Achievements of QR Code Team

■ Recipients

QR Code Team

Members:

Masahiro Hara

Chief Engineer, DENSO WAVE INCORPORATED

Specially Appointed Professor, Nagoya Gakuin University

Motoaki Watabe

R&D Division, DENSO WAVE INCORPORATED

Takahiro Kurobe

Executive Director, DENSO WAVE INCORPORATED

Hiromitsu Takai

Expert, Solution Services Department, GS1 Japan

■ Citation

For the invention, practical implementation, and global spread of QR Code

■ Achievements

In the 1980s, barcodes (one-dimensional codes) were widely used in manufacturing, logistics, retail and other fields for identification, tracking, and managing items. However, as the number of parts managed at manufacturing sites increased during 1990s, the limited data storage capacity of conventional barcodes became a problem. QR Code (two-dimensional code), invented in 1994, addressed this challenge by enabling dramatically greater data capacity with fast, accurate scanning. Today, QR Codes are used in a wide range of fields—including distribution, manufacturing, payment, mobile authentication, and ticket management—and are contributing significantly to the digitalization and efficiency of both society and industry.

In 1992, Masahiro Hara, who was involved in the development of barcode scanners and optical character recognition (OCR) devices at DENSO CORPORATION, was given permission by his supervisor for the need to develop a new code to replace barcodes. He joined forces with Motoaki Watabe and two researchers from Toyota Central R&D Labs, and the project began with four people. At the time, two-dimensional codes had been developed in the United States, but none could satisfy all the necessary requirements: large data capacity, compact size, fast reading, and resistance to dirt or damage. Therefore, they aimed to develop a two-dimensional code with

advanced features not available in existing codes.

Hara chose a matrix type as the information storage method for the 2D code, which has a high information density and can be read from any angle. Position detection patterns are placed at the three corners of the code to quickly detect the code's position and serve as markers that can be recognized from the top, bottom, left, and right. To prevent misrecognition of the position detection patterns, Hara and Watabe identified the least commonly used ratio of black to white among printed materials, 1:1:3:1:1, and used this to determine the ratio of the widths of the black and white parts of the position detection patterns. In this way, they created a system that could determine the code's position and read it quickly from any direction. To make the code more suitable for use in the workplace, it was equipped with an error correction function that allows information to be read correctly even if it is dirty or damaged. It used a Reed-Solomon code that is resistant to burst errors, and by balancing this with the amount of information stored, it achieved a recovery rate of up to 30%. In August 1994, two years after the project began, a two-dimensional code was completed that could store large amounts of information, including alphanumeric characters and kanji, in a small space, was resistant to dirt and damage, and could be read in as little as 0.03 seconds. The code was named QR Code, an abbreviation of Quick Response, highlighting its most important feature: high-speed scanning. The subsequent QR Code Model 2 added an alignment pattern to enable reading even when the code is distorted and could store approximately 200 times as many characters as a barcode, or up to 7,089 numbers.

At the time, leading U.S. companies in 2D code technology declared their patents public domain and chose not to enforce them. The 2D Code was adopted as a standard by industry groups, and efforts to standardize it began. DENSO accelerated efforts to establish industry and international standards. Through lobbying with the automotive industry, QR Code was recognized as an industry standard. After becoming a standard of the Japan Automatic Identification Industry Association in 1996, QR Code was declared public domain, and in 1997 it was established as a standard of the International Automatic Identification Industry Association. Subsequently, efforts were made to standardize it at ISO/IEC. In 1998, a New Work Item Proposal (NP) was submitted to ISO/IEC JTC1/SC31. After discussions and verification by the Working Group (WG), QR Code standard was published as the international standard ISO/IEC 18004 in June 2000. Hiromitsu Takai was responsible for the standardization of QR Code and served as project editor for the ISO/IEC standardization process.

DENSO WAVE INCORPORATED made active efforts to promote and expand the market for QR Codes. Takahiro Kurobe was one of the key contributors to these promotional activities, helping to achieve global spread of the technology. QR Codes were initially used for factory production management and parts traceability. Their high versatility has been recognized across a wide

range of industries, including distribution, logistics, healthcare, electronic payments, electronic tickets, identity authentication, and personal information management, and their applications are expanding year by year. In Japan, QR Code reading services for mobile phones launched in 2002, and in 2006, ANA adopted QR Codes for e-tickets, helping to further establish them socially. QR Code payments have been widely adopted in China since 2011, with Alipay and WeChat Pay accounting for 85% of payment methods by 2020. In Japan, QR Code payments named "XX Pay" have become widespread and widely used since the late 2010s. QR Code payments are steadily expanding worldwide.

While new applications for QR Codes continue to be developed, the code itself has also evolved to meet social needs. Derivative types include the Micro QR Code, which can print about 20 alphanumeric characters in a 1mm-square micro-format; the SQRC, which can store encrypted private data for enhanced security; anti-counterfeit QR Codes to prevent ticket forgery; Frame QR, allowing integration of illustrations or logos; and tQR, used for platform door control at railway stations.

QR Code, by not only offering technological superiority but also promoting open patents and international standardization, has become a social infrastructure technology accessible to everyone worldwide. Its versatility and extensibility have enabled the creation and expansion of new applications in a variety of environments. QR Code technology has made enormous contributions to advancements in ICT and the creation of social value. DENSO WAVE, especially the QR Code Team, is highly regarded for its role in developing and spreading QR Code and is deemed fully worthy of the C&C Prize. Going forward, QR Codes are expected to continue to lead the creation of new application fields and innovations, contributing further to the advancement of society and industry.

*QR Code is a registered trademark of DENSO WAVE INCORPORATED.

■ Personal History and Major Awards

Masahiro Hara (Born in August 1957)

- March 1980 BS degree in Faculty of Engineering, Department of Electrical and Electronic Engineering, Hosei University
- April 1980 Nippon Denso Co., Ltd. (now DENSO CORPORATION)
- 2001 DENSO WAVE INCORPORATED
- January 2012 AUTO-ID Business Division, DENSO WAVE INCORPORATED
- August 2017 Chief Engineer, DENSO WAVE INCORPORATED
- October 2023 Visiting Professor, University of Fukui (concurrent)

- April 2024 Specially Appointed Professor, Nagoya Gakuin University (concurrent)

Motoaki Watabe (Born in October 1965)

- March 1984 Aichi Prefectural Toyokawa Technical High School (currently Toyokawa Technical High School), Department of Electronics
- April 1984 Nippon Denso Co., Ltd. (now DENSO CORPORATION)
- March 1985 Nippon Denso Academy (now DENSO Technical Academy)
- October 2001 DENSO WAVE INCORPORATED
- July 2011 Development Department (currently Technology Development Department), DENSO WAVE INCORPORATED

Takahiro Kurobe (Born in August 1972)

- March 1995 Faculty of Law, Keio University
- April 1995 Nippon Denso Co., Ltd. (now DENSO CORPORATION)
- From 1995 Engaged in market development, promotion, and marketing for “QR Code”
- 2001 Responsible for business planning, product planning, sales, etc. at DENSO WAVE INCORPORATED
- Present Executive Officer responsible for corporate planning and human resources/general affairs at DENSO WAVE INCORPORATED

Hiromitsu Takai (Born in January 1956)

- March 1979 Faculty of Engineering, Department of Information Science, Kyoto University
- April 1979 Nippon Denso Co., Ltd. (now DENSO CORPORATION)
- From 1981 Engaged in the design and development of barcode readers
- From 1996 Engaged in standardization and promotion of “QR Code”
- 2001 DENSO WAVE INCORPORATED
- 2021 GS1 Japan

[Major Awards]

Year	Award	Recipient(s)
2004	Mobile Project Award, Mobile Solution Category, Grand Prize	Takahiro Kurobe, Masahiro Hara, Motoaki Watabe, others
2007	Japan Innovator Award	Masahiro Hara
2009	METI Standardization Contributor Award, Director-General's Award, Industrial Science and Technology Policy and Environment Bureau	Hiromitsu Takai

2012	Good Design Award Best 100	DENSO, DENSO WAVE
2014	European Inventor Award, Popular Prize	DENSO WAVE: Masahiro Hara, Motoaki Watabe, Tadao Nojiri; Toyota Central R&D Labs: Takayuki Nagaya, Yuji Uchiyama
2016	Standardization Contributor Award (Japanese Industrial Standards Committee)	Hiromitsu Takai
2016	IEC 1906 Award (International Electrotechnical Commission)	Hiromitsu Takai
2020	The Ichimura Prize in Industry for Outstanding Achievement	DENSO WAVE: Hiroyasu Nakagawa, Masahiro Hara, Motoaki Watabe
2021	Good Design Award, Long Life Design Award	DENSO, DENSO WAVE, Masahiro Hara
2022	IEEE Milestone	DENSO, DENSO WAVE
2022	IEEE Corporate Innovation Award	DENSO
2023	Japan Academy Prize and Imperial Prize	Masahiro Hara
2024	Chunichi Culture Award	Masahiro Hara
2024	Japan Automotive Hall of Fame Inductee	Masahiro Hara