korea, 7 Taiwan, 8 Romania, 9 India, 10 Germany (2002)	1 China, 2 Iran, 3 S. Korea, 4 Russia, 5 Hungary, 6 Indonesia, 7 India, 8 Taiwan, 9 Romania, 10 Georgia (USA did not participate in 2002)	1 China, 2 Thailand, 3 Taiwan, 4 Ukraine, 5 Austria, 6 S. Korea, 7 USA, 8 Germany, 9 Poland, 10 Iran (2002)	1 Slovakia, 2 USA, 3 Singapore, 4 Finland, 5 S. Korea, 6 Romania 7 Poland, 8 Bulgaria, 9 Vietnam, 10 Germany (2001)	1 China, 2 S. Korea, 3 Taiwan, 4 Singapore, 5 Thailand (2002)	1 Russia, 2 India (2002)
Japanese participation	Since 1990 (scheduled to host 2003 competition)	None (Participation being considered by relevant academic organizations) (Observer at 2001 Asian competition)	Scheduled to begin in 2003 (Observer at 1989 and 2002 competitions)	1994-1996	None (Observer at 1995 competition)	None

Note: The Science Olympiads are individual competitions; no country standings are announced. The standings above are calculated as follows: total points in the Mathematical Olympiad, total points for prize winners in the Physics Olympiad, aggregate placement in the Chemistry Olympiad, and number of prize winners in the Astronomy Olympiad.

Sources: relevant websites [1]

Figure 1: Sample problems from the Mathematical Olympiad (42nd Olympiad, July 2001, USA)

Day 1, July 8 (Test time 4 hours 30 minutes; each problem 7 points)

1. Let ABC be an acute-angled triangle with circumcenter O. Let P on BC be the foot of the altitude from A. Suppose $\angle BCA \geq \angle ABC + 30^\circ$ prove that $\angle CAB + \angle COP < 90^\circ$.

2. Prove that
$$\frac{a}{\sqrt{a^2+8bc}} + \frac{b}{\sqrt{b^2+8ca}} + \frac{c}{\sqrt{c^2+8ab}} \geq 1.$$
for all positive real numbers a, b and c.

3. 21 girls and 21 boys took part in a mathematics contest.
   • Each contestant solved at most six problems.
   • For each girl and each boy, at least one problem was solved by both of them.
   Prove that there was one problem that was solved by at least three girls and at least three boys.

Source: Mathematical Olympiad Foundation of Japan website (http://village.infoweb.ne.jp/~fvgm9250/)

participation.

(1) IMO:
International Mathematical Olympiad

— Overview

The first International Mathematical Olympiad was held in 1959, with Hungary, Bulgaria, Poland, former Czechoslovakia, former E. Germany, and the former Soviet Union participating at the invitation of Romania. Western countries steadily joined thereafter, including Finland in 1965, France, the United Kingdom, Italy, and Sweden in 1967, the United States in 1974, and West Germany in 1977. Japan first participated at the 31st Mathematical Olympiad, held in China in 1990. Four hundred eighty-one people from 84 countries participated in the 43rd Olympiad in 2002. Japan is scheduled to host the 44th Olympiad in 2003.

The problems focus mainly on geometry, mathematical theory, and discrete mathematics, which are not widely taught in Japanese high schools. Calculus and linear algebra are not included. (Figure 1)

— Japanese participation and results

Japan selects its competitors through the annual Japan Mathematical Olympiad held by the Mathematical Olympiad Foundation of Japan. Of the approximately 1,500 participants in preliminaries held all over Japan, about 100 pass and move on to the finals. In the finals, approximately 20 high scorers are chosen for a weeklong training camp at which the 6 Japan representatives are chosen.

Table 2: Recent results

	41st Olympiad (2000)	42nd Olympiad (2001)	43rd Olympiad (2002)
Participating countries	82	83	84
1st	China	China	China
2nd	Russia	Russia, USA	Russia
3rd	USA	—	USA
4th	S. Korea	Bulgaria, S. Korea	Bulgaria
5th	Bulgaria, Vietnam	—	Vietnam
6th	—	Kazakhstan	S. Korea
7th	Belarus	India	Taiwan
8th	Taiwan	Ukraine	Romania
9th	Hungary	Taiwan	India
10th	Iran	Vietnam	Germany
Japan	15th	13th	16th

Source: Mathematical Olympiad Foundation of Japan website (http://village.infoweb.ne.jp/~fvgm9250/)

Table 3: Placement trends since 1990

	China	Russia (former Soviet Union)	USA	S. Korea	Germany	Japan	France	UK
1990	1	2	3	32	7 (East) 12 (West)	20	5	10
1991	2	1	5	17	4	12	13	18
1992	1	6	2	18	7	8	10	5
1993	1	4	7	16	2	20	17	14
1994	2	3	1	14	12	10	19	7
1995	1	3	11	7	15	9	30	10
1996	6	4	2	8	10	11	36	5
1997	1	4	4	11	13	12	32	16
1998	(DNP)	6	3	12	16	14	26	17
1999	1	1	10	7	17	13	33	20
2000	1	2	3	4	20	15	48	22
2001	1	2	2	4	14	13	28	31
2002	1	2	3	6	10	16	19	27

Source: Mathematical Olympiad Foundation of Japan website (http://village.infoweb.ne.jp/~fvgm9250/) and materials

The Olympiad is an individual competition, but if we add the points of participants to get country placements, Japan finishes in the upper half of the second 10 (see Table 2). Special training for participants and potential competitors takes place in every country. In most places, like Japan, that training is one or two weeks long, but some countries are make more intense efforts. In the former Soviet Union, for example, organized selection and gifted education were carried out, while in China training could last for several months. South Korea offered nationwide support when the Olympiad was held there in 2000.

Looking at results since 1990, Japan has been holding steady in the second 10. China and Russia regularly finish at the top, while the United States has relatively large swings but usually finishes among the leaders. Germany, France, and the United Kingdom were on a downward trend, but have regained their positions. The longtime participants from Eastern Europe and the former Soviet Union also appear among the leaders. In Asia, South Korea has shown remarkable progress, while Iran and Vietnam have also taken their places among the leaders (see Table 2 and 3).

(2) IPhO: International Physics Olympiad

The first International Physics Olympiad was held in Poland in 1967 with five Eastern European nations participating. Sixty-six countries took part in the 33rd Olympiad in 2002. An Asian Physics Olympiad has been held since 2000.

In Japan, education committees of the Physical Society of Japan and the Japan Society of Applied Physics have been considering the International Physics Olympiad since 1990.[2] At the 57th annual meeting of the Physical Society of Japan this past spring, the Physics Education Society of Japan and the physics education subcommittee of the Japan Society for Applied Physics held a joint symposium where they discussed issues such as the value of participation, the required conditions to do so, and gaps between the Olympiad problems and Japanese curricula.

(3) IChO: International Chemistry Olympiad

The first International Chemistry Olympiad was held in 1968 at the suggestion of former Czechoslovakia. Hungary and Poland were the other participating countries. In 2002, 57 countries took part in the 34th Olympiad.

In Japan, the Chemical Society of Japan and the Chemical Education Society of Japan studied the Olympiad and sent observers to the 1989 contest. They did not attempt to participate due to the difficulties of securing funds and competition facilities and the difference in content between the Olympiad and Japanese high school curricula.

Since 1998, however, the Chemical Society of Japan, its Chemistry Education Council, the "Yume Kagaku 21 Committee" (including Chemical Society of Japan, Society of Chemical Engineers, Japan, Association for the Progress of New Chemistry, Japan Chemical Industry Association) have been holding the High School Chemistry Grand Prix, which is patterned after the Chemistry Olympiad, so a domestic competition system is now in place. Competitors selected at this year's contest will be sent to participate in the 2003 Olympiad in Greece.[3]

(4) IOI:

International Olympiad in Informatics

The first International Olympiad in Informatics was held in 1989, with 13 countries including Bulgaria, China, East and West Germany, and the Soviet Union participating. Seventy-two countries took part in the 13th Olympiad in 2001.

Japan sent delegations to the International Olympiad in Informatics from 1994 through 1996, treating it as a part of the International Mathematical Olympiad. Domestic competition and participation in the international competition were enabled by financial support from the Mathematical Olympiad Foundation of Japan and the volunteer work of university professors. Since 1997, however, no teams have been sent due to a lack of a dedicated source of funds and less than expected growth in domestic participation. Since the field is not designated as a subject in Japanese schools (the emphasis is different from the informatics that will be introduced in high schools next year), and because the difficult economic conditions in Japan make it unlikely that funding can be found, resumed participation is not being considered.

9.2.2 ISEF: International Science and Engineering Fair[4]

— Overview

The International Science and Engineering Fair is operated by Science Service, a non-profit organization in the United States. This science and engineering competition for high school students has been held annually throughout the USA since 1950. Alumnae/i of the competition include five Nobel laureates and two winners of the Fields Medal, as well as many other distinguished scientists. The quality of the exhibits is so high that about 15 percent of them have U.S. patents applied for. Since Intel became the event's primary sponsor in 1997, new prizes have been added and international participation has increased.

Participants are selected through cooperating competitions in each foreign country and U.S. state. No more than two individuals and one group are accepted from each contest. Participants display their projects in separate booths, and are judged by 700 to 900 judges on originality, scientific thought, and technical completeness. Approximately 1,200 people (80 percent of them from the USA) from each U.S. state and 40 foreign countries including the UK, Germany, Canada, Russia, Australia, China, Taiwan, and South Korea took part in the 2002 Fair.

The 15 sectors of the Fair include 14 fields (behavioral/social science, biochemistry, botany, chemistry, computer science, earth/space science, engineering, environmental science, gerontology, mathematics, medicine/health care, microbiology, physics, zoology) plus team projects.

First to fourth place winners in each sector receive awards and prize money. (More than one winner receives each kind of prize.) Three participants are selected from among all prizewinners to receive the Intel Young Scientist award, which includes a trip to the Nobel Prize award ceremony and a $50,000 scholarship. Other companies and organizations sponsor their own prizes as well.

The Fair lasts one week, and in addition to the judging of the projects by specialists, it includes lectures by invited Nobel laureates (open to the public), corporate exhibits, a dance, and sightseeing. An enjoyable atmosphere is created for the awards ceremony, with teams from each country wearing uniforms, waving flags, and cheering. The event is so popular that even the competition to host it can become intense.

— Japanese participation and results

Since 1958, high school winners of the Japan Students Science Award (sponsored by the Yomiuri Shimbun Co.) have gone on to ISEF. Created in 1957, the Japan Students Science Award is an open scientific research competition for junior high and

high school students. Its fields are physics, chemistry, biology, earth science, and interdisciplinary. Because there are no other Japanese competitions with links to ISEF, the number of participants from Japan remains very small.

At the 52nd ISEF in 2001, among Japan's two individuals and one team participating, the team project won a fourth-place prize. Two Japanese individuals participated in the 53rd ISEF in 2002, taking home a third place in botany and a fourth place in physics.

9.3 Contests related to technology

9.3.1 ACM/ICPC: ACM International Collegiate Programming Contest

— Overview

Sponsored by the Association for Computing Machinery (ACM) of the USA, this is the world's oldest and largest programming competition for college students. Its is to provide college students with opportunities to improve their problem solving abilities and computer skills.

Based on a contest first held in 1970, in 1977 the contest became a multi-round competition with finals. The contest network has expanded to universities around the world since the 1980s. Now teams battle in regional competitions in six regions, and the best move on to the world contest. Since IBM became its sponsor in 1997, the contest has grown roughly three times as large. Today 17,000 individuals on over 3,000 teams from more than 1,300 colleges and universities in 67 countries compete in the contest. At the 26th world finals in 2002, 64 teams (2 from Africa and the Middle East, 15 from Europe, 5 from Latin America, 25 from North America, 2 from Oceania, 15 from Asia) selected through 29 regional contests vied for the championship.

At the world finals, three-person teams work to solve about eight problems. Time is limited to five hours. Teams finishing in 1st through 3rd places win gold medals, those in 4th through 6th win silver, and those in 7th through 10th win bronze. Scholarships are awarded along with the medals.

— Japanese participation and results

Japan has participated in the world finals since 1998, and in the Asian regionals since 1997.

To move on to the world finals, a Japanese team must give an outstanding performance in the Asian regionals, which include Japan, South Korea, China, Iran, and so on. In the 2001 Asian regionals, eight regional preliminaries were held. (Each team may compete in two regional preliminaries.) In addition to the first-place teams in each regional preliminary, performance, hosting, and female participation were considered in choosing the remainder of the 15 teams that went on to the world finals in 2002.

Results at the world finals since Japan began competing in 1998 are shown in Table 4. Over those five years, the United States has placed in the top 10, 12 times, Russia 8 times, Canada 8 times, and China 7 times.

9.3.2 Supercomputer Programming Contest [5]

Since 1995, the Tokyo Institute of Technology's Global Scientific Information and Computing Center has held a national programming contest for high school students with the goal of having supercomputers play a positive role in society. The contest requires problem solving skills as well as programming techniques.

Preliminaries are judged based on documents including the program submitted, the results of running the program, and a report with an overview of the program's algorithms. Ten of the 30 to 40 three-person teams competing move on to the finals. There they spend four days tackling university-level problems under the guidance of instructors. Not merely a contest, the event is notable for including lectures and other educational features as well as promoting interaction among the participants.

Winning teams through 1998 attended the SuperComputing conference in the USA. Since 1999, workstations have been donated. Top finishers this year will have the opportunity to present their results at a joint national conference of the Information Processing Society of Japan and the Institute of Electronics, Information and Communication Engineers.

Table 4: ACM/ICPC Results since 1998

	1998	1999	2000	2001	2002
1st	Charles U.-Prague (Czech Rep.)	U. of Waterloo (Canada)	St. Petersburg U. (Russia)	St. Petersburg U. (Russia)	Shanghai Jiao Tong U. (China)
2nd	St. Petersburg U. (Russia)	Albert-Ludwigs U. (Germany)	U. of Melbourne (Australia) U. of Waterloo (Canada)	Virginia Tech. (USA)	Massachusetts Inst. of Technology (USA)
3rd	U. of Waterloo (Canada)	St. Petersburg Inst. of Fine Mechanics and Optics (Russia)	Albert Einstein U. Ulm (Germany)	St. Petersburg Inst. of Fine Mechanics and Optics (Russia)	U. of Waterloo (Canada)
4th	U. of Umea-Sweden (Sweden)	Bucharest U. (Romania)	St. Petersburg Inst. of Fine Mechanics and Optics (Russia) Tsinghua U. (China)	U. of Waterloo (Canada)	Tsinghua U. (China)
5th	Massachusetts Inst. of Technology (USA)	Duke U. (USA)	—	Albert Einstein U. Ulm (Germany)	Stanford U. (USA)
6th	U. of Melbourne (Australia)	California Polytechnic State U. (USA)	—	Warsaw U. (Poland)	Saratov State U. (Russia)
7th	Tsing Hua U.-Beijing (China)	U. of California at Berkeley (USA)	Kyoto U. (Japan) Shanghai Jiao Tong U. (China)	Massachusetts Inst. of Technology (USA)	Fudan U. (China)
8th	U. of Alberta (Canada)	Harvard U. (USA)	U. of Alberta (Canada) The Chinese U. of Hong Kong (China)	Seoul National U. (S. Korea)	Duke U. (USA)
9th	Warsaw U. (Poland)	St. Petersburg State U. (Russia)	California Inst. of Technology (USA)	Sharif U. of Technology (Iran)	Moscow State U. (Russia)
10th	Polytechnic U. Bucharest (Romania)	National Taiwan U. (Taiwan)	Charles U. Prague (Czech Rep.)	Harvard U. (USA)	U. of Buenos Aires (Argentina)
Japan	30+: Kyoto U.	18th: Kyoto U.	7th: Kyoto U.	14th: Kyoto U.	18th: U. of Tokyo

Source: ACM/ICPC website (http://icpc.baylor.edu/)

9.3.3 NHK Robocon (robot contest)

Based on a proposal by Masahiro Mori, emeritus professor at Tokyo Institute of Technology, to give young people a taste of the importance of creativity and the wonder of making, technical colleague Robocon was established in 1988 and all 62 schools have been participating in the regional preliminaries since the third Robocon,. IDC Robocon (mixed teams of university students from various participating countries compete) was established in 1990, and University Robocon was established in 1991. In each contest, contestants build robots based on a theme and test their success by competing against one another. With the contest broadcast on national television, it is very well-known and has become a major goal for many students.

Foreign universities have participated since the third University Robocon, and have won the last three in a row (see Table 5). This year the Asia-Pacific Broadcasting Union (ABU) established the ABU Asia-Pacific Robot Contest, and University Robocon also became the contest to select the Japanese team. At the 2002 ABU Robocon held at the end of August, 21 teams from 20 countries and territories (host Japan had two teams) participated.

Table 5: NHK Robocon Recent results (through 2001)

Year	6th (1997)	7th (1998)	8th (1999)	9th (2000)	10th (2001)
Participating schools	Japanese: 19 Foreign: 3 (Indonesia, Thailand, China)	Japanese: 15 Foreign: 5 (China, Singapore, Thailand, Australia)	Japanese: 12 Foreign: 8 (Indonesia, China, Thailand, Philippines, France, Australia)	Japanese: 13 Foreign: 7 (Indonesia, China, Thailand, France, Australia)	Japanese: 14 Foreign: 6 (Indonesia, China, Thailand, France, France,
Winner	Nagaoka University of Technology	Toyohashi University of Technology	Bangkok University (Thailand)	King Mongkut's University of Technology Thonbu (Thailand)	Politeknik Elektronika Negeri Surabaya (Indonesia)
2nd place	Nagasaki Institute of Applied Science	King Mongkut's University of Technology Thonbu (Thailand)	Nagaoka University of Technology	Nagaoka University of Technology	Kyushu University

Source: NHK University Robocon website (http://www.nep21.co.jp/robocon/jp/daigaku/)

Table 6: RoboCup 2002 results by league

League	1st	2nd	3rd
Soccer (simulation)	TsinghuAeolus (China, Tsinghua University)	Everest (China, Beijing Institute of Technology)	Brainstormers (Germany, Universitaet Dortmund)
Soccer (small robots)	Big Red (USA, Cornell University)	FU Fighters (Germany, Freie Universitaet Berlin) Lucky Star (Singapore, Ngee Ann University)	—
Soccer (medium robots)	EIGEN (Keio University)	WinKIT Kanazawa Institute of Technology	Osaka University Trackies (Osaka University)
Soccer (4-legged robots)	CMPack'02 (USA, Carnegie Mellon University)	rUNSWift (Australia, University of New South Wales)	Nubots (Australia, University of Newcastle)
Soccer (2-legged robots)	NAGARA (Gifu Prefecture Industrial Association)	—	—
Rescue (simulation)	Arian 2002 (Iran, Shari University of Technology (SUT))	YowAI 2002 (University of Electro-Communications)	NITRescue02 (Nagoya Institute of Technology)
Rescue (Robots)	KAVOSH (Iran, Javan Robotics Club)	MARR (Tokyo Institute of Technology)	—
Junior (middle/high school 1-on-1 soccer)	Team finland (Finland)	Slovakia (Slovakia)	SG-2 [George] (Thailand)
Junior (middle/high school 2-on-2 soccer)	E-strikers (Australia)	Pilatoren (Germany)	snowwhite (Germany)
Junior (elementary school 2-on-2 soccer)	winning 3 (Japan)	Tokai 1 (Japan)	Samurai-damashii (Japan)
Junior (dance)	beautiful sky (Japan)	Victory (Japan)	SAKURA (Japan)

Source: RoboCup 2002 website (http://www.robocup2002.org.japanese/index.html)

9.3.4 RoboCup: The Robot World Cup Initiative

RoboCup is an international research project to promote research in fields such as robotics and artificial intelligence. Proposed primarily by Japanese researchers, it is based on this vision: "By mid-21st century, develop a team of fully autonomous humanoid robot soccer players shall win the soccer game, comply with the official rule of the FIFA, against the winner of the most recent World Cup." Competition among autonomous robots at RoboCup international competitions is seen as one method to promote research. Following the competitions, conferences are held to present the research of participants, and technical data are made public. The RoboCup International Committee is the international governing organization, while the Japan RoboCup Committee is the organization in Japan.

After two years of implementation-oriented research beginning in 1993, the concept was announced in 1995, and the first competitions and conference were held in 1997 in Nagoya. Following RoboCups in Paris, Stockholm, Melbourne, and Seattle, the sixth RoboCup was held jointly in 2002 in Pusan, Korea, and Fukuoka, Japan. The Japan Open has also been held since 1998.

In addition to RoboCupSoccer, current fields include RoboCupRescue for the application of robots to large-scale disaster rescue (since 2001), and the RoboCupSoccer Humanoid League (beginning this year) for autonomous bipedal robots. RoboCupJunior (since 2000) is for elementary, middle, and high school students, and offers local robot-building classes in addition to the competition. The categories are as follows.

— Soccer
Simulation, small size, middle size, four-legged, humanoid.
— Rescue
Simulation, robot.
— Junior
Soccer, rescue, dance (varies by age).

At the 2002 Fukuoka-Pusan RoboCup, 1,004 people on 188 teams from 29 countries (including 234 people on 58 teams from 12 countries in the Junior category) participated. Results by league are shown in Table 6 below.

9.4 Overview of contests related to skills

9.4.1 World Skills Competition

— Overview

Operated by the International Vocational Training Organization, the World Skills Competition is held in odd-numbered years. The international headquarters is in Switzerland, while the International Organizing Committee office is in Spain. The goals of the competition are the promotion of vocational training in participating countries and international exchange and friendship among young trades people.

The competition began in 1950 as a contest between 12 competitors from Spain and 12 from Portugal. In 1966, the Skills Olympics Organizing Committee was formed by representatives from participating countries, and the competitions are carried out under rules set by that committee. Member countries have steadily increased, and currently include 38 countries and territories. Six hundred and sixteen people from 35 countries took part in the 36th World Skills Competition. Participants must be age 22 or younger during the year of the competition.

The competition lasts 22 hours over four days. There are three categories of trades in the competition, official, demonstration, and other. Official trades are limited to 40, so a new trade can be entered only by replacing an existing one. Each participating country can enter one competitor per trade (two for landscape gardening and mechatronics). The following 39 trades were included in the 2001 competition.

Fitting, press tool making, instrument making, mechatronics, engineering drafting/CAD, turning/CNC, milling/CNC, construction steel work, information technology, welding, pattern making, autobody repair, sheet metal work, commercial wiring, industrial electronics, industrial wiring, plumbing, automobile technology, car painting, wall and floor tiling, bricklaying, stonemasonry, painting and decorating,

plastering, cabinetmaking, joinery, carpentry, jewelry, floristry, ladies' hairdressing, men's hairdressing, ladies' dressmaking, cooking, waiting, refrigeration, IT PC and network support, landscape gardening, graphic design, confectioner.

Gold, silver, and bronze medals are awarded to the competitors who finish first, second, and third in their respective trades. In addition, competitors who score more than 500 points receive a Diploma of Excellence. The highest scorer in the entire competition receives the Albert-Vidal award, and the highest scorer from each country receives a "Best of the nation" medal. The female competitor with the highest score in a male-dominated trade also receives a special award. ("Male-dominated trades" are determined by the Technical Committee before the competition).

—Japanese participation and results

Japan has been participating since the 11th competition in 1962. The winners of Japan's national championships in the year prior to the World Competition go on to compete there. Japan hosted the 19th (1970) and 28th (1985) competitions, and will host for the third time in 2007.

Thirty-three Japanese competed in 31 categories at the 36th competition in 2001. They won 4 gold medals (in fitting, instrument making, milling/CNC, and industrial wiring), 2 silver (in press tool making and sheet metal work), and 4 bronze (in pattern making, autobody repair, industrial electronics, and ladies' dressmaking), for a total of 10 medals in all. Japan was third in gold medals and fourth in total medals (see Table 7).

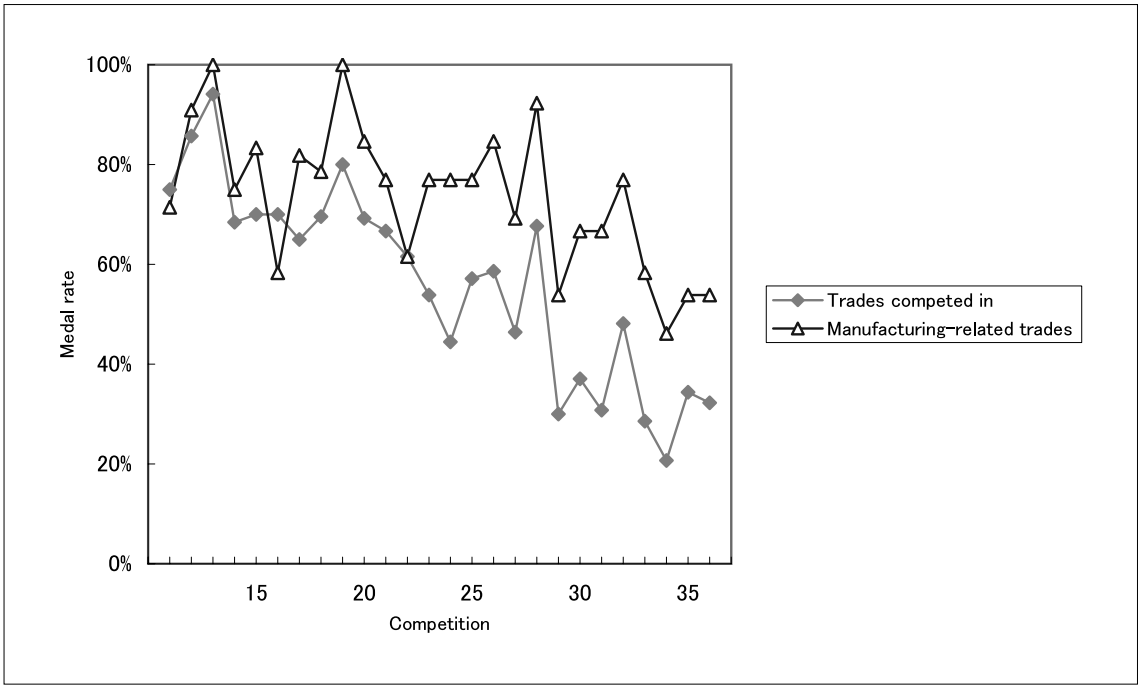
Japan consistently finished first or second

Table 7: Recent competition results (in order of gold medals received; numbers in parentheses are gold/total medals)

	31st competition (1991)	32nd (1993)	33rd (1995)	34th (1997)	35th (1999)	36th (2001)
Location	Netherlands	Taiwan	France	Switzerland	Canada	South Korea
1st	South Korea (13/18)	Taiwan (18/32)	South Korea (10/18)	South Korea (10/17)	South Korea (7/16) Taiwan (7/16)	South Korea (20/32)
2nd	Taiwan (8/20)	South Korea (12/20)	Taiwan (6/17)	Taiwan (8/17) Switzerland (8/19)	—	Germany (5/10)
3rd	Austria (6/10)	Germany (3/8)	Japan (4/8) Germany (4/7) Switzerland (4/6)	—	Japan (6/11)	Japan (4/10) Austria (4/7)
4th	Japan (4/8) Switzerland (4/8)	Japan (2/13) France (2/10) Ireland (2/4) Switzerland (2/3)	—	France (7/10)	Switzerland (5/15)	—
5th	—	—	—	Germany (4/10) Austria (4/9)	Austria (3/10) Australia (3/4) France (3/10)	Taiwan (3/16) Switzerland (3/11) France (3/7) Australia (3/4)
Other countries with at least 5 medals	Germany (3/12) Netherlands (3/9) France (3/7) England (0/6) Australia (0/5)	Austria (1/9) England (0/9) Netherlands (0/7) Australia (0/5)	Australia (3/10) France (1/8) England (3/6)	Australia (3/5) Netherlands (0/5)	Germany (2/9) Ireland (2/7)	Singapore (2/5)
Japan	4th	4th	3rd	8th (2/6)	3rd	3rd

Source: Japan Vocational Ability Development website (http://www.javada.or.jp/jigyou/gno/kokusai/) and materials.

Figure 2: Japan's medal rate



Note: Manufacturing-related trades are considered to be the following. Fitting, press toll making, instrument making, mechatronics, engineering drafting/CAD (separate trades in 1993), turning/CNC, milling/CNC, construction steel work, welding (2 trades, gas welding and electrical welding, through 1985), pattern making, autobody repair (sheet metal embossing from 1963 through 1991, industrial sheet metal in 1962), sheet metal work, commercial wiring, iron casting (1962-1970), mechanical forging (1962-1964).

Source: Calculated from Japan Vocational Ability Development Association materials.

through about the 20th competition (1971). Since then, South Korea has taken over the top position, and Japan has finished second, third, or lower. Japan's eighth place finish in 1997 at the 34th competition was its worst ever, but it has bounced back since then. South Korea and Taiwan have distanced themselves form the other competitors in terms of medal totals. Looking at Japan's results in trades closely connected to manufacturing in which it has steadily competed (7 trades in 1962, 11-14 since then), Japan's medal rate (medals divided by trades in which it competes) is gradually declining. The type and number of trades actually engaged in change with the times, but except for its earliest competitions Japan has generally participated in 80 to 90 percent of the trades. Participation is declining along with the medal rate (see Figure 2).

9.5 Conditions in Japan

9.5.1 Contests held in Japan

A number of contests are held in Japan in addition to those described above. Table 8 shows some examples of contests held on a regular basis.

Chiba Institute of Technology's Whale Ecology Observation Satellite (WEOS), which received an award at the first Satellite Design Contest, is scheduled to be piggy-backed into orbit on ADEOS-II via the H-IIA. In the Birdman Contest, improved manufacturing and flight technologies led to a record human-powered propeller flight of 23, 688 km in 1998 and a record glider flight of 417 m in 2001.

9.5.2 Participation in international contests

The top countries in recent International Science Olympiads are China, Russia, the United States, South Korea, and Taiwan. In the Mathematical Olympiad, the only one it competes in, Japan is in the upper half of the second 10. In programming contests for university students, Japan finishes in the mid-teens, in contrast to the United States, Russia, Canada, and China, who have numerous universities finishing in the top 10. In the Skills Olympics, South Korea is overwhelmingly strong, and Japan is consistently third or fourth. Contests do not measure all scientific and technological abilities, and results also depend on contest-specific training, so the future scientific and technological level of a country cannot be obtained directly from contest results. Moreover,

Table 8: Examples of contests held in Japan

Type	Name	Competitors	Organizer	Overview	History
Mathematics	Mathematical Olympiad Hironaka Cup Japan Jr. High Mathematics Contest	Elementary. The Hironaka Cup is for jr. high.	Mathematical Olympiad Committee	Established at the suggestion of Kyoto University emeritus professor Heisuke Hironaka. Outstanding performers at the Mathematical Olympiad attend the World Youth Mathematics Conference in Hong Kong.	Since 1992; jr. high competition since 2000.
	Japan Mathematics Contest, Junior Mathematics Contest	High school. Junior contest is jr.high.	Japan Mathematics Contest Committee	Mathematics contest operated by the Japan Mathematics Contest Committee comprising Nagoya University and high school educators and chaired by Masayuki Ito.	Since 1990; junior contest since 1997; thesis prize since 2000.
Science	Natural Science Observation Contest	Elementary, jr. highstudents	Mainichi Shinbun, Natural Science Observation Research Society, others	Observation and record keeping of habitat and growth of animals and plants, minerals, astronomy, weather.	Since 1960.
	Science Grand Prix	Elementary 4-6 grade, jr. high, Kanto region, Yamanashi and Shizuoka Prefectures	Tokyo Electric Power Co.	Contest in basic science with summer vacation projects. All aspects of natural science (chemistry, physics, biology, geology, environment, etc.).	Since 1995.
	Japan Art and Science Contest	Elementary, jr. high, high school (natural .science for jr high and high school)	Obunsha Co.	14 fields in three sectors: information/science, art, literature. Information/science sector includes multimedia, human/social science research, natural science research.	Since 1957.
Programming	Japan High School and Vocational School Student Programming Contest	High school, vocational school 1-3 grade, vocational college	Informatization Month Promotion Council, Ministry of Economy, Trade and Industry, Japan Information Processing Development Association.	A major event during National Informatization Month. Comprises a programming sector and a content sector.	Since 1980.
	Japan High School and Vocational School Programming Contest	High school	High School and Vocational School Contact Committee.	Issue sector (sports and computers this year), free sector, competition sector.	Since 1990.
	JSPP Parallel Software Contest	Students in high school, vocational school, vocational college, university, graduate school. Open section is unlimited.	PSC2001 Executive Committee.	Contest on designated parallel computers (cutoff particles) and free sector. (JSPP comprises several information processing societies related to parallel processing. It holds several symposiums related to parallel processing each year.)	Since 1994.
Technology	Satellite Design Contest	High/vocational school, university, graduate school students	Japan Society for Mechanical Engineering, Japan Society for Aeronautical and Space Sciences, Institute of Electronics, Information and Communications Engineers, Institute of Space and Aeronautical Science, National Space Development Agency, SPSS, Japan Space Forum.	Contest for open mission concepts, ideas, and designs of small satellites by students. Design and concept divisions.	Since 1993.
	Japan Robot Sumo Tournament	High school and general	Fuji Soft ABC Inc. The National Association Principals of Technical Senior High School	All-Japan (general) and high school divisions. Autonomous and radio-controlled robots (20 cm wide, 20 cm deep, any height, 3 kg or less).	Since 1990; high school division since 1993.
	Japan Micromouse Conference Japan Student Micromouse Contest	Open. There is a jr.high robot race division. High school, vocational, university students	New Technology Foundation.	Proposed by the USA's IEEE (Institute of Electrical and electronics Engineers) in 1977 as a competition to explore the possibilities of microcomputers. In addition to Japan, competitions are held in Europe and Asia. The contest comprises timed races through mazes by "mice" (self-propelled small vehicles loaded with microcomputers and sensors). The 2001 contest included micromouse races, robot races, and microclipper races.	Since 1980; student competition since 1986.
	Dream Cup Suzuka Solar Car Race	Open.	Yomiuri Shimbun, Suzuka Circuit Land, Japan Automobile Federation (JAF).	Endurance races of 8 or 4 hours depending on battery type, and electric car races.	Since 1992.
	Birdman Contest	Open.	Yomiuri Broadcasting.	Flight contest made for television with homemade aircraft. Glider, human-powered propeller, and human-powered helicopter divisions.	Since 1977

Source: Contest websites.

there is no guarantee that those who do well in contests will even remain in those fields. Nevertheless, one can hardly say that Japan's current results are outstanding.

Contest participation can

- Build the skills of young people. (Contests can provide goals for young people and become appropriate stimuli to build their skills.)
- Provide experience on a wider stage. (Participation can inspire young people to set new goals after experiencing world-class competition, make them aware of the importance of language study, and inspire them to take on new challenges. Accomplishing a task can build great confidence.)
- Shine a spotlight on the world of science and technology. (When contests or those who excel in them are reported on in the media and praised, society becomes more aware of the world of science and technology, and that world itself is vitalized.)

Those things can result from contest participation. In Japan as well, there is movement not only to participate in existing contests, but also to propose new international competitions and give young people opportunities to take on such challenges. At the same time, however, some question the results, claiming that only a few students benefit so the overall level is not raised and widespread interest is not generated.

Reasons given for a lack of widespread participation include, first, the difficulty of finding participants. In Japan there is a strong sense that time spent on problems outside the standard high school curriculum is time taken away from study for entrance examinations. Because participation and prizes do not bring any benefit to scholastic plans, students, parents, and teachers are not very interested in them. In contrast, ISEF, for example, offers scholarships and can lead to recruitment by universities and opportunities for internships, so interest is high in the United States. The autobiographical novel Rocket Boys by a former NASA engineer tells how ISEF led the main character from dreaming about launching homemade rockets to actually fulfilling his dreams. In China, where results in Science Olympiads are connected to university admissions and scholarships, "Olympic fever" has grown to the point that there are now special tutoring schools that teach students how to succeed in Olympiads.

In the case of the World Skills Competition, doing away with in-house training schools is said to have weakened Japanese competitors. According to Kagaku Gijutsu Gakuen High School, which is connected to vocational training schools and offers high school diplomas, in 1970 and 1971 it had links to 41 corporate training schools, but by 2002 that number had shrunk to 5. With a higher percentage of young people going to college, it has become difficult to secure people of the right age for vocational training and participation in the Competition.

A second problem is lack of awareness. With the exception of competitions sponsored by media companies, contests are not in the public eye, and society's awareness of them in general is low. Therefore even when students are selected for international competitions, and even if they do well there, they are not reported on or publicly praised like athletes or performers, so participation and prizes are not exciting for young people.

A third problem is securing financial resources. Most contests have insufficient funding as well as too few university professors to provide volunteer leadership. In particular, hosting that costs a few hundred million yen are a major issue for would-be participants. Corporate support is difficult to find because of the recession, and public support is not currently forthcoming. Japan's ISEF leadership points out that corporations in the United States have a much stronger sense of an obligation to gave back to and contribute to society.

9.6 Conclusion

While Japan is not currently a top-class competitor in international contests, there are some circumstances that give hope for the future as various contests are held.

In the Japan Mathematical Olympiad, junior high school and elementary school students who are developing their talents from an early age can be

found among the outstanding performers. At the 12th Olympiad in February 2002, the 20 outstanding competitors included three third-year junior high school students and one sixth-grade elementary school student. At the 11th Olympiad, the top 17 competitors included six junior high school students, three of whom won awards for finishing in the top 5. With 10 years having passed since Japan began participating, former competitors now in graduate school are able to provide coaching to current team competitors.

At ISEF, although the quality of Japanese projects is considered generally high, lack of presentation experience and language ability lead to difficulty in getting the attention of judges, which is a concern for Japanese participants.

At the Supercomputer Contest, teams that outperform university teams and teams that produce elegant albeit not generalizable solutions different from those developed by the testers can be seen after only one day of lectures. Those programs have subsequently been used in university courses. Despite the fact that it will be of no use on entrance examinations, some students have been excited by encountering supercomputers for the first time and taking on advanced problems to such an extent that they will sometimes stay up all night working on programs.

Regarding skills, society as a whole is reevaluating them, and the environment is becoming brighter. In some corporations, fully-skilled technicians at manufacturing sites are being considered and treated as experts. Efforts to appreciate and handle technicians more appropriately and to pass on their skills are being made, with systems for passing on skills to new generations and to give technicians the same job titles (department manager, section chief, etc.) as office workers being put in place. The advanced technical skills of small and medium companies and the difficulty of passing them on, as well as the problems skilled workers have finding reemployment are being reported in the mass media, and society is becoming more aware of them.

In 2003, Japan will host the Mathematical Olympiad and participate in the Chemistry Olympiad for the first time. For young people interested in science and technology, opportunities to take on new challenges will continue to expand. Holding and participating in science and technology contests bears watching as one index of science and technology.

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