INVITED SURVEY PAPER *Special Issue on the Past, Present, and Future of Communications Technologies in the IEICE*

Establishment of EMC Research in Japan and its Future Prospects

Osamu FUJIWARA[†a)], ***Fellow***

SUMMARY Systematic research on electromagnetic compatibility (EMC) in Japan started in 1977 by the establishment of a technical committee on "environmental electromagnetic engineering" named EMCJ, which was founded both in the Institute of Electronics and Communication Engineers or the present IEICE (Institute of Electronics, Information and Communication Engineers) and in the Institute of Electrical Engineers of Japan or the IEEJ. The research activities have been continued as the basic field of interdisciplinary study to harmonize even in the electromagnetic (EM) environment where radio waves provide intolerable EM disturbances to electronic equipment and to that environment itself. The subjects and their outcomes which the EMCJ has dealt with during about 40 years from the EMCJ establishment include the evaluation of EM environment, EMC of electric and electronic equipment, and EMC of biological effects involving bioelectromagnetics and so on. In this paper, the establishment history and structure of the EMCJ are reviewed along with the change in activities, and topics of the technical reports presented at EMCJ meetings from 2006 to 2016 are surveyed. In addition, internationalization and its related campaign are presented in conjunction with the EMCJ research activities, and the status quo of the EMCJ under the IEICE is also discussed along with the prospects.
key words: *electromagnetic compatibility, technical committee on environmental electromagnetic engineering, establishment, research activities, prospects*

1. Introduction

"Environmental electromagnetic engineering" is defined as an academic discipline dealing with extensive electromagnetic (EM) issues on electromagnetic compatibility (EMC) in EM environments. It was named in 1976 by Risaburo Sato, Professor of Tohoku University at that time [1]–[5]. As this academic research organization, a technical committee on environmental electromagnetic engineering, which is called "EMCJ," was established in 1976 under the umbrella of the Institute of Electronics and Communication Engineer of Japan or the present IEICE (Institute of Electronics, Information and Communication Engineers) and the Institute of Electrical Engineers of Japan (IEEJ). The first technical meeting organized by the EMCJ was held in May 1977. The IEICE will celebrate its 100th anniversary in 2017, and the EMCJ will be 40 years old.

To mark these occasions, the establishment history and construction of the EMCJ/IEICE are reviewed in this paper. In addition, research activities that the EMCJ has performed so far are surveyed over the past 10 years from 2006 to 2016, and the current status and the prospects for the EMCJ activities under the IEICE are discussed along with internationalization and related campaign.

2. EMCJ

2.1 EMC and EMCJ Establishment

Basically, the EMC, which derived from radio frequency interference (RFI) in the USA in the 1960's [1], describes the ability of a device, equipment, or system to function satisfactorily in its EM environment without introducing intolerable EM disturbances to anything in that environment [6], [7]. In the USA, the establishment of the "professional group on RFI" was approved by the Institute of Radio Engineers (IRE), which is the origin of the Institute of Electrical and Electronic Engineers (IEEE), and the first meeting (the present IEEE EMC Society) was held in October 1957 [8].

In Japan, on the other hand, as a research organization of EMC, a technical committee on environmental electromagnetic engineering or EMCJ was proposed by Risaburo Sato (1st EMCJ past chair) to the Institute of Electronics and Communication Engineers (nominative) and the IEEJ (associative), and was approved in December 1976 by both of the Board of Directors meetings [9], [10]. The first meeting organized by the EMCJ was held in May, 1977. Accordingly, Japan was 20 years later than the USA as an EMC academic organization. In 2017, therefore, the IEEE EMC society and the EMCJ will celebrate their 60th and 40th anniversary*, respectively.

Figure 1 is a photo of Risaburo Sato, which appeared on a cover sheet of the IEEE EMC Society Newsletter, Issue No. 229, Spring 2011 [11]. He was considered "The Father of EMC in Japan."

Since there was no awareness of EMC in Japan in the 1970's, there was much energetic discussion about the nature of EMC before the establishment of EMCJ [1]. The situation is shown in Fig. 2. The elephant in the figure symbolizes the whole image of EMC because the Japanese words for elephant and image have the same pronunciation. In those days, it was difficult to grasp the whole image of EMC, and EMC was understood with the part such as a trunk, an ear, a

Manuscript received September 20, 2016.
Manuscript revised December 26, 2016.
Manuscript publicized March 27, 2017.
† The author is with the Nagoya Institute of Technology, Nagoya-shi, 466-8555 Japan.
a) E-mail: fujiwara@nitech.ac.jp
DOI: 10.1587/transcom.2016PFI0001

*The IEEE EMC Society and the EMCJ celebrated their 50th and 30th anniversary at the Symposium in Honolulu, Hawaii on July, 2007 and at the EMCJ Technical Meeting in Sendai on October, 2007, respectively.

Fig. 1 Emeritus Professor Risaburo Sato, Tohoku University and Tohoku Gakuin University, passed away in Sendai at the age of 89 early in the morning of April 12, 2011.

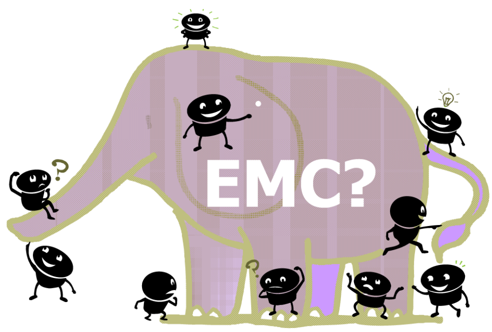


Fig. 2 What is "EMCb"?

foot or a tail of the elephant.

Figure 3 shows the collaboration and contribution to the EMCJ establishment of researchers and engineers in academia, research laboratories and industries, who had expertise in various specialized fields around the 1975's. As a result, the concept of EMC, which is one technical term in the USA, was expanded to the interdisciplinary learning field. It was called "environmental electromagnetic engineering" in Japan. The prospectus† [12] of the EMCJ is shown in Fig. A· 1 in the Appendix. "Environmental electromagnetic engineering" was then widely defined as the basic learning field of interdisciplinary study in a large variety of fields involving engineering, science, medicine, economics and sociology, to serve as a contribution to the effective utilization of EM energy and to the harmonization of EM environment by grasping and predicting the change in the EM ambient environment surrounding the earth and the celestial bodies as well as the state of electric and electronic equipment together with a control method for harmonizing the environment from the proliferation of EM energy utilization.

EMCJ is a technical committee on environmental electromagnetic engineering from the aspect of EMC; however, environmental electromagnetic engineering is sometimes regarded as a synonym for EMC in Japan despite the fact that EMC has no meaning of environment. In addition, technical meetings that the EMCJ holds are also called technical meetings on EMC. This shows that the concept of EMC is still confusing even today in Japan.

†The Japanese original was translated into English by the author.

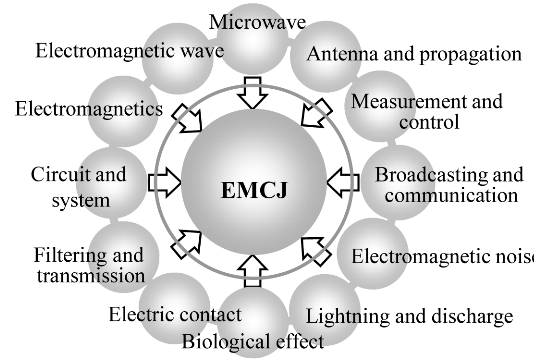


Fig. 3 Collaboration and contribution to EMCJ establishment from researchers and engineers, who worked in various specialized fields.

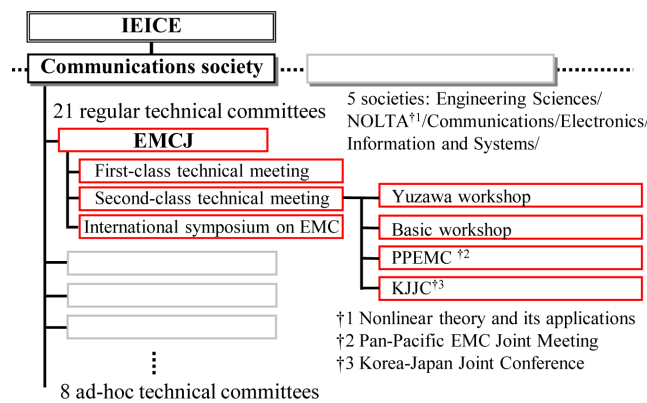


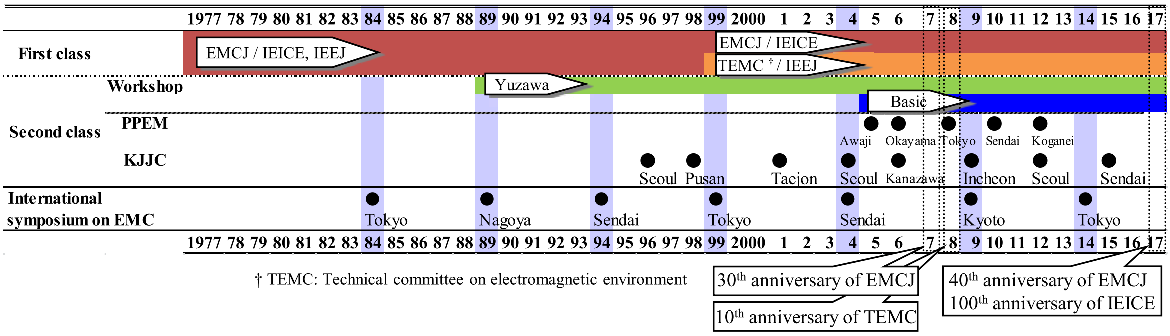
Fig. 4 Organization and structure of EMCJ affiliated with the communications society of IEICE.

2.2 Organization Form and Activity System

At present, EMCJ is affiliated with the IEICE. Figure 4 shows its organization form and activity system. In 2016, the IEICE consists of 5 societies, including the "communications society" to which the EMCJ belongs. The communications society has 21 technical committees and 8 ad-hoc committees. The EMCJ plans and holds technical meetings monthly in principle. According to EMC topics, joint meetings have been convened in cooperation with the following other technical committees under the "electronics society" of the IEICE: Electromechanical Devices (EMD), Electromagnetic Theory (EMT), Microwaves (MW) and so on. The EMCJ has also planned international symposiums on EMC to be held every 5 years in Japan. In the technical meetings that the EMCJ holds, there are first class and second class. A first-class meeting is held every month at each of the venues all over Japan except for August and February, but there have also been technical joint meetings in Korea and Thailand outside Japan. In 2016, the joint meeting was held in Taipei. The second-class meeting, which is held almost every year, includes workshops and joint meetings across Asia.

Research activities on EMC are performed through an oral presentation and technical discussion at first-class meetings by the general solicitation of technical reports without

Table 1 Activity change in technical meetings and international symposiums on EMC held by EMCJ/IEICE.



any peer review. At the second-class meetings, on the other hand, a "Yuzawa" workshop, which was named after the venue of "Echigo-Yuzawa," Niigata Prefecture, is specialized in the latest topics and technical discussion on specific EMC issues, while the "basic" workshop provides an EMC basis as tutorial sessions for young people including researchers and engineers unfamiliar with EMC. They are held once a year. The joint meetings in Asian areas are also held to exchange views of mutual interest among EMC colleagues of various neighboring countries. Table 1 shows activity changes in technical meetings and international EMC symposiums that the EMCJ held for 40 years up to now from the EMCJ establishment.

As described above, research activities on EMC issues in Japan have been conducted through submission of technical reports and the oral presentations with discussions at technical meetings on environmental electromagnetic engineering belonging both to the IEICE and IEEJ. With the arrival of the high information-oriented society and the diversification in EMC issues, however, requests for systematic research investigations of every EMC issue rose rapidly in the IEEJ. At that time, a technical committee on physics in electrical engineering of the IEEJ was re-organized in April 1999, and a technical committee on EM environment (named TEMC), which belongs to a technical society on fundamental and materials of the IEEJ, was newly started [13]. The first TEMC past chair was Tadasu Takuma of Kyoto University, at that time, and the 2nd TEMC past chair was followed by Osamu Fujiwara (15th EMCJ past chair) of Nagoya Institute of Technology. The present 5th TEMC chair is Ken Kawamata of Tohoku Gakuin University. The prospectus can be found in [14]. As shown in Table 1, the two technical committees of EMCJ and TEMC have begun to come into action independently from a different viewpoint of the respective academic meetings since 1999. At present, the EMCJ has joint meetings twice a year in collaboration with the TEMC for the purpose of cooperative research investigation and mutual complementing of research activities. The EMCJ and TEMC celebrated the 30th anniversary [15] in 2007 and the 10th anniversary [14] in 2008, respectively, under the leadership of Hiroshi Inoue (14th EMCJ past chair) and Tsuyoshi Funaki (4th TEMC past chair), respectively.

The Yuzawa workshop on "electromagnetic interference (EMI) of electronic equipment and its countermeasure" was first proposed in 1989 by Tasuku Takagi of Tohoku University, who was the 4th EMCJ past chair. The Yuzawa workshop is being held every year, and is in its 28th year in 2016. The workshop also provides not only the latest on EMI technical measures but also the newest information about international standards of CISPR/IEC† or industry standards such as ARIB and VCCI††. The basic workshop on EMC basis also started in 2005 for young people, researchers and engineers, and is being held every year, which will be 12 years old in 2016.

An EMC joint meeting in the Asian areas was held for the first time in Seoul, Korea as a first-class meeting in 1988. After that, a Korea and Japan Joint Conference or KJJC meeting is now held in Korea or Japan every other year as a second-class meeting since 1996. Youji Kotsuka, Tokai University, who was the 12th EMCJ past chair, proposed a Pan-Pacific joint meeting on EMC or PPEMC, and the first meeting was held in 2005 in Awaji, Hyogo Prefecture. This meeting is to run every year, but is becoming difficult to hold yearly due to the recent increase of EMC international conferences and symposia in the Asian areas such as URSI (International Union of Radio Science) Asia-Pacific Radio Science Conference (AP-RASC), Asia-Pacific Conference on Environmental Electromagnetics (CEEM) and Asia-Pacific EMC Symposium (APEMC).

In 1984, an international symposium on EMC was held in Japan, Tokyo, for the first time. This was organized by the EMCJ in co-sponsorship with the IEEE EMC Society that has annually sponsored an IEEE international symposium on EMC in USA since 1959 [16]. The 1984 IEEE EMC symposium marked the first time that it was held outside the USA [17]. The organizing chair was Risaburo Sato, Tohoku University, and the secretary was Tasuku Takagi, Tohoku University, at that time. Since then, an international symposium of this kind started to be held every 5 years in technical co-sponsorship with the IEEE EMC Society. The latest symposium was the 7th in 2014 organized by Masao

†CISPR: International special committee on radio interference/IEC: International electromechanical commission

††ARIB: Association of radio industries and businesses/VCCI: Voluntary control council for interference by information technology equipment

Taki (17th EMCJ past chair), Tokyo Metropolitan University. The next 8th symposium is planned for Sapporo, Hokkaido in 2019 by Hideaki Sone (the present EMCJ chair), Tohoku University as organizing chair.

3. Research Activities

Figure 5 shows the annual change in the number of technical reports presented at the technical meetings held by the EMCJ for about 40 years from 1977 to 2016. Open circles on the figure are the total number of all technical reports every year, and closed circles are the cumulative total number. It was found from Fig. 5 that there were 65 technical reports a year in 1977, and later around 100 reports a year [18], [19], although the yearly number slightly decreased since 2003. Until September of 2016, the cumulative total number reached 4341.

Table 2 shows topics of technical reports presented at technical meetings on environmental electromagnetic engineering for the past 10 years from 1996 to 2006, which were categorized from a total number of 1489 by Ryuji Koga (13th EMCJ past chair) [18]. He also classified a change in the number of technical reports chronologically, and pointed out a high number in 2006 in the order of biological effect, PCB (including radiated emissions), measurement, materials, discharge and EM field analysis.

Figure 6 shows annual changes in the cumulative number and total number of technical reports presented over the past 10 years (cumulative total number: 1274) from 2006 to 2016 according to Koga's categorized topics. A circular graph in the following figure shows the cumulative number of 7 types of technical reports including miscellaneous topics in 2016. These figures indicate that the report number was larger in the order of biological effect (including bioelectromagnetics), PCB, discharge, measurement, analysis (involving EM field analysis) and materials, which is the same as the top two largest numbers in topics of the Koga survey result in 2007. This chapter is unable to cover all the research on these topics due to the limited space. Therefore, the top two topics of "biological effects" and "PCB" are reviewed here, in terms of their contents and trends.

The greatest concern of research on "biological effects" is to develop anatomically-based human body models for

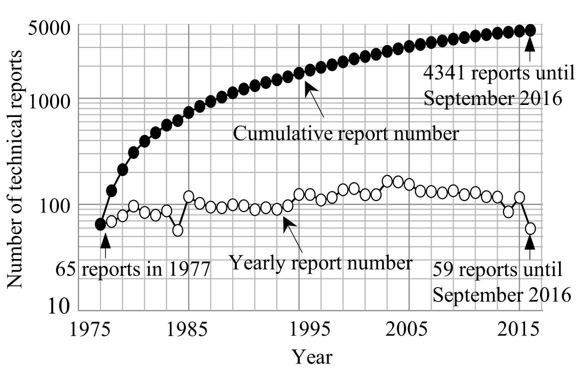


Fig. 5 Yearly change in number of technical reports presented at technical meetings on environmental electromagnetic engineering during 1977–2016.

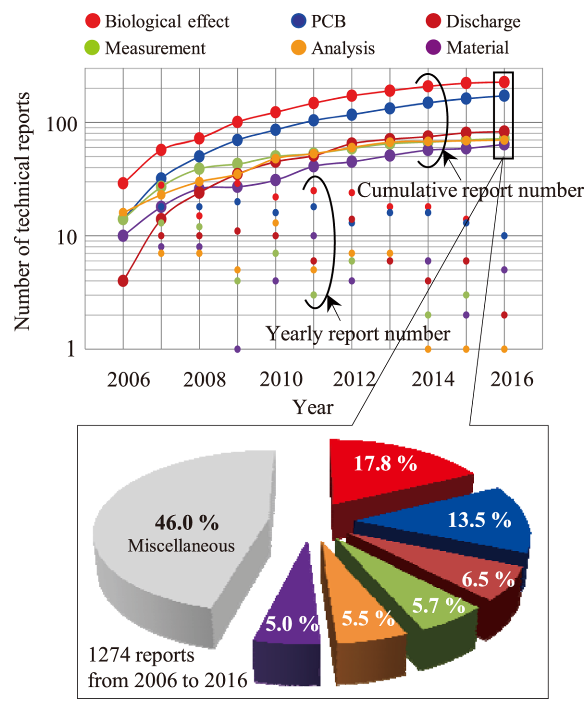


Fig. 6 Yearly change in number of technical reports according to six topics that appeared from 2006–2016.

Table 2 Categorized topics of technical reports presented at technical meetings on environmental electromagnetic engineering [18].

Printed circuit board (PCB)	Power and ground	
	Transmission line	Signal integrity
		Common mode
		Cross talk
		Radiation
	Radiation	Near field
		Far field
	Immunity	
Cable	Common mode/ radiation	
	Immunity	
	Balance /imbalance conversion	
Equipment	Radiation	
	Immunity	
Large-Scale Integration (LSI)	Driving source model	
	Immunity	

Material	Measurement
	Meta-material
	Absorption body
	Shield
Discharge	Electrostatic dischaege
	Lightning
	Contact
Electromagnetic field	Analysis
	Radiation prediction
Electromagnetic environment	Noise source model
	Radiowave environment
	Universe/ionosphere
Measurement	Site
	Antenna
	Probe
	Noise source estimation
	Immunity

Biological effect	SAR (Specific absorption rate)
	Nonthermal effect
	Medical applications
Countermeasure	Measure case
	Measure parts
	Grounding
	Automobiles
	Airplanes/Railroad/Shipping
Communication system EMC Miscellaneous	Power line communication (PLC)
	Intelligent transport systems (ITS)
	Electronic toll collection system (ETC)
	Wireless local area network (LAN)
	Bluetooth
	Ultra wide band (UWB)
	Power electronics
Standard/regulation	CISPR/IEC/ARIB/VCCI

human safety assessment of radio-frequency (RF) electromagnetic fields, and thereby conduct dosimetry† evaluation about whether or not RF exposure levels conform to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guideline [20] or the Japan protection policy for the human body from effects of radio waves use [21]. Over the past decade, anatomically-based numerical models of children [22], infants [23], [24], pregnant women [25]–[28], and fetuses [29] have been developed, and finite-difference time-domain (FDTD) calculations of whole body average SARs have been vigorously conducted. Furthermore, a large-scale computational technique of temperature elevation [30] was developed by using bio-heat conduction equations combined with Maxwell's equations. Core temperature in deep tissues of adults and children [31], [32] for far field exposure was calculated. The specific absorption rates (SARs) and temperature elevation inside a small animal such as a rat [33]–[36] and a rabbit [37]–[39] were numerically evaluated for biological exposure testing.

On the other hand, attempts were made to estimate the whole-body average SAR in human for plane wave exposure from the human-body surface area [40], spatially averaged squares of induced currents [41] and an external-cylindrical field scanning technique [42]. A reverberation chamber [43]–[45] was used to estimate the whole-body SAR [46], [47]. From the measurement and simulation of the whole body average SAR of human volunteers [48] in the reverberation chamber, the validity of the FDTD computation results on computational human models having a limited number of tissue types and organs was shown [49]. In addition, concern about the influence on human body for electromagnetic field exposure of ELF [50]–[52] and intermediate frequency band [53] has been raised, and induced currents inside human models exposed to the magnetic near-field of electromagnetic induction heating cookers [54], [55] and alternating electric shavers [56] were analyzed. In 2010 the ICNIRP guideline in the low-frequency range from 1 Hz to 100 kHz [57] was revised, which attracted attention to contact currents [58] as an indirect effect of electromagnetic field exposure, and the threshold levels of electric shock were measured for human volunteers.

In recent years, much attention has been paid to a technique of wireless power transfer (WPT) in the intermediate frequency band, and the human dosimetry evaluation [59]–[63] in the vicinity of the WPT system has been attempted.

Regarding the research on "PCB", it is well known that the radiated electromagnetic waves (emission noise) from a PCB are generated by common-mode (CM) currents flowing on signal traces on the PCB or wires/cables connected to the PCB. The greatest concern, therefore, is simply to predict the CM currents, and how to suppress them. Over the past decade various analytical methods [64]–[69] and equivalent circuit models [70], [71] for accurately calculating the CM currents have been developed. Furthermore, in order to analyze the emission noise from a PCB equipped with an integrated circuit (IC)/large-scale integration (LSI), it is necessary to simulate the high-frequency currents of the IC/LSI power supply system. From this point of view, to calculate the high-frequency currents caused by switching of the complementary metal oxide semiconductor (CMOS) transistor, a model consisting of a linear equivalent circuit and internal current source, which is named LECCS [72]–[76], has been proposed, and its usefulness was shown experimentally.

As for the reduction methods of the emission noise, it is often used to implement bypass capacitors [77]–[79] and CM mode choke coils [80]. A design method [81] has been proposed to reduce the CM current by balancing the inductance and the capacitance of the wiring on the PCB. An electromagnetic band gap (EBG) structure [82] was used to suppress the power noise in electronic equipment. A noise suppression sheet [83] with an EBG pattern formed in the power/ground layer has also been proposed. Also, in order to elucidate the electromagnetic shielding effectiveness of an enclosure, leakage electromagnetic waves from the aperture were measured using a case model [84]–[86] incorporating a PCB as an emission noise source. The result showed that the shielding effect was significantly affected by the PCB arrangement location.

Regarding vehicle-mounted PCBs, analyses were made in order to predict the emission noise from the power supply system [87] caused by the voltage fluctuation of the mounted IC or conduction noise currents [88] generated by direct current motors, and their measurements and validations were also conducted. In addition, since the conduction noise currents flowing out from a PCB to wire harnesses act as a source of disturbance on the onboard FM radios, ground patterns with slits [89]–[93] which suppress the conduction noise currents were found through computer simulation and measurement.

The above-described technical topics feature prominently in the EMCJ technical meetings, which can also often be seen in the international EMC symposiums held in Japan [94] and even in Europe [95]. It should be noted that the number of technical reports on each topic every year decreased after a peak in 2011. This is because new EMC problems such as EMC tests of power electronics, wireless power transmission (WPT), medical equipment and in-vehicle electronic equipment have increased with the proliferation and diversification of EM energy use.

4. Status-Quo and Prospects

The EMCJ under the IEICE, launched in 1977, is already 39 years old. It is no exaggeration to say that the history represents the EMC research activities themselves in Japan. In those days, there was no publicity of EMC at all when the EMCJ was started. Thanks to the various activities of the EMCJ, which were done through concentration and collaboration by many researchers and experts from their existing

†Dosimetry: Measurement or determination by calculation of internal electric field strength or induced current density or specific absorption or specific absorption rate (SAR) in humans or animals exposed to electromagnetic fields.

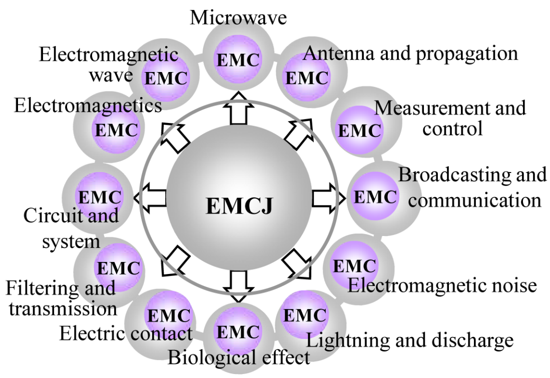


Fig. 7 EMC groups born in other technical fields owing to EMCJ activities.

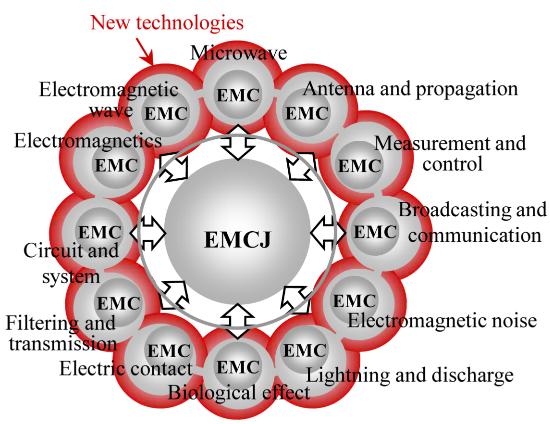


Fig. 8 Expansion and development of EMCJ activities in collaboration with different EMC groups in other technical fields incorporated with newly emerging technologies.

technical fields, a vast number of study results were published worldwide, which improved the awareness of EMC remarkably in Japan. Hence EMC came to be also discussed in many other specialized fields. This situation is shown in Fig. 7. However, the EMC issues, which should be discussed in the EMCJ basically, were first studied separately by different EMC groups, which were newly born in other technical areas owing to the EMCJ activities. This may have led to the mild decrease in the yearly number of technical reports since 2003 as shown in Fig. 5. As a result, the EMCJ activities, which depend largely upon the general solicitation of technical reports, shrank and began to show the aspect of hollowing. As indicated in Fig. 3, a new learning field draws attention at first, and grows dramatically for a while because many researchers gather to join the field; for study, but the growth tapers off. Such a trend is often seen in new learning fields.

Figure 8 shows the future state of EMCJ activities in the author's view. The mission of the EMCJ is to construct fundamental technologies to provide the world with highly reliable systems [5]. Accordingly, the EMCJ simply continues to contribute to the essential outcomes of EMC in collaboration with different EMC groups in other technical areas incorporated with newly emerging technologies such as information and communications technology (ICT), the

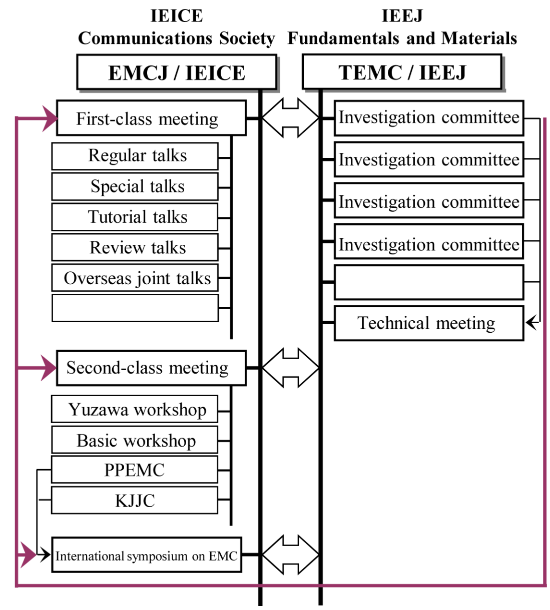


Fig. 9 Future activity forms of EMCJ/IEICE in positive collaboration with TEMC/IEEJ.

Internet of things (IoT), virtual reality (VR), artificial intelligence (AI) and the like. To achieve this effectively, the author proposes that the EMCJ should aggressively collaborate with the TEMC, which has the same purpose but different forms of activities that do not rely on the public call for technical reports. This view is shown in Fig. 9, which is based on the experience of the author who served as chairperson of both of the EMCJ and the TEMC. As described in 2.2, the main research activities of the EMCJ under the IEICE are based on the public solicitation of technical reports and presentations with open discussion, whereas the TEMC of the IEEJ has an individual style of research activities entirely different from the EMCJ; that is to say, the TEMC establishes investigation committees on specific EMC subjects according to the need, and publishes the results as technical investigation reports through closed discussion, although it also holds technical meetings with oral presentations and open discussion on technical reports, which are normally submitted from the investigation committees. Both research policies are just heterogeneous. Such collaboration activities with the TEMC of the IEEJ, which has an activity policy and research territory quite different from the EMCJ, may indeed lead to technological breakthroughs in further complicated EMC issues, and therefore will be indispensable to the EMCJ and the TEMC for further growth and development. As shown in Fig. 9, both committees should more often exchange technical information according to the EMC issues. The first-class meeting of the EMCJ should further be held in the Asian areas in collaboration with the TEMC for the purpose of aiming at normalization of English and Japanese of manuscripts or presentations. Second-class meetings including PPEMC and KJJC should also be held in closer cooperation with the TEMC and the EMC colleagues in these Asian areas. EMC standards such as CISPR/IEC, ARIB and VCCI should be provided as a theme by the basic workshop for the training of young people in this field. These activities described above may enhance the originality and quality of an international symposium on EMC from the aspect of environmental electromagnetic engineering that the EMCJ organizes every 5 years in Japan.

5. Conclusion

In 2017, the IEICE and the EMCJ will celebrate their 100th and 40th anniversary, respectively. By taking this as an opportunity, the establishment process and activity forms of the EMCJ under the IEICE have been reviewed, and the features of EMC studies in Japan have been demonstrated from the survey of technical reports presented over the past 10 years. A private idea has also been provided to show the way of the future EMCJ which should be developed from now on.

As regards an international symposium on EMC, the EMCJ/IEICE is holding one every 5 years, while international conferences and symposia in Europe, USA and Asia except Japan are being held every year. There is also a process by which the state of the symposium in Japan has often been eagerly discussed so far, although the EMCJ has particularly collaborated with the APEMC that holds an international symposium every year. Concerning our own international symposium, however, the author thinks that by deviating from the annual framework, holding one every 5 years in Japan should be kept in order to send research results of EMC pursued from an environmental electromagnetic engineering perspective worldwide.

Besides, it should be noted that there are no examples in foreign countries where a new learning field of "environmental electromagnetic engineering" was founded in Japan by expanding a concept of EMC. Due to such concept expansion, however, confusion has also occurred in the understanding of EMC in Japan, since environmental electromagnetic engineering is still misunderstood to be identical with EMC, despite the fundamental learning field which pursues EMC of all technologies emerging in EM environments. In EMCJ and TEMC, therefore, technical terminologies on EMC and their related terms should be rearranged to be unified for the next generation of EMC researchers, though this had already been pointed out 40 years ago in [1] as one of the future subjects for EMC.

In 2017, the EMCJ will celebrate its 40th anniversary, and is expected to further develop in future.

Acknowledgments

The author thanks all of the present EMCJ staff of Hideaki Sone, EMCJ chair, Osami Wada, EMCJ vice-chair, EMCJ secretaries, EMCJ expert members and EMCJ advisors, who have provided an opportunity to write this paper.

References

[1] R. Sato and H. Echigo, "Electromagnetic compatibility - EMC - the state and problems," J. IEICE, vol.59, no.8, pp.829–835, 1976 (in Japanese).
[2] Y. Endo, "Environmental electromagnetic engineering (EMC)," Journal of the Institute of Television Engineers of Japan (The Journal of The Institute of Image Information and Television Engineers), vol.32, no.3, pp.11–18, 1979 (in Japanese).
[3] R. Sato and E. Hiroshi, "Status quo and prospect of environmental electromagnetic engineering," Journal of the Institute of Electrical Engineers of Japan, vol.99-1, pp.11–18, 1979 (in Japanese).
[4] T. Takagi, "A review of electromagnetic compatibility by an instrumentation and control engineering," Journal of the Society of Instrument and Control Engineers, vol.18, no.12, pp.1012–1018, 1979 (in Japanese).
[5] H. Echigo and T. Takagi, "Electromagnetic compatibility and high reliability," Journal of the Society of Instrument and Control Engineers, vol.24, no.4, pp.296–300, 1985 (in Japanese).
[6] IEEE Standard 100-1992, "The new IEEE standard dictionary of electrical and electronics terms," Fifth Edition Newly Revised and Expanded, p.424.
[7] IEC (International Electrotechnical Commission) website, http://www.iec.ch/emc/ (accessed Sept. 25 2016).
[8] J. O'Neil, Editor-in-Chief, IEEE EMC Society newsletter, Issue no.215, Fall 2007.
[9] R. Sato, Commemorative speech for 30th anniversary of EMCJ on "Beginning of EMC research in Japan," IEICE Technical Report, EMCJ2007, Oct. 2007 (in Japanese).
[10] T. Takagi, Commemorative speech for 30th anniversary of EMCJ on "reminisce in the early part of EMCJ," IEICE Technical Report, EMCJ2007, Oct. 2007 (in Japanese).
[11] J. O'Neil, Editor-in-Chief, IEEE EMC Society newsletter, Issue no.229, Spring 2011.
[12] IEICE EMCJ Homepage, http://www.ieice.org/cs/emcj/Eng/index.html (accessed Sept. 25 2016).
[13] Edition by IEEJ 125th anniversary memorial event committee, "125th annals of Institute of Electrical Engineers of Japan," pp.199–200, 2013 (in Japanese).
[14] IEEJ-TC-EMC- Osaka University, website, http://emc.eei.eng.osaka-u.ac.jp/˜emc/ (accessed September 25 2016).
[15] Edition by EMCJ 30th anniversary memorial event execution committee, "Commemorative issue for 30th anniversary of technical committee for electromagnetic compatibility (EMCJ)," Oct. 25, 2007 (in Japanese).
[16] D. Hoolihan, "An overview of the first 25 IEEE International symposiums on EMC," http://www.emcs.org/acstrial/newsletters/summer05/overview.html (accessed Sept. 25 2016).
[17] R.B. Schulz, "EMC symposium," IEEE Trans. Electromagn. Compat., vol.EMC-24, no.3, p.293 Aug. 1982.
[18] R. Koga, "Development and prospects of EMC engineering in Japan," IEICE Trans. Commun. (Japanese Edition), vol.J90-B, no.11, pp.1083–1088, Nov. 2007.
[19] O. Fujiwara, "Electromagnetic fields due to electrostatic discharges and their FDTD simulation," IEICE Trans. Commun. (Japanese Edition), vol.J94-B, no.11, pp.1452–1460, Nov. 2011.
[20] International Commission on Non-Ionizing Radiation Protection (ICNIRP), "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)," Health Physics, vol.74, no.4, pp.494–522, 1998.
[21] A reply to inquiry number 38 from the telecommunications technology council, ministry of posts and telecommunications: "The protection policy for the human body from effects of radio waves use," pp.25–27, June 25, 1990.
[22] Y. Nagaya, A. Hirata, O. Fujiwara, T. Nagaoka, and S. Watanabe, "FDTD calculation of whole-body average SAR in the child models," IEICE Technical Report, EMCJ2006-10, June 2006 (in Japanese).
[23] H. Miwa, A. Hirata, O. Fujiwara, T. Nagaoka, and S. Watanabe, "Uncertainty of GHz-band whole-body average SARs in infants based on Kaup indicies," IEICE Technical Report, EMCJ2009-32, June 2009

(in Japanese).

[24] H. Miwa, Y. Kazama, A. Hirata, O. Fujiwara, T. Nagaoka, and S. Watanabe, "Estimation of 1–6 GHz whole-body averaged SARs in infants using their dielectric properties," IEICE Technical Report, EMCJ2009-86, Dec. 2009 (in Japanese).

[25] J. Wang, O. Fujiwara, K. Wake, and S. Watanabe, "Dosimetry analysis of pregnant and new-born rats in a 2-GHz unrestrained whole-body exposure setup," IEICE Technical Report, EMCJ2006-38, July 2006 (in Japanese).

[26] T. Nagaoka, T. Togashi, K. Saito, M. Takahashi, K. Ito, and S. Watanabe, "Numerical dosimetry of a pregnant woman model for plane wave exposures," IEICE Technical Report, EMCJ2006-101, Jan. 2007 (in Japanese).

[27] H. Kawai, T. Nagaoka, S. Watanabe, K. Saito, M. Takahashi, and K. Ito, "SAR dosimetry inside a 4-, 8-, and 12-week pregnant woman model exposed to the plane wave," IEICE Technical Report, EMCJ2007-82, Nov. 2007 (in Japanese).

[28] R. Asayama, J. Wang, and O. Fujiwara, "Calculation of whole-body average SARs in pregnant woman and infant for multiple RF exposure in real environment," IEICE Technical Report, EMCJ2012-2, April 2012 (in Japanese).

[29] T. Nagaoka, T. Niwa, S. Dahdou, J. Wiart, and S. Watanabe, "Development of high-fidelity fetal models based on MRI during the second and third trimesters," IEICE Technical Report, EMCJ2012-52, Sept. 2012 (in Japanese).

[30] T. Asano, A. Hirata, and O. Fujiwara, "FDTD calculation of temperature elevation in the human body due to far-field exposure," IEICE Technical Report, EMCJ2006-9, June 2006 (in Japanese).

[31] T. Asano, A. Hirata, and O. Fujiwara, "Uncertainty analysis of temperature-rise in human body for far field exposure," IEICE Technical Report, EMCJ2006-82, Dec. 2006 (in Japanese).

[32] T. Asano, A. Hirata, and O. Fujiwara, "Body-core temperature elevation in human adult and child," IEICE Technical Report, EMCJ2007-107, Jan. 2008 (in Japanese).

[33] K. Wake, S. Watanabe, Y. Yamanaka, and M. Taki, "SAR analysis for a large-scale and long-term animal experiment of exposure to 2-GHz W-CDMA signals," IEICE Technical Report, EMCJ2006-17, June 2006-06 (in Japanese).

[34] Y. Kanai, A. Hirata, O. Fujiwara, H. Masuda, H. Kawai, T. Arima, and S. Watanabe, "Analysis of temperature rise in rats for 1.5-GHz microwave exposure," IEICE Technical Report, EMCJ2009-193, June 2009 (in Japanese).

[35] J. Wang, K. Wake, T. Arima, S. Watanabe, and O. Fujiwara, "Dosimetry analysis for pregnant and new-born rats based on their activity pattern in a 2-GHz whole-body exposure setup," IEICE Technical Report, EMCJ2010-73, Nov. 2010 (in Japanese).

[36] J. Wang, W. Liao, H. Kawai, K. Wake, S. Watanabe, and O. Fujiwara, "Design and validation of a multi-frequency whole-body exposure system for bio-effect test with rats," IEICE Technical Report, EMCJ2012-11, May 2012 (in Japanese).

[37] A. Hirata, S. Watanabe, M. Taki, O. Fujiwara, M. Kojima, and K. Sasaki, "Temperature elevations in rabbit eye irradiated by 2.45-GHz exposure systems," IEICE Technical Report, EMCJ2006-50, Sept. 2006 (in Japanese).

[38] A. Hirata, S. Watanabe, M. Taki, O. Fujiwara, M. Kojima, and K. Sasaki, "FDTD simulation of temperature elevations in rabbit eye due to microwave energy," IEICE Technical Report, EMCJ2007-4, April 2007 (in Japanese).

[39] H. Sugiyama, A. Hirata, O. Fujiwara, H. Kawai, M. Kojima, Y. Yamashiro, S. Watanabe, and K. Sasaki, "Study of body-core temperature rise in a rabbit for 2.45 GHz microwave exposure," IEICE Technical Report, EMCJ2007-31, June 2007 (in Japanese).

[40] Y. Nagaya, A. Hirata, O. Fujiwara, T. Nagaoka, and S. Watanabe, "Correlation between absorption cross section and body surface area of human for far-field exposure in GHz bands," IEICE Technical Report, EMCJ2006-81, Dec. 2006 (in Japanese).

[41] T. Suzuki, A. Hirata, O. Fujiwara, T. Nagaoka, and S. Watanabe, "Estimation of whole-body average SARs in human for vertical polarized far-field exposure at frequencies over 1 GHz using spatially averaged squares of induced currents," IEICE Technical Report, EMCJ2010-24, July 2010 (in Japanese).

[42] N. Kobayashi, Y. Kawamura, T. Hikage, T. Nojima, T. Nagaoka, and S. Watanabe, "Estimation of direction-of-arrival dependence of whole-body averaged SAR in Japanese human models exposed to plane-wave," IEICE Technical Report, EMCJ2010-43, Sept. 2010 (in Japanese).

[43] J. Chakarothai, J. Wang, O. Fujiwara, K. Wake, and S. Watanabe, "Experimental validation of MoM-derived electric field distribution in reverberation chamber for bio-effect testing," IEICE Technical Report, EMCJ2012-10, May 2012 (in Japanese).

[44] J. Chakarothai, J. Wang, O. Fujiwara, K. Wake, and S. Watanabe, "Numerical dosimetry of small animal in reverberation chamber," IEICE Technical Report, EMCJ2012-86, Dec. 2012 (in Japanese).

[45] J. Chakarothai, J. Wang, O. Fujiwara, K. Wake, and S. Watanabe, "A dosimetry design of reverberation chamber for whole-body exposure of small animals," IEICE Technical Report, EMCJ2013-15, pp.31–36, 2013-05 (in Japanese).

[46] K. Harima, "Estimation of absorbed power in human body using a reverberation chamber," IEICE Technical Report, EMCJ2011-106, Dec. 2011 (in Japanese).

[47] T. Suzuki, J. Wang, and O. Fujiwara, "Calculation of GHz-band whole-body average SARs in children models for electromagnetic field exposure inside reverberation chamber," IEICE Technical Report, EMCJ2011-109, Nov. 2011 (in Japanese).

[48] T. Suzuki, J. Wang, and O. Fujiwara, "Measurement and validation of GHz-band whole-body Average SAR in human volunteer using reverberation chamber," IEE Japan, Paper of Technical meeting on Electromagnetic Compatibility, Reference no.EMC-11-22, pp.17–22, 2011-10 (in Japanese).

[49] J. Wang, T. Suzuki, O. Fujiwara and K. Harima, "Measurement and validation of GHz-band whole-body average SAR in a human volunteer using reverberation chamber," Physics in Medicine and Biology, vol.57, no.23, pp.7893–7903, 2012.

[50] H. Tarao, K. Kirita, N. Hayashi, and K. Isaka, "Relation between ELF magnetic fields and induced currents inside tissues of human Body," IEICE Technical Report, EMCJ2007-90, Nov. 2007-11 (in Japanese).

[51] M. Ikehata, S. Yoshie, Y. Suzuki, M. Taki, and T. Hayakawa, "Effects of combined magnetic fields with static and 50Hz on mutagenesis," IEICE Technical Report, EMCJ2007-91, Nov. 2007 (in Japanese).

[52] Y. Takano, A. Hirata, and O. Fujiwara, "Induced current density/electric field in human body for ELF electric and magnetic field exposures at reference level/MPE," IEICE Technical Report, EMCJ2009-85, Dec. 2009 (in Japanese).

[53] Y. Yoshino, S. Igo, M. Katsuragi, and M. Taki, "Assessment of human exposure to electromagnetic field from an intra-body communication device using intermediate-frequency electric field," IEICE Technical Report, EMCJ2012-9, May 2012 (in Japanese).

[54] Y. Kamimura, D. Yamaura, A. Yamashita, and K. Sato, "Measurement of exposure level around an IH cooker (second report)," IEICE Technical Report, EMCJ2015-2, April 2015 (in Japanese).

[55] H. Tarao, N. Hayashi, and K. Isaka, "Calculation of induced currents in adult and child human models by intermeadiate frequency magnetic fields from an induction heater," IEICE Technical Report, EMCJ2006-15, June 2006-06 (in Japanese).

[56] Y. Kamimura, M. Kouno, Y. Yamada, S. Nishizawa, and F. Landstorfer, "Study on equivalent magnetic source of ac drive electric shaver," IEICE Technical Report, EMCJ2006-16, June 2006 (in Japanese).

[57] International Commission on Non-Ionizing Radiation Protection (ICNIRP), "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (1 Hz to 100 kHz)," Health Physics, vol.99, no.6, pp.818–836, Dec. 2010.

[58] R. Munakata and Y. Kamimura, "A study on equivalent circuit for

contact current measurement," IEICE Technical Report, EMCJ2015-6, April 2015 (in Japanese).
[59] S. Ishihara, T. Onishi, and A. Hirata, "Magnetic field measurement near wireless power transfer systems for information household appliances," IEICE Technical Report, EMCJ2014-19, July 2014-07 (in Japanese).
[60] T. Iwamoto, J. Chakarothai, K. Wake, K. Fujii, T. Arima, and S. Watanabe, and T. Uno, "Comparison of human exposure from two different wireless power transfer systems at MHz-band," IEICE Technical Report, EMCJ2014-88, Jan. 2015 (in Japanese).
[61] Y. Keita and M. Taki "A consideration on numerical analysis of human exposure by the intermediate frequency band wireless power transfer system," IEICE Technical Report, EMCJ2016-68, Jan. 2016 (in Japanese).
[62] S. Shimoyama, J. Chakarothai, K. Wake, L. Hamada, T. Arima, T. Uno, and S. Watanabe, "An investigation on SAR measurement method for MHz-band wireless power transfer systems," IEICE Technical Report, EMCJ2016-46, July 2016 (in Japanese).
[63] K. Matsubara, H. Yoshino, K. Wada, and Y. Suzuki, "Design of magnetic field generator to evaluate biological effects for electrical vehicle WPT system," IEICE Technical Report, EMCJ2016-53, Sept. 2016-09 (in Japanese).
[64] M. Takashima, T. Tobana, T. Sasamori, and K. Abe, "Analysis of emission from printed circuit board with linear conductor," IEICE Technical Report, EMCJ2006-18, July 2006 (in Japanese).
[65] F. Ga, T. Watanabe, and Y. Iizuka, "Simulation of electromagnetic emissions from LSIs on printed circuit boards," IEICE Technical Report, EMCJ2006-40, July 2006-07 (in Japanese).
[66] T. Tsuda, T. Uno, and K. Ichikawa, "EMI model improvement taking LSI package structure into consideration," IEICE Technical Report, EMCJ2006-84, Dec. 2006-12 (in Japanese).
[67] A. Sadatoshi, Y. Sakai, T. Watanabe, Y. Toyota, K. Iokibe, R. Koga, and O. Wada, "Estimation of electromagnetic-emission from PCBs with a connector through the common-mode antenna Model," IEICE Technical Report, EMCJ2007-9, pp.19–54, April 2007 (in Japanese).
[68] K. Fukumasu, T. Watanabe, Y. Toyota, K. Iokibe, R. Koga, and O. Wada, "Estimation of radiated emissions with common-mode antenna model of printed circuit board – superposition of common-mode excitation sources –," IEICE Technical Report, EMCJ2007-25, June 2007 (in Japanese).
[69] R. Kobayashi, N. Nakamura, and K. Tajima, "Simultaneous measurement method for conducted common-mode voltage and current," IEICE Technical Report, EMCJ2008-5, April 2008 (in Japanese).
[70] Y. Kayano, and H. Inoue, "An equivalent circuit model for predicting CM radiation from a surface-microstrip line structure," IEICE Technical Report, EMCJ2007-58, Oct. 2007 (in Japanese).
[71] K. Matsumoto, Y. Toyota, K. Iokibe, and R. Koga, "Development of an equivalent circuit model with transmission line model for designing filter formed on printed circuit boards," IEICE Technical Report, EMCJ2009-112, Jan. 2010 (in Japanese).
[72] A. Osaki, K. Iokibe, Y.T., R. Koga, and O. Wada, "Determination of impedances in LECCS-I/O model by 3-port VNA measurement for higher frequency range," IEICE Technical Report, EMCJ2006-21, July 2006 (in Japanese).
[73] A. Koyama, T. Hisakado, and O. Wada, "Linear time-invariant analysis of CMOS output buffer with LECCS model using time-variant resistors," IEICE Technical Report, EMCJ2007-8, April 2007-04 (in Japanese).
[74] R. Higashi, K. Iokibe, T. Tsuda, K. Ichikawa, K. Nakamura, Y. Toyota, and R. Koga, "Evaluation of multiple power-supply pin LECCS-core model with different pattern design boards," IEICE Technical Report, EMCJ2008-33, July 2008 (in Japanese).
[75] M. Yasuhara, Y. Funato, Y. Saito, U. Paoletti, T. Hisakado, and O. Wada, "LECCS-core model including inter-block coupling in multiple power-supply pin LSI," IEICE Technical Report, EMCJ2008-90, July 2008 (in Japanese).
[76] T. Tasaka, N. Oka, K. Iokibe, Y. Toyota, and R. Koga, "Examination of EMC macro model LECCS-I/O with two current sources simulating power and output currents of CMOS inverter IC," IEICE Technical Report, EMCJ2009-35, Sept. 2009 (in Japanese).
[77] T. Okabe, S. Sasaki, and S. Yoshimatsu, "A study of the radiation noise reduction technique from power supply layers in the PCB," IEICE Technical Report, EMCJ2008-8, June 2008 (in Japanese).
[78] Y. Sasaki, C. Miyazaki, N. Oka, and K. Misu, "Voltage distribution measurement of power plane by decoupling capacitor on PCBs," IEICE Technical Report, EMCJ2009-19, May 2009 (in Japanese).
[79] T. Nozaki, H. Nakanishi, and A. Tanaka, "Effect of adding bypass capacitors between partially formed power and ground layers and resulting PCB noise reduction," IEICE Technical Report, EMCJ2014-26, July 2014 (in Japanese).
[80] F. Nakamoto, Y. Sasaki, Y. Watanabe, C. Miyazaki, and N. Oka, "Practical model of an on-board type common mode choke coil for 3D EMC simulation," IEICE Technical Report, EMCJ2012-109, Jan. 2013 (in Japanese).
[81] K. Mizui, O. Wada, U. Paoletti, and T. Hisakado, "Balance control of power-supply interconnection in printed circuit boards and ICs for reduction of common-mode current flowing on attached cables," IEICE Technical Report, EMCJ2007-45, Sept. 2007 (in Japanese).
[82] N. Ando, H. Toyao, T. Tsukagoshi, and T. Harada, "A study on EBG structures for suppression of power noise in electronic equipment," IEICE Technical Report, EMCJ2007-110, Jan. 2008 (in Japanese).
[83] S. Yano, Y. Toyota, K. Iokibe, R. Koga, K. Kondo, and S. Yoshida, "Effect of reducing electromagnetic noise between power/ground planes with an EBG pattern on applying noise suppression sheets," IEICE Technical Report, EMCJ2009-2, April 2009 (in Japanese).
[84] S. Miyata, K. Katsumata, T. Kasuga, Y. Kayano, and H. Inoue, "A Study on EM radiation from aperture of enclosure with PCB as internal noise source," IEICE Technical Report, EMCJ2006-52, Oct. 2006 (in Japanese).
[85] S. Miyata, Y. Kayano, and H. Inoue, "A study on EM radiation through aperture of enclosure by internal PCB noise source (Part 3)," IEICE Technical Report, EMCJ2007-14, May 2007 (in Japanese).
[86] S. Yoneda, T. Kumamoto, C. Miyazaki, and N. Oka, "A study on shield structure of a connector substrate with single point ground plane connection," IEICE Technical Report, EMCJ2009-28, June 2009 (in Japanese).
[87] Y. Shiraki, Y. Yamanaka, and N. Abe, "Moments analysis of EM noise caused by power/ground noise of electric unit," IEICE Technical Report, EMCJ2006-53, Oct. 2006 (in Japanese).
[88] M. Torigoe, Y. Tsuchie, Y. Yahagi, T. Suga, H. Osaka, and T. Inagaki, "Estimation of conducted emission from automotive components by using noise equivalent circuit," IEICE Technical Report, EMCJ2013-92, Nov. 2013 (in Japanese).
[89] T. Maeno, T. Uno, K. Ichikawa, and O. Fujiwara, "Difference reduction effects of ground patterns on conductive noise currents from PCB," IEICE Technical Report, EMCJ2006-88, Dec. 2006 (in Japanese).
[90] H. Ueyama, T. Maeno, A. Hirata, J. Wang, and O. Fujiwara, "FDTD calculation of conduction noise currents from printed circuit board with ground-layer slits," IEICE Technical Report, EMCJ2007-96, Dec. 2007 (in Japanese).
[91] T. Maeno, H. Ueyama, M. Iida, and O. Fujiwara, "Characteristics and their mechanism of FM-band cross-talks between two parallel signal traces on printed circuit boards," IEICE Technical Report, EMCJ2008-62, Oct. 2008-10 (in Japanese).
[92] M. Iida, T. Maeno, and O. Fujiwara, "Size dependence of return ground patterns on FM-band cross-talks between two parallel signal traces on printed circuit boards for vehicles," IEICE Technical Report, EMCJ2010-38, July 2010 (in Japanese).
[93] M. Iida, T. Maeno, J. Wang, and O. Fujiwara, "Dependence on ground patterns size of FM-band cross-talks between two parallel signal traces on printed circuit boards for vehicles," IEICE Technical Report, EMCJ2010-126, March 2011 (in Japanese).
[94] M. Taki, "EMC'14/Tokyo report," IEEE Trans. Electromagn. Com-

pat., vol.3, no.3, pp.95–99 2014.
[95] O. Fujiwara, "A technical trend seen in the latest international EMC symposia," IEEJ Trans. FM, vol.125, no.1, pp.7–8, 2005.

Appendix

Figure A·1 shows the prospectus of EMCJ, in its original version of December 20, 1977.

Prospectus
Recent electronic technologies, which have developed remarkably, provide immeasurable benefits for our lives; however, the increase in the number and kinds of electronic equipment results in the problem of unnecessary electromagnetic (EM) energy, and influence among various equipment. Such unnecessary EM energy not only causes EM disturbances to radio and television but also many measurement systems and automated control systems, damaging them and causing their malfunction. This is likely to lead to serious accidents and endanger human life. In addition, as electromagnetics becomes more involved with human society these days, its influence on humans is becoming a problem. Issues of this kind have deep relations not only with electrical engineering but also other fields of engineering, science, mathematics, sociology, economics, medicine and so on. Consequently, such issues should now be studied as a part of environmental problems by concentrating more of all connected technologies of art and science toward humans. It has been pointed out by many knowledgeable people that academic meetings on such problems are significantly important; unfortunately, however, such activities in Japan still seem inadequate. In foreign countries, on the other hand, such academic activities have really been moving ahead in recent years; each of specialized technical fields is cooperating and is promoting this interdisciplinary study overall. In Japan, which has a high distribution of electronic equipment and depends on the export of industrial goods for its economy, study of this kind should have been conducted well ahead of that in other nations. Given the above-mentioned situation, therefore, establishment of a technical committee on environmental electromagnetics from the aspect of EMC has been demanded by the Institute of Electronics and Communication Engineers (the present IEICE). Now, "environmental electromagnetic engineering" as an academic field can be defined as follows: "environmental electromagnetic engineering is the basic learning field of interdisciplinary study in various fields like engineering, science, medicine, economics and sociology, to serve as a contribution to the effective utilization of EM energy and to the harmonization of EM environment by grasping and predicting the change in the EM ambient environment surrounding the earth and the celestial bodies as well as the state of electric and electronic equipment together with the control method for harmonizing the environment from the proliferation of EM energy utilization." In particular, the IEICE technical committee on environmental electromagnetic engineering named "EMCJ" is expected to widely contribute to a solution of various problems from the aspect of electronic communication technologies.

EMCJ deals with the following fields:
(1) EM theory in environmental electromagnetic engineering
(2) Electric circuit theory in environmental electromagnetic engineering
(3) Logic model of environmental electromagnetic engineering
(4) Characteristics and their measurement of the origins of EM waves (man-made and urban EM noise, etc.)
(5) Technologies involving environmental electromagnetic engineering (EM shielding technology, EM noise filter, bonding and unwanted reflection prevention technology, etc.)
(6) Prediction of EM environment
(7) Exclusion characteristics of unnecessary EM fields
(8) Effective utilization of EM frequency spectra
(9) Society system (electric power, transportation, broadcast, communications information, medical treatment and education, etc.)
(10) Effects of EM environment on biological effects and ecology

Relations with other technical committees
The following technical committees have a particularly deep relation with the EMCJ:
- Integrated circuit and system theory (electric circuit, logic model and EM noise filter in environmental electromagnetic engineering)
- Microwave (EM theory in environmental electromagnetic engineering, prevention of unnecessary emission and reflection)
- Medical electronics and bioengineering (medical system in environmental electromagnetic engineering and relation between EM fields and biological effects)
- Antenna and propagation (EM noise radiation, unnecessary reflection and measurement of EM environment)

Fig. A·1 Prospectus of technical committee on environmental electromagnetic engineering (its original version on December 20, 1977) [12].

Osamu Fujiwara received his B.E. degree in electronic engineering from Nagoya Institute of Technology, Nagoya, Japan, in 1971, and his M.E. and D.E. degrees from Nagoya University, Nagoya, Japan, in 1973 and 1980, respectively, both in electrical engineering. From 1980 to 1984, he was with the Department of Electrical Engineering, Nagoya University as a Research Associate, and from 1984 to 1985 as an Assistant Professor. In 1985, he joined the Nagoya Institute of Technology as an Associate Professor. In 1993 he became a Professor with the Graduate School of Engineering. In 2012 he retired and was awarded Emeritus Professor from National University Corporation, Nagoya Institute of Technology. His research interests include bioelectromagnetics and electromagnetic compatibility. He served as Chair of IEICE EMCJ from 2009–2010, IEEJ TEMC from 2002–2004, IEEE EMC Chapter of Japan Council from 2004–2005 and IEEE Nagoya Section from 2005–2006. Dr Fujiwara is a Fellow of the IEICE and the IEEJ, and an IEEE life member. He received IEEE EMC Society Honored Member Award in 2016, and is the recipient of Distinguished Paper Awards in 1980 and 2000 from the IEEJ and the IEICE, respectively, Technical Development Award in 2013 and Achievement Award in 2014 all from the IEEJ.