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Editorial Note

Engineering the Quantum Era: From the Discovery of the Nobel Prize to a Technology Platform

Yudan Whulanza[1*], Eny Kusrini[2,3,4], Ruki Harwahyu[5], Ismi Rosyiana Fitri[5], Muhamad Asvial[5], Arun Kumar Sangaiah[6], Nofrijon Sofyan[7], Sri Harjanto[7], Akhmad Herman Yuwono[7]

[1]Department of Mechanical Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

[2]Department of Chemical Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

[3]Green Product and Fine Chemical Engineering Research Group, Laboratory of Chemical Product Engineering, Universitas Indonesia, Kampus Baru UI, Depok, 16424, Indonesia

[4]Advanced Materials Research Center, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok, 16424, Indonesia

[5]Department of Electrical Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

[6]National Yunlin University of Science and Technology International Graduate Institute of Articial Intelligence No. 123, Section 3, Daxue Rd, Douliu City, Yunlin Country, 64002, Taiwan (ROC)

[7]Department of Metallurgical and Materials Engineering, Faculty of Engineering, Universitas Indonesia, Kampus Baru UI, Depok 16424, Indonesia

[*]Corresponding author's email: yudan.whulanza@ui.ac.id; Tel.: +62-217270032; Fax.: +62-217270033

The 2025 Nobel Prize in Physics 2025 delivered a message with immediate relevance for engineers: quantum behavior can be realized in engineered circuits. John Clarke, Michel H. Devoret, and John M. Martinis "for the discovery of macroscopic quantum mechanical tunneling and energy quantization in an electric circuit." This recognition is not only a milestone in fundamental physics but also a clear signal that quantum phenomena can be approached through design choices, fabrication routes, measurement strategy, and system integration—the everyday language of engineering research. For an engineering community, the significance is not simply what was discovered but how it reframes participation. Once a circuit exhibits tunneling and discrete energy levels, quantum science becomes more than a theoretical construct: it becomes something that can be specified, tested, and iteratively improved. The frontier that opens here is not a claim that quantum systems are "solved," but that they are increasingly engineerable, and therefore, reachable when physics is translated into performance metrics, process discipline, and reliability thinking.

Where engineers enter the quantum field

Quantum circuits operate in the microwave regime, and their performance critically depends on the resonator design, coupling, impedance environment, filtering, shielding, and amplification. In practice, the "quantum" part is inseparable from radio frequency (RF) engineering decisions that shape readout fidelity and stability (Kurniawati et al., 2023; Rahayu et al., 2021; Sholeh et al., 2020).

Materials science and surface/interface engineering Practical device limits are often traced to surfaces, interfaces, thin films, and microscopic defects. This places deposition, cleaning, passivation, metrology, and microstructural control at the center of progress. This is mostly because improved material quality can translate into improved coherence and consistency (Whulanza et al., 2015; Udhiarto et al., 2014; Suwandi et al., 2014).

Micro/nanofabrication and manufacturing quality. Once quantum systems become circuits, they inherit manufacturing realities: process windows, run-to-run variation, wafer-level screening, and yield learning. Therefore, quantum engineering requires the same discipline used in

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advanced manufacturing, such as statistical process control, failure analysis, and design-for-manufacture (Rahman et al., 2025; Suwandi et al., 2019; Whulanza et al., 2014).

Cryogenics, instrumentation, and metrology Experiments requiring extreme environmental control and precision measurement The transcript's emphasis on instrumentation as a pathway to quantum insight reflects a key point: cryogenic integration, packaging, calibration, and low-noise measurement are not peripheral. They often determine what phenomena can be observed and what performance can be validated (Herbirowo et al., 2023; Hernandez-Vasquez et al., 2023).

Control, computer engineering, and software-defined (SD) experimentation. The operation of quantum hardware requires layered control stacks: waveform generation, timing synchronization, feedback, calibration routines, and automation. As noted in the transcript, this work sits near the "bottom" of a computing stack. However, the system value depends on how engineers integrate diagnostics, control, and reliability practices into repeatable workflows (Siregar et al., 2025; Y. N. Nugroho et al., 2023; H. A. Nugroho et al., 2023).

Reliability, noise engineering, and system integration The "enemy" of engineered quantum behavior is electromagnetic, thermal, material, and even packaging-related noise. Noise modeling, root-cause analysis, and reliability frameworks are as important as physics derivations. Scaling also introduces the following system-level questions: interconnects, shielding, crosstalk, modularity, maintainability, and qualification protocols (Chaiyachet et al., 2025; Putri et al., 2025; Kusumalestari et al., 2024).

For the IJTech community, this is an invitation to contribute with methods already familiar in other technology domains, such as materials optimization, process development, design-for-manufacture, reliability engineering, and system integration. Therefore, the emerging identity of "quantum engineering" is not an add-on to physics; it is a convergent space where multiple disciplines can drive measurable progress.

This issue

The contributions gathered here show how design methods, new materials, energy and environmental studies, advanced manufacturing and industrial systems, communication technologies, and digital intelligence can be directed toward pressing societal needs. Taken together, they demonstrate actionable ways for industry to advance sustainable development while strengthening broader societal well-being.

The first study, written by Kurihara et al., 2026, proposes a fiber-optic bending sensor that combines optical frequency-domain reflectometry with two-photon absorption in a silicon avalanche photodiode. This study localizes multicore Bragg gratings and measures their reflection spectra simultaneously using a single detector and chirped intensity modulation. Experiments show accurate curvature estimation with 25 s measurement time for real-time bending sensing (Kurihara et al., 2026).

The second study, written by Koura et al., 2026, proposes an efficient block partitioning method for spatial scalable encoding in Versatile Video Coding. The method reuses block boundary and area information from the base layer to restrict partition candidates in the enhancement layer. It cuts enhancement-layer encoding time by about 55% with at most a 3.45% BD-rate increase for scalable video streaming (Koura et al., 2026).

The third study, written by Safitri et al., 2026, designs and simulates an EV charging station integrated with a 2.5 kW grid-connected PV microgrid using fuzzy-controlled charging. This study compares uncontrolled, controlled, and delayed smart-charging scenarios using MATLAB/Simulink models. It shows that smart charging increases PV utilization from 68% to 84% and extending battery life (Safitri et al., 2026).

The fourth study, written by Tyas et al., 2026, reviews methods and developments in nuclear power plant safety assessment, emphasizing probabilistic and deterministic approaches and their applications to evolving reactor designs. This study maps research gaps in initiating event identification, human reliability, fire risk integration, time-trend analysis, and computational efficiency. It proposes strategies, validation frameworks, and capacity building tailored to

Indonesia's future NPP program (Tyas et al., 2026).

The fifth study, written by Ardi et al., 2026, develops a hybrid PLS-SEM and ANN model to predict consumers' purchase intention toward recycled PET products. This study links environmental literacy, moral obligation, and willingness to pay and tests generational differences. It finds willingness to pay as the dominant driver for literacy, ethics, and perceived control (Ardi et al., 2026).

The sixth study, written by Bimbi et al., 2026, investigates overlapping strategies in rotary TIG directed energy deposition for cladding steel. This study varies electrode position, current, and rotation, combining 3D scanning to model bead geometry and molten pool behaviour. It shows that rotating electrode configurations achieve flatter surfaces with lower heat input (Bimbi et al., 2026).

The seventh study, written by Nugraha et al., 2026, develops a coaxial magnetic induction (CMI) sensor as a radiation-free alternative to radiographic testing for weld defect detection in steel pipes. This study combines multiphysics simulation and laboratory experiments on plates and pipes with 0.5–2.0 mm artificial flaws. It demonstrates reliable sub-millimeter defect detection with low variability and clear separation between defective and sound welds (Nugraha et al., 2026).

The eighth study, written by Matteb et al., 2026, presents the design and dynamic modeling of a quadruped robot to analyse vertical ground contact forces on hard and soft surfaces. This study develops a five-bar leg mechanism in MATLAB, fabricates an ABS prototype with force sensors, and validates simulations against experiments. It reports peak forces, experiment error, and efficient legged locomotion (Matteb et al., 2026).

The ninth study, written by Cancino-Gómez et al., 2026, analyses how usability, humanization, and perceived service quality shape customer satisfaction in AI-driven chatbot interactions. This study surveys 423 Millennials in Colombia and applies covariance-based SEM to test a unified model. It finds that all three factors strongly and significantly predict satisfaction of its variance and high-quality chatbot services (Cancino-Gómez et al., 2026).

The tenth study, written by Li and Yamada, analyses how seasonal stratification and depth-specific temperature affect chub and Japanese Spanish mackerel yields in the Bohai Sea. Using Grey Relational Analysis and Bayesian GLMM, this study links SST/SSS at 0–50 m with fishing effort and lagged catches. It finds that 50 m temperature, surface salinity, and their interactions with vessel power strongly shape species-specific productivity under climate change (M. Li and Yamada, 2026).

The eleventh study, written by Septiningrum et al., 2026, examines how pH adjustment sequence in green synthesis with Jatropha extract shapes TiO_2 nanoparticle structure for dye-sensitized solar cells. This study compares pre- and post-pH adjustment routes at various pH and links crystallite size to photovoltaic performance. It shows that pre-adjusting to pH 3 yields the smallest crystallites and outperforms commercial TiO_2 (Septiningrum et al., 2026).

The next study, written by Nasruddin et al., 2026, investigates partial replacement of fine aggregate with HDPE plastic waste in 20 MPa concrete using melt processing and water quenching. This study tests 0.50–0.90% substitutions and evaluates 7 and 28-day compressive strength. It finds that water-quenched HDPE at 0.50% gives the highest strength while promoting sustainable plastic reuse (Nasruddin et al., 2026).

The thirteenth study, written by Ginting et al., 2026, redesigns a dental mouth prop to improve comfort, stability, and cost efficiency. This study integrates Quality Function Deployment and Value Engineering to translate dentist and patient requirements into design changes, prioritizing a width-adjustable screw-jack mechanism. It replaces all-silicone construction with a PMMA support and TPE bite surface, improves load distribution in simulations, and reduces material costs by 21% (Ginting et al., 2026).

The fourteenth study, written by K. Li and Jing, 2026, conducts a whole-process cost–benefit analysis of importing fully prefabricated steel structure buildings from China to New Zealand versus locally produced and conventional concrete construction. Integrating life-cycle costing

with grey relational analysis across design, production, transport, and installation. It finds Chinese imports offer 25–35% lower unit costs and supporting greener, more affordable housing delivery (K. Li and Jing, 2026).

The fifteenth study, written by Alie et al., 2026, proposes an analytical approach to assess hull-girder ultimate strength while accounting for the side-hopper angle in Indonesian rules. This study applies Smith's progressive collapse method to oil tanker and bulk carrier cross-sections under hogging and sagging. It shows that changing the side-hopper slope from 45° to 35° has negligible effects on tankers (Alie et al., 2026).

The sixteenth study, written by Ibrahim et al., 2026, investigates early post-operational land value capture potential around Jakarta's Dukuh Atas–Cawang Light Rail Transit (LRT) corridor. This study applies a hedonic price model and multiscale geographically weighted regression to 97 residential listings within 1 km of stations. It finds that building size and proximity to schools currently drive land prices (Ibrahim et al., 2026).

The seventeenth study, written by Kothadiya et al., 2026, proposes an ensemble deep learning framework that combines U-Net MRI segmentation with a Graph Attention Network (U-GAT) for Alzheimer's disease detection. This study leverages OASIS MRI data, data augmentation, and probability averaging to classify dementia stages. It achieves 96% accuracy, outperforming CNN and other U-Net ensembles (Kothadiya et al., 2026).

The eighteenth study, written by Nishi et al., 2026, proposes ZO-FedSGD, a zeroth-order stochastic gradient descent method for communicationefficient federated learning. This study replaces high-dimensional gradient exchanges with scalar two-point function evaluations and shared random seeds, making communication cost independent of model size. Experiments on MNIST show that ZO-FedSGD cuts communicated parameters by two orders of magnitude (Nishi et al., 2026).

The next study, written by Murakami et al., 2026, engineers the model diatom Phaeodactylum tricornutum to biosynthesize prostaglandins by heterologously expressing cyclooxygenase genes. This study combines protein structural modelling, transformation, qRT–PCR, and LC–MS/MS to compare COX activity. It shows that Trcox expression enables mixed PG2/PG3 production for sustainable prostaglandin biomanufacturing (Murakami et al., 2026).

The twentieth study, written by Dowaki et al., 2026, develops cell detection methods to enhance the sorting rate of a millifluidic large-cell sorter. This study replaces camera-based image processing with an analog fluorescence detection circuit using a CdS photosensor and Darlington transistors to trigger on-the-fly switching. It boosts detection from 1.6 to 2.85 cells/s and points toward >10 cells/s high-speed sorting of millimeter-scale cells (Dowaki et al., 2026).

The twenty-first study, written by Chen et al., 2026, investigates multicomponent liposomal formulations co-encapsulating vitamin C with vitamin D3 and calcium aspartate with vitamin D3 for improved nutrient delivery. This study characterises vesicle morphology, encapsulation efficiency, six-month stability, and simulated digestion. It reports stable spherical nanoscale liposomes with high vitamin D3 retention will support enhanced bioavailability of hydrophilic–lipophilic nutrient combinations (Chen et al., 2026).

The last study, written by Abed et al., 2026, investigates reliable multi-class knee osteoarthritis classification from OAI X-ray images using fine-tuned CNNs. This study compares eleven deep models and ensemble strategies to classify normal, moderate, and severe stages. It shows robust AI-assisted tool for clinical decision support (Abed et al., 2026).

New technologies and expanding scientific knowledge are changing the way we tackle the toughest challenges in society. As the pace of change accelerates, innovation is needed not only to deliver solutions but also to shape the direction of future progress. IJTech welcomes contributions that share fresh results, practical insights, and thoughtful perspectives.

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