



2021 Survey on

Technological Cooperation

among China-Japan-Korea



公益社団法人

日本工学アカデミー

THE ENGINEERING ACADEMY OF JAPAN

NAEK

한국공학한림원

The National Academy of Engineering of Korea





The survey was intended to

- identify changes and trends on the perception of technical cooperation among the three countries
- understand the views and opinions of researchers in the three countries on a particular field of science and technology (MEMS this year)
- provide a cooperative platform for mutual development of the East Asia to resolve common issues laid in the region



224 valid questionnaires were collected



More than 50% of the questions were answered

Profession	China	Japan	Korea	Total
Professor	31(56.3%)	25(61.0%)	74(57.8%)	130(58.0%)
Researcher	16(29.1%)	1(2.4%)	17(13.3%)	34(15.2%)
Business employer or employee	5(9.1%)	12(29.3%)	32(25.0%)	49(21.9%)
Government official or public sector employee	3(5.5%)	1(2.4%)	1(0.8%)	5(2.0%)
Others	0(0.0%)	2(4.9%)	4(3.1%)	6(2.9%)
Total	55(24.6%)	41(18.3%)	128(57.1%)	224

Others: retired professor, government executive, etc.



Specialty	China	Japan	Korea	Total
Civil and environmental engineering	11(20.0%)	5(12.3%)	9(7.0%)	25(11.2%)
Mechanical engineering	4(7.3%)	6(14.6%)	31(24.2%)	41(18.3%)
Technology management	3(5.5%)	7(17.1%)	5(3.9%)	15(6.7%)
Material and energy resource engineering	12(21.8%)	3(7.3%)	29(22.7%)	44(19.6%)
Electric/electronic engineering & ICT	8(14.5%)	11(26.8%)	22(17.2%)	41(18.3%)
Chemical and biomedical engineering	5(9.1%)	3(7.3%)	24(18.7%)	32(14.3%)
Others	12(21.8%)	6(14.6%)	8(6.3%)	26(11.6%)
Total	55(24.6%)	41(18.3%)	128(57.1%)	224

Others: Biomedical Engineering, Chemistry, Aerospace Engineering, Industry Engineering, Medicine, Surgery, Instrument Science and Technology, etc.



research experience	China	Japan	Korea	Total
Less than 5 years	2(3.6%)	1(2.5%)	5(3.9%)	8(3.6%)
5-10 years	3(5.5%)	0(0.0%)	2(1.6%)	5(2.2%)
10-20 years	9(16.4%)	3(7.3%)	4(3.1%)	16(7.1%)
More than 20 years	41(74.5%)	34(82.9%)	114(89.1%)	189(84.4)
Unanswered	0(0.0%)	3(7.3%)	3(2.3%)	6(2.7%)
Age	China	Japan	Korea	Total
35-49	14(25.5%)	2(4.9%)	3(2.3%)	19(8.5%)
50-59	12(21.8%)	11(26.8%)	36(28.1%)	59(26.3%)
60-69	20(36.4%)	12(29.3%)	74(57.8%)	106(47.3%)
70-79	7(12.7%)	11(26.8%)	8(6.3%)	26(11.6%)
80 and older	2(3.6%)	5(12.2%)	5(3.9%)	12(5.3%)
Unanswered	0(0.0%)	0(0.0%)	2(1.6%)	2(1.0%)
Total	55(24.6%)	41(18.3%)	128(57.1%)	224

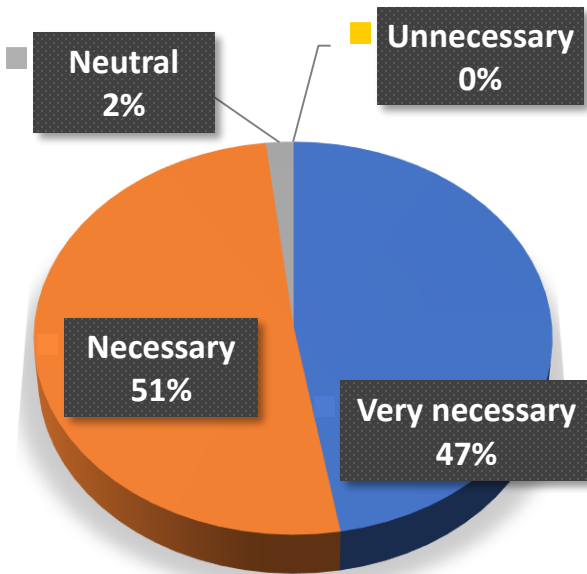




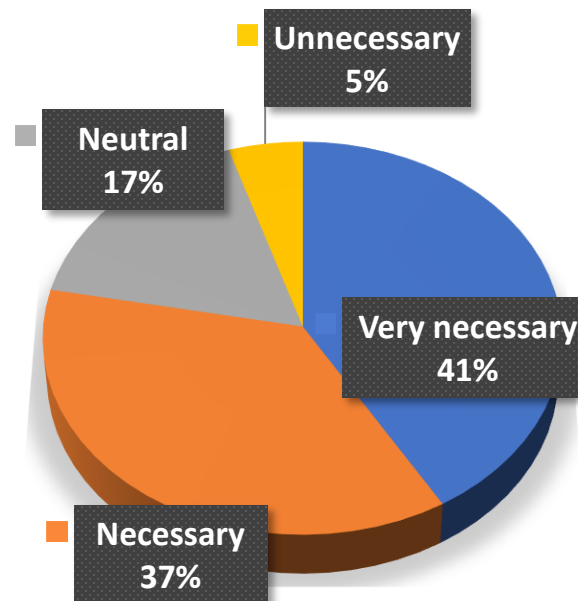
Technological cooperation index

Necessity of Cooperation

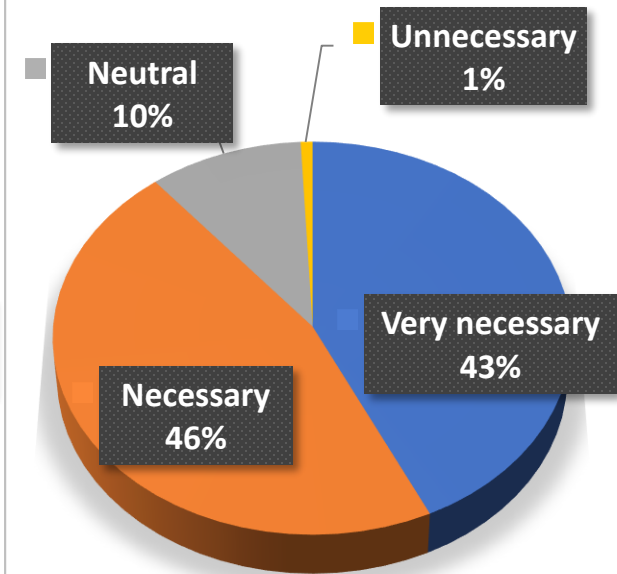
China



Japan



Korea

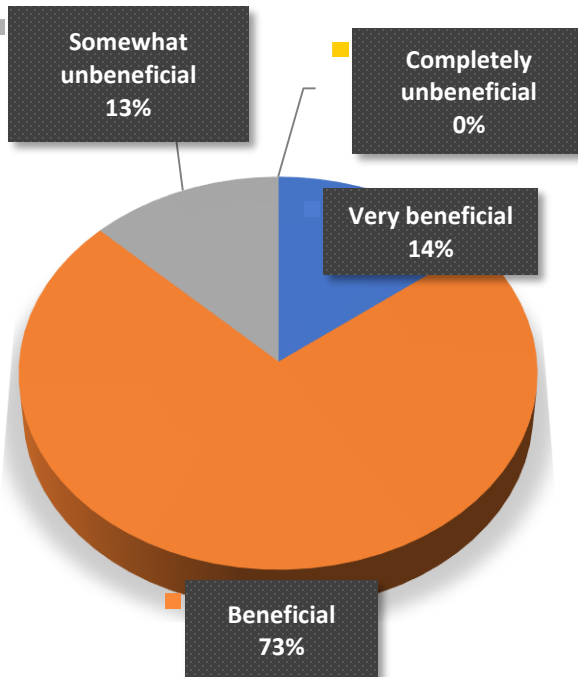


Very necessary	Necessary	Neutral	Unnecessary	Total
98(43.7%)	102(45.6%)	21(9.4%)	3(1.3%)	224

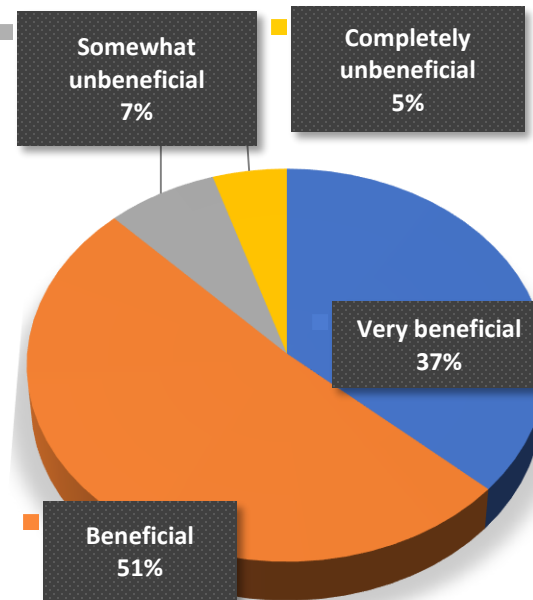


Expectations on the Benefit of Cooperation index

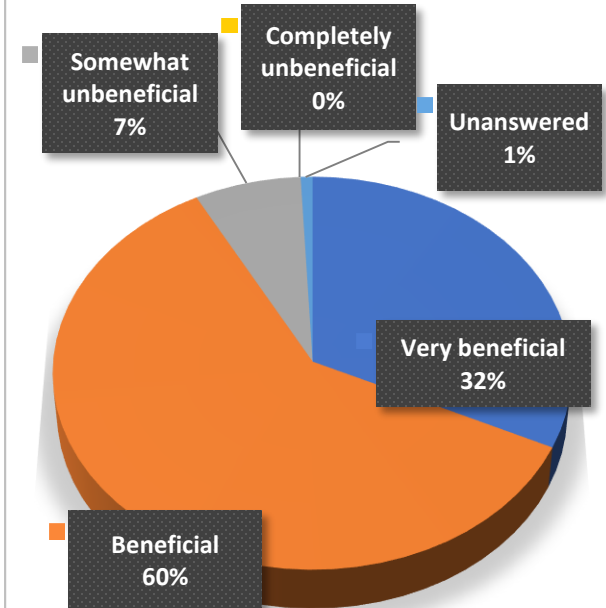
China



Japan



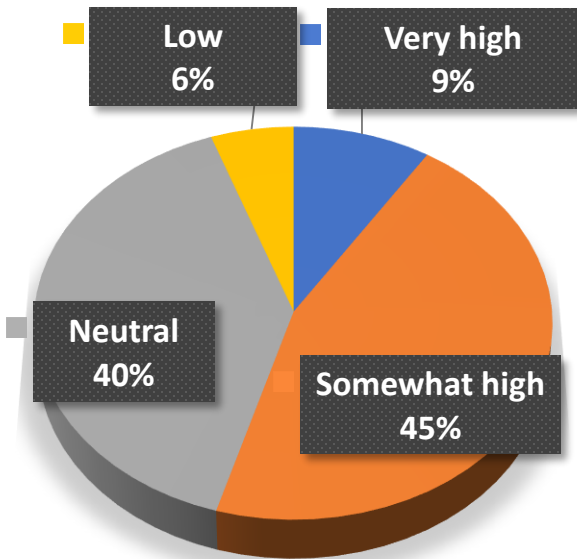
Korea



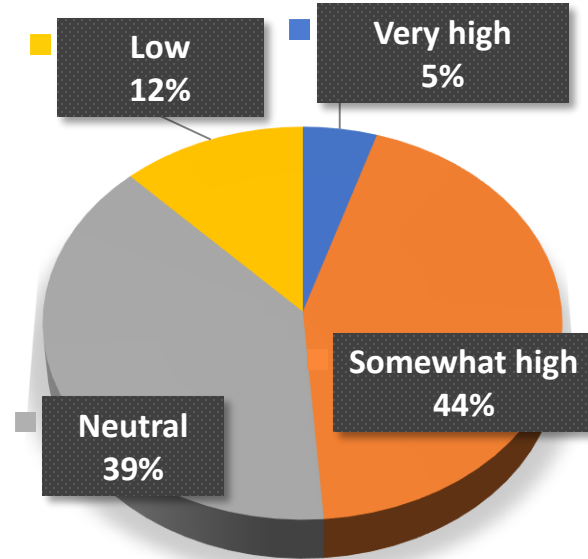
Very beneficial	Beneficial	Somewhat unbeneficial	Completely unbeneficial	Unanswered	Total
64(28.6%)	138(61.6%)	19(8.5%)	2(0.9%)	1(0.4%)	224

Level of Cooperation in terms of Quantity index

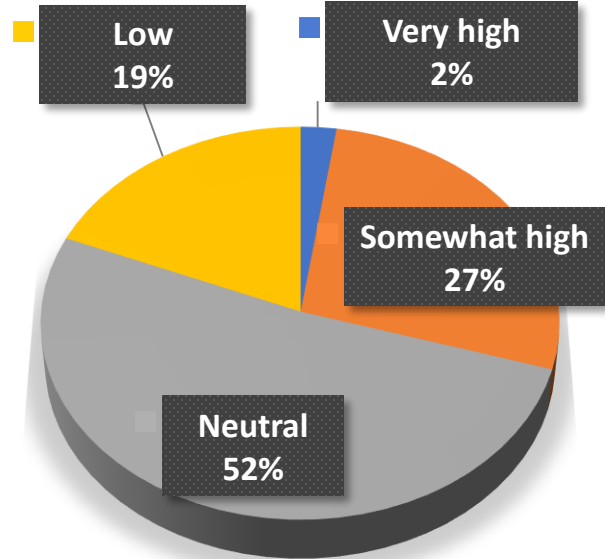
China



Japan



Korea

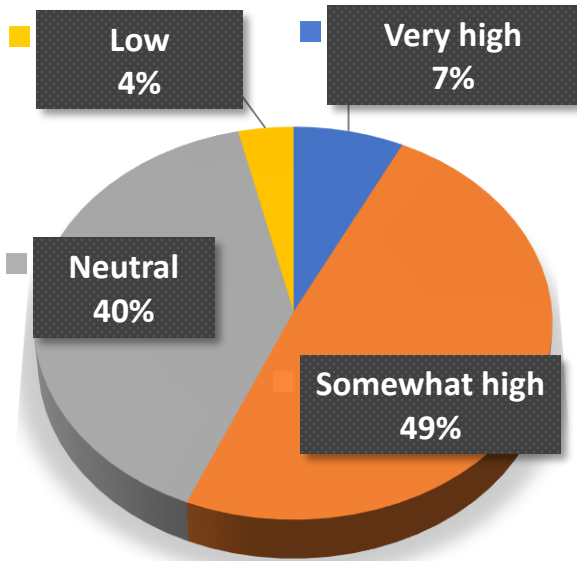


Very high	Somewhat high	Neutral	Low	Total
10(4.5%)	78(34.8%)	104(46.4%)	32(14.3%)	224

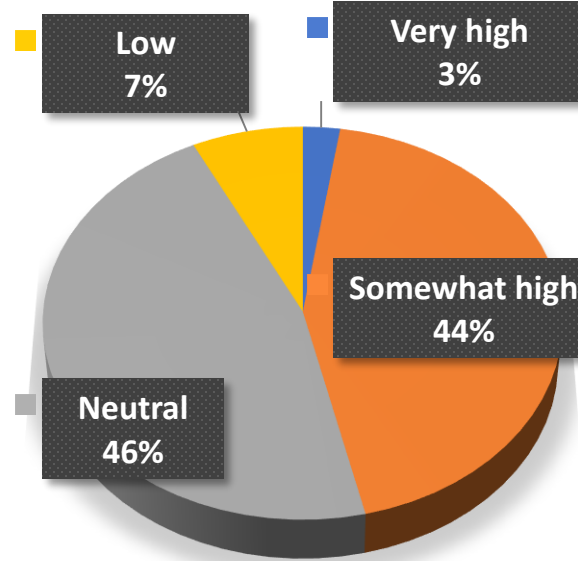


Level of Cooperation in terms of Quality

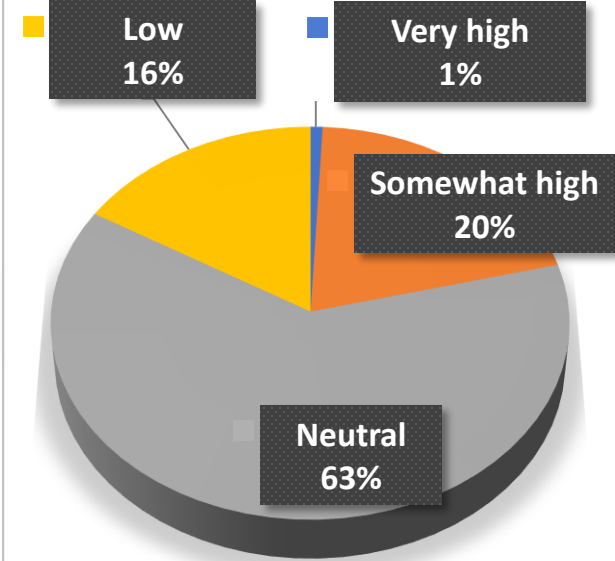
China



Japan



Korea

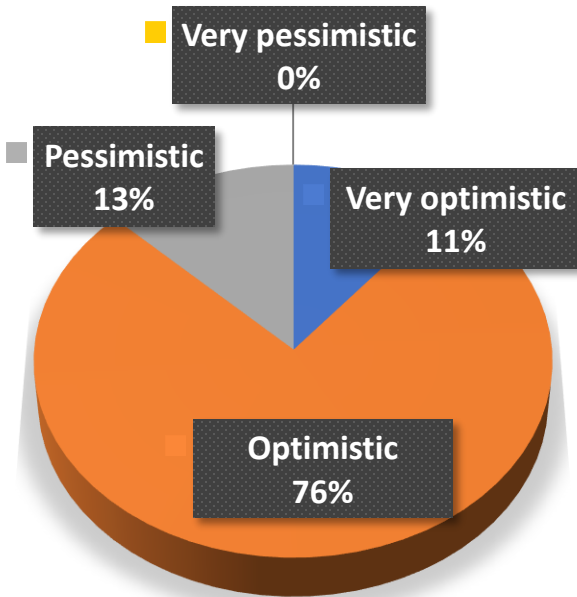


Very high	Somewhat high	Neutral	Low	Total
6(2.7%)	71(31.7%)	121(54.0%)	26(11.6%)	224

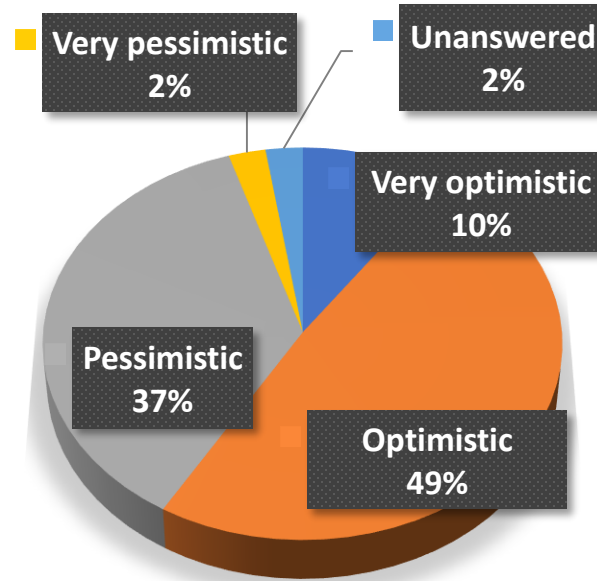


Future Prospect and Potentials

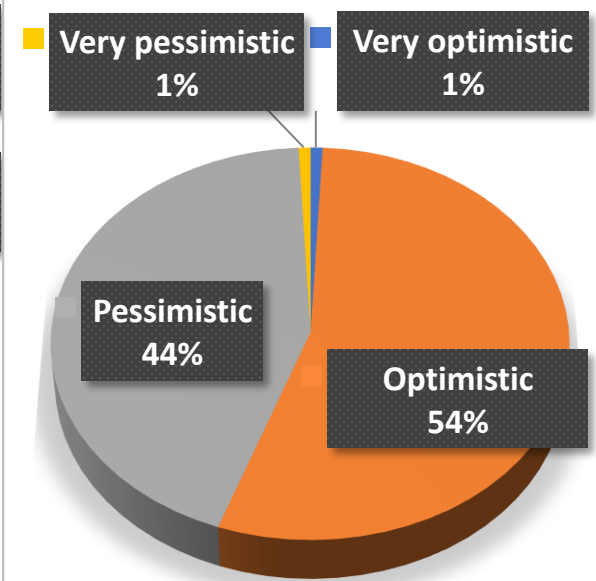
China



Japan



Korea



Very optimistic	Optimistic	Pessimistic	Very pessimistic	Unanswered	Total
11(4.9%)	132(58.9%)	78(34.8%)	2(0.9%)	1(0.5%)	224

MEMS for automobiles

	China	Japan	Korea	Total	Weight1
I don't know	8(14.6%)	2(4.9%)	4(3.1%)	14(6.3%)	0.6
I'm not sure	24(43.6%)	10(24.4%)	44(34.4%)	78(34.8%)	0.7
I know something about it	22(40.0%)	24(58.5%)	73(57.0%)	119(53.1%)	0.8
I know it very well and my work has some relevance	1(1.8%)	2(4.9%)	6(4.7%)	9(4%)	0.9
I know it very well and my work is closely related	0(0.0%)	2(4.9%)	1(0.8%)	3(1.3%)	1.0
Unanswered	0(0.0%)	1(2.4%)	0(0.0%)	1(0.5%)	0.5
Total	55(24.6%)	41(18.3%)	128(57.1%)	224	





Fact-finding survey

Among the applications of MEMS listed below, which do you think are the most important for **automotive safety**? (Choose 3 items and rank them in **descending order of importance**)

For a respondent' s answer:

	Weight2
1 st Choice	1.0
2 nd Choice	0.8
3 rd Choice	0.6
Others	0

Importance factors were then calculated as:

$$IF1_{\alpha} = \left(\sum_1^T Weight2 \right) \times 10 \div T$$

$$IF2_{\alpha} = \left(\sum_1^T Weight1 \times Weight2 \right) \times 10 \div T$$

$\alpha=A, B, C, \dots, M, N$

T: the number of respondents



Fact-finding survey

Percentage	China	Japan	Korea
Electronic Stability Program (ESP)	① 80.0%	① 63.4%	① 73.4%
Tire Pressure Monitoring System (TPMS)	② 50.9%	④ 29.3%	④ 23.4%
Engine management system	③ 47.3%	② 46.3%	② 56.3%
Power steering system	④ 27.3%	③ 36.6%	③ 32.0%
Transmission Control Unit (TCU)	21.8%	⑤ 17.1%	⑤ 18.0%
Electrical Park Brake System (EPB)	10.9%	9.8%	10.2%
Hill-launch Assist System (HAS)	1.8%	0.0%	0.8%
Electronic Control Suspension System (ECS)	7.3%	14.6%	⑤ 18.0%
Side airbag triggering	⑤ 25.5%	9.8%	7.0%
Anti-theft detection system	3.6%	4.9%	3.1%
Tank pressure monitoring	1.8%	4.9%	2.3%
Inertial navigation	1.8%	14.6%	13.3%
In-car heartbeat detection	3.6%	⑤ 17.1%	0.8%
Others	1.8%	0.0%	0.0%





Fact-finding survey

IF1	China	Japan	Korea
Electronic Stability Program (ESP)	① 7.71	① 5.61	① 6.72
Tire Pressure Monitoring System (TPMS)	② 4.11	④ 2.34	④ 1.80
Engine management system	③ 3.60	② 4.15	② 4.86
Power steering system	⑤ 1.82	③ 2.78	③ 2.30
Transmission Control Unit (TCU)	1.49	⑤ 1.27	1.20
Electrical Park Brake System (EPB)	0.76	0.63	0.69
Hill-launch Assist System (HAS)	0.15	0.00	0.05
Electronic Control Suspension System (ECS)	0.44	1.02	⑤ 1.22
Side airbag triggering	④ 1.96	0.78	0.48
Anti-theft detection system	0.25	0.29	0.19
Tank pressure monitoring	0.11	0.34	0.19
Inertial navigation	0.18	1.12	0.97
In-car heartbeat detection	0.25	1.07	0.05
Others	0.18	0.00	0.00





Fact-finding survey

IF2	China	Japan	Korea
Electronic Stability Program (ESP)	① 5.63	① 4.43	① 5.21
Tire Pressure Monitoring System (TPMS)	② 2.97	④ 1.86	④ 1.40
Engine management system	③ 2.65	② 3.19	② 3.70
Power steering system	⑤ 1.36	③ 2.22	③ 1.80
Transmission Control Unit (TCU)	1.16	0.93	0.90
Electrical Park Brake System (EPB)	0.52	0.47	0.54
Hill-launch Assist System (HAS)	0.10	0.00	0.03
Electronic Control Suspension System (ECS)	0.32	0.79	⑤ 0.97
Side airbag triggering	④ 1.45	0.66	0.38
Anti-theft detection system	0.19	0.22	0.15
Tank pressure monitoring	0.09	0.27	0.14
Inertial navigation	0.11	⑤ 0.95	0.77
In-car heartbeat detection	0.20	0.84	0.04
Others	0.11	0.00	0.00





Fact-finding

survey

Among the applications of MEMS listed in the previous question, which do you think are the most important for **automotive comfort**?
(Choose 3 items and rank them in **descending order of importance**)

For a respondent' s answer:

	Weight2
1 st Choice	1.0
2 nd Choice	0.8
3 rd Choice	0.6
Others	0

Importance factors were then calculated as:

$$IF1_{\alpha} = \left(\sum_1^T Weight2 \right) \times 10 \div T$$

$$IF2_{\alpha} = \left(\sum_1^T Weight1 \times Weight2 \right) \times 10 \div T$$

$\alpha=A, B, C, \dots, M, N$

T: the number of respondents



Fact-finding survey

Percentage	China	Japan	Korea
Electronic Stability Program (ESP)	① 72.7%	② 43.9%	① 42.2%
Tire Pressure Monitoring System (TPMS)	③ 30.9%	⑤ 26.8%	⑤ 24.2%
Engine management system	⑤ 27.3%	⑤ 26.8%	④ 26.6%
Power steering system	③ 30.9%	③ 36.6%	② 41.4%
Transmission Control Unit (TCU)	② 34.5%	④ 29.3%	18.0%
Electrical Park Brake System (EPB)	18.2%	9.8%	19.5%
Hill-launch Assist System (HAS)	14.5%	4.9%	3.1%
Electronic Control Suspension System (ECS)	⑤ 27.3%	① 46.3%	③ 35.9%
Side airbag triggering	3.6%	2.4%	5.5%
Anti-theft detection system	0.0%	14.6%	15.6%
Tank pressure monitoring	0.0%	0.0%	0.8%
Inertial navigation	7.3%	9.8%	12.5%
In-car heartbeat detection	3.6%	7.3%	3.9%
Others	1.8%	0.0%	0.8%



IF1	China	Japan	Korea
Electronic Stability Program (ESP)	① 6.18	① 3.85	① 3.75
Tire Pressure Monitoring System (TPMS)	③ 2.55	⑤ 2.34	⑤ 1.95
Engine management system	⑤ 2.36	⑤ 2.34	④ 2.28
Power steering system	④ 2.40	③ 2.83	② 3.31
Transmission Control Unit (TCU)	② 2.95	④ 2.39	1.39
Electrical Park Brake System (EPB)	1.38	0.63	1.55
Hill-launch Assist System (HAS)	1.09	0.34	0.27
Electronic Control Suspension System (ECS)	2.07	② 3.71	③ 2.64
Side airbag triggering	0.22	0.20	0.34
Anti-theft detection system	0.00	0.93	1.08
Tank pressure monitoring	0.00	0.00	0.08
Inertial navigation	0.51	0.63	1.03
In-car heartbeat detection	0.25	0.54	0.27
Others	0.18	0.00	0.05



IF2	China	Japan	Korea
Electronic Stability Program (ESP)	① 4.51	② 3.01	① 2.89
Tire Pressure Monitoring System (TPMS)	④ 1.80	1.79	⑤ 1.50
Engine management system	⑤ 1.71	⑤ 1.80	④ 1.77
Power steering system	③ 1.83	③ 2.22	② 2.57
Transmission Control Unit (TCU)	② 2.25	④ 1.81	1.06
Electrical Park Brake System (EPB)	1.01	0.49	1.18
Hill-launch Assist System (HAS)	0.78	0.29	0.22
Electronic Control Suspension System (ECS)	1.53	① 3.03	③ 2.09
Side airbag triggering	0.16	0.16	0.27
Anti-theft detection system	0.00	0.79	0.82
Tank pressure monitoring	0.00	0.00	0.07
Inertial navigation	0.40	0.54	0.79
In-car heartbeat detection	0.19	0.43	0.21
Others	0.11	0.00	0.03





Fact-finding

survey

Among the application trends of MEMS listed below, which do you think will be **marketable** in the next 10 years? (Multiple choice)

	China	Japan	Korea
External environment monitoring	③ 65.5%	③ 39.0%	② 41.4%
New energy system status monitoring	④ 58.2%	② 41.5%	④ 30.5%
State monitoring of vehicle occupants	② 69.1%	③ 39.0%	③ 39.8%
Passenger-vehicle information interaction	① 74.5%	① 46.3%	① 51.6%
Intelligent noise reduction in the car	⑤ 34.5%	③ 19.5%	⑤ 16.4%
Others	0.0%	2.4%	0.0%

Others: adaptive headlight beam steering, etc.





For **automotive safety**, most important MEMS applications are:

- ◆ Electronic Stability Program (ESP)
- ◆ Engine management system
- ◆ Tire Pressure Monitoring System (TPMS)
- ◆ Power steering system

For **automotive comfort**, most important MEMS applications are:

- ◆ Electronic Stability Program (ESP)
- ◆ Engine management system
- ◆ Transmission Control Unit (TCU)
- ◆ Tire Pressure Monitoring System (TPMS)
- ◆ Power steering system
- ◆ Electronic Control Suspension System (ECS)

Applications that will be **marketable** in the next 10 years:

- ◆ External environment monitoring
- ◆ State monitoring of vehicle occupants
- ◆ New energy system status monitoring
- ◆ Passenger-vehicle information interaction



MEMS for healthcare

	China	Japan	Korea	Total	Weight1
I don't know	7(12.8%)	3(7.3%)	10(7.8%)	20(8.9%)	0.6
I'm not sure	28(50.9%)	13(31.7%)	53(41.4%)	94(42.0%)	0.7
I know something about it	17(30.9%)	19(46.3%)	58(45.3%)	94(42.0%)	0.8
I know it very well and my work has some relevance	2(3.6%)	3(7.3%)	4(3.1%)	9(4.0%)	0.9
I know it very well and my work is closely related	1(1.8%)	2(4.9%)	0(0.0%)	3(1.3%)	1.0
Unanswered	0(0.0%)	1(2.5%)	3(2.4%)	4(1.8%)	0.5
Total	55(24.6%)	41(18.3%)	128(57.1%)	224	



Fact-finding

survey

Which factors do you think are the most important to increase **the life expectancy of the population**? (Choose 3 items and rank them in descending order of importance)

For a respondent' s answer:

	Weight2
1 st Choice	1.0
2 nd Choice	0.8
3 rd Choice	0.6
Others	0

Importance factors were then calculated as:

$$IF1_{\alpha} = \left(\sum_1^T Weight2 \right) \times 10 \div T$$

$\alpha = A, B, C, \dots, M, N$

T: the number of respondents



Fact-finding survey

Percentage	China	Japan	Korea
Drug development	① 70.9%	② 56.1%	④ 43.0%
Rapid pathologic diagnosis	④ 45.5%	④ 39.0%	① 73.4%
Biomedical research	③ 49.1%	③ 43.9%	⑤ 30.5%
Daily health monitoring	② 61.8%	① 73.2%	② 49.2%
Artificial organs	⑤ 30.9%	26.8%	③ 46.1%
Noninvasive/minimally invasive surgery	18.2%	④ 39.0%	28.1%
Others	3.6%	2.4%	0.8%

Others: traditional medicine development, patient monitoring etc.



IF1	China	Japan	Korea
Drug development	① 5.78	② 4.20	④ 3.47
Rapid pathologic diagnosis	④ 3.82	④ 3.07	① 6.34
Biomedical research	③ 3.85	③ 3.80	⑤ 2.38
Daily health monitoring	② 5.05	① 6.59	② 4.03
Artificial organs	⑤ 2.58	1.95	③ 3.50
Noninvasive/minimally invasive surgery	1.27	⑤ 2.73	1.94
Others	0.29	0.15	0.05

Others: traditional medicine development, patient monitoring etc.





Fact-finding survey

Among the following applications of **MEMS (in vitro)**, which one do you think is the most promising?

Importance factors were calculated as:

$$IF3_{\alpha} = \left(\sum_1^T Weight1 \right) \times 10 \div T$$

$\alpha = A, B, C, D$

T: the number of respondents





Fact-finding survey

Percentage	China	Japan	Korea
Biosensors	② 32.7%	① 53.7%	② 39.1%
Biochemical analysis and disease diagnosis	① 41.8%	② 31.7%	① 46.9%
Tissue engineering	③ 23.6%	③ 9.8%	3.9%
Others	1.8%	0.0%	③ 5.5%
Unanswered	0.0%	4.9%	4.7%

Others: micro robots, etc.





Fact-finding survey

IF3	China	Japan	Korea
Biosensors	② 2.36	① 4.10	② 2.92
Biochemical analysis and disease diagnosis	① 3.11	② 2.51	① 3.54
Tissue engineering	③ 1.71	③ 0.76	0.29
Others	0.13	0.00	③ 0.39
Unanswered	0.00	0.00	0.00





Fact-finding

survey

Among the following applications of MEMS (wearable/implantable), which ones do you think are the most promising? (Choose 3 items and rank them in descending order of importance)

For a respondent' s answer:

	Weight2
1 st Choice	1.0
2 nd Choice	0.8
3 rd Choice	0.6
Others	0

Importance factors were then calculated as:

$$IF1_{\alpha} = \left(\sum_1^T Weight2 \right) \times 10 \div T$$

$$IF2_{\alpha} = \left(\sum_1^T Weight1 \times Weight2 \right) \times 10 \div T$$

$\alpha=A, B, C, \dots, H, I$

T: the number of respondents

Fact-finding survey

Percentage	China	Japan	Korea
Intrusive testing	③ 54.5%	22.0%	② 53.1%
Minimally invasive surgery	① 69.1%	③ 43.9%	③ 43.8%
Miniature drug delivery injection system	⑤ 18.2%	② 46.3%	① 57.0%
Micro artificial organs	④ 41.8%	④ 41.5%	④ 35.2%
Articles for the disabled	7.3%	⑤ 24.4%	6.3%
Daily health parameters monitoring	② 60.0%	① 65.9%	② 53.1%
Flexible chips	⑤ 18.2%	22.0%	17.2%
Body energy harvesting	1.8%	19.5%	2.3%
Others	1.8%	0.0%	0.0%



Fact-finding survey

IF1	China	Japan	Korea
Intrusive testing	② 4.73	1.56	② 4.48
Minimally invasive surgery	① 5.96	③ 3.66	④ 3.70
Miniature drug delivery injection system	⑤ 1.42	② 3.90	① 4.67
Micro artificial organs	④ 3.60	④ 3.02	⑤ 2.72
Articles for the disabled	0.51	⑤ 1.85	0.45
Daily health parameters monitoring	③ 4.55	① 5.90	③ 4.14
Flexible chips	1.16	1.61	1.14
Body energy harvesting	0.11	1.32	0.16
Others	0.18	0.00	0.00



Fact-finding survey

IF2	China	Japan	Korea
Intrusive testing	② 3.43	1.19	② 3.33
Minimally invasive surgery	① 4.37	③ 2.83	④ 2.78
Miniature drug delivery injection system	⑤ 1.06	② 2.95	① 3.51
Micro artificial organs	④ 2.67	④ 2.34	⑤ 2.08
Articles for the disabled	0.40	⑤ 1.50	0.35
Daily health parameters monitoring	③ 3.33	① 4.56	③ 3.10
Flexible chips	0.89	1.20	0.86
Body energy harvesting	0.08	1.10	0.12
Others	0.13	0.00	0.00





Most important factors to increase the life expectancy of the population

- ◆ Drug development
- ◆ Rapid pathologic diagnosis
- ◆ Biomedical research
- ◆ Daily health monitoring

For **in vitro scenarios**, most important MEMS applications are:

- ◆ Biosensors
- ◆ Biochemical analysis and disease diagnosis

For **wearable/implantable scenarios**, most important MEMS applications are:

- ◆ Intrusive testing
- ◆ Minimally invasive surgery
- ◆ Miniature drug delivery injection system
- ◆ Daily health parameters monitoring



MEMS in other fields

Which applications of MEMS do you think are the most important for the development of the national economy, including automotive and healthcare? (Choose 3 items)

Percentage	China	Japan	Korea
Vehicles	① 60.0%	③ 34.1%	② 48.4%
Medical equipment	② 52.7%	① 51.2%	① 49.2%
Personal computers and smartphones	18.2%	7.3%	17.2%
Wearable devices	③ 30.9%	① 51.2%	③ 47.7%
Aerospace	18.2%	2.4%	6.3%
The Internet of things	⑤ 21.8%	③ 34.1%	20.3%
Robots	④ 27.3%	③ 34.1%	④ 32.8%
Virtual Reality/Augmented Reality	9.1%	14.6%	⑤ 22.7%
Industrial Internet	⑤ 21.8%	7.3%	8.6%
Body/Environmental energy harvesting	14.5%	19.5%	7.0%
Analytical instruments	1.8%	4.9%	7.0%
Others	3.6%	0.0%	0.0%

Others: chemical pharmaceutical, etc.



Fact-finding

survey

How important do you think the cooperation between China, Japan and South Korea in MEMS technology is?

Percentage	China	Japan	Korea
Very important	23.6%	31.7%	16.4%
Relatively important	63.6%	24.4%	40.6%
Generally important	10.9%	31.7%	27.3%
Not very important	1.8%	2.4%	7.8%
Not important at all	0.0%	2.4%	0.0%
Unanswered	0.0%	7.3%	7.8%





Fact-finding

survey

In what areas do you think China, Japan and Korea should cooperate in MEMS technology? (Multiple choice)

Percentage	China	Japan	Korea
Fundamental research	54.5%	61.0%	55.5%
Prototype design	40.0%	22.0%	14.1%
Advanced process development	63.6%	14.6%	16.4%
Professional personnel training	52.7%	19.5%	24.2%
Industry standard establishment	34.5%	53.7%	52.3%





Comments and suggestions

➤ China

- ✓ Traditional medicine in East Asia is of the same origin. As the world gradually enters an aging society, I expect researchers in related fields to make concerted efforts to contribute to human health.
- ✓ Technical cooperation between the three countries is common, but deep cooperation is still faced with many difficulties.

➤ Japan

- ✓ Cooperation in the basic research is very important.
- ✓ International cooperation between Japan, China and South Korea is extremely important, but due to the speculation of each country, the situation has been quite difficult. The Engineering Academy of Japan also needs a new approach for trilateral cooperation.





Comments and suggestions

- ✓ It was difficult to choose the answers for me who do not understand the technologies mentioned above.
- **Korea**
- ✓ With regard to cars, I think it is important to concentrate on electric cars.
- ✓ I wish you a way of mutual cooperation.
- ✓ It is hoped that practical cooperation measures can be established to produce tangible results among the National Academies of Engineering of the three countries.
- ✓ I think Korea, China, and Japan should cooperate in a future-oriented way.
- ✓ For scholars like me, who have retired from my career for more than 10 years, it would be better to collect judgments about my long experiences and feelings rather than items such as the current status of technology or the presentation of specific technology contents



Comments and suggestions

- ✓ Due to changes in the international environment, technological cooperation with Japan and China needs to be carried out carefully, unlike in the past. It is necessary to raise awareness of the situation in which significant sensitive issues are emerging regarding the leakage of national technology and secrets.
- ✓ We hope that actual cooperation projects between Korea, China and Japan will be created as a follow-up project to the Korea-China daily survey and the meeting.
- ✓ The application of MEMS is very diverse and in order to cooperate between Korea, China, and Japan, a consensus should be formed first, and the easiest field of cooperation will be education and basic research.





Thanks for your attention

