History of the Electronics (Engineering) Design Center (EDC)

By

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The Electronics Design Center, or Engineering Design Center as it was originally known, was established in 1959, by a group of faculty who hoped to create an interdisciplinary research center on the campus of Case Institute of Technology which now part of Case Western Reserve University. A grant from the Ford Foundation assisted in establishing the Engineering Design Center, creating a goal-oriented research and development program which carried research projects from concept and design through to prototype construction and evaluation. Prior to the actual construction to the laboratories, a fundamental philosophy was established by the faculty of the Electronics Design Center. These philosophical principles were:

Philosophical Principles of the Engineering Design Center

Design is the Essential Purpose of Engineering – It begins with the recognition of a need and the conception of an idea to meet this need. It proceeds with the definition of the problem, continues through a program of directed research and development, and concludes its first phase with prototype construction and evaluation.

Design is a Creative Activity. It involves bringing into being something innovative and useful that has not existed previously. This total job is becoming more challenging and difficult as the demands of society require the engineer to deal with increasingly complex systems.

Design is an Interdisciplinary Education. Students actively participating in professional design experience the interaction and cooperation of many academic disciplines.

Based on these philosophical principles and recognizing the inter-disciplinary nature of research, the Engineering Design Center (EDC) was created at Case Institute of Technology in 1960.

The EDC became the site of the first cleanroom for microelectronics fabrication built on a university campus (known as “the bubble”) in 1962. This was just one of the many first accolades that the EDC received over its long and varied history in seminal academic and practical research and development endeavors.

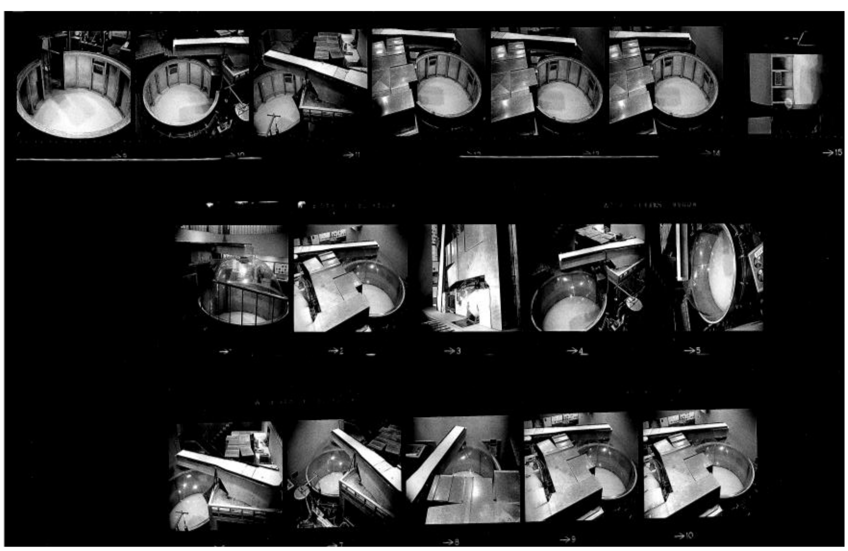

Figure 1 shows selected details of the construction of the “bubble” cleanroom. It was in the basement of the Bingham Building and remained in that location until 1999. It was fully functional and in use up to the mid-1990 because cleanroom space for micro-electronics assembly remained limited. The EDC constructed a 5,000 square feet Class 100 Cleanroom on the 3rd floor of the Bingham Building in 1989 to accommodate research and development activities that required a higher degree of environmental control and cleanliness.

The type of design and concept research conducted in the EDC have changed over its 60-year history. Consequently, the advancements in technology and the research interests and focuses of the CWRU faculty led to unique innovations in the research areas and needs from monitoring apparatus for newborn infants to microfabricated fuel cells to miniature sensors to the detection of biomarkers of cancer and other diseases. Biomedical related research was a long established multi-disciplinary focus of study in the Center, including early work in electrical stimulation systems to aid those with mobility problems.

Timeline of the History of the Engineering Design Center.

1959 – Establishment of Engineering Design Center

A five million dollars over five years grant from the Ford Foundation provided the foundation of a goal oriented, inter- and multi-disciplinary research and development center. The center was to be research and development oriented, with an emphasis on professional and practical design. The focus was on a teamwork approach which brought students, technical staff, faculty, and industrial engineers together to work on industrial and academic experiments.

1959 – 1963 – Initial Phase of Engineering Design Center

In this initial period, major research and development efforts in EDC were:

- Medical Engineering – Arm Aid (Prostheses, Hall Effect Transducers)
- Digital Systems – Control Systems
- Solid State Electronics – Telemetry (EMG, EKG) devices
- Engineering Syntheses and Optimization
- Aerospace and Industrial Thrust – 10-5 g, Control Systems, Fluid Logic

Figure 2 shows the testing of an Aerospace Control Systems developed in the early years of the EDC.

1964-1970 – Growth Period of Engineering Design Center

Additional research grants from various Federal, state, and private foundations as well as industrial support to the faculty and the projects allowed the expansion of the research and development efforts in this period. Major research activities in the Center included:

- Medical Engineering
    - Prostheses - Arm Aide, Hand Study
    - Biomechanics – Tissue Properties (electrical and mechanical)
    - Dental – Mechanics of Mastication (instruments and study)
    - Microelectronic Laboratory for Biomedical Sciences (1966-1981 grant from National Institute of General Medical Sciences aimed at applying solid state electronics to biomedical instrumentation)
- Digital Systems – Logic Synthesis, Speech Analysis, Optimum Rocket Control
- Solid State Electronics
    - Clean Room and Facilities
    - Telemetry – K-1, K-5 and multiplex systems
    - Thin Film Material Study
    - MOS (metal oxide semiconductors) – Capacitors and Technology
- Engineering Syntheses
    - Elementary Systems – Air Foil, Spring-Damper
    - Interrelation between Synthesis, Analysis and Design Philosophy
    - Operational Synthesis Capability
    - Synthesis Techniques
- Control System – Fluid logic devices and systems, Control System Design
- Urban Transportation

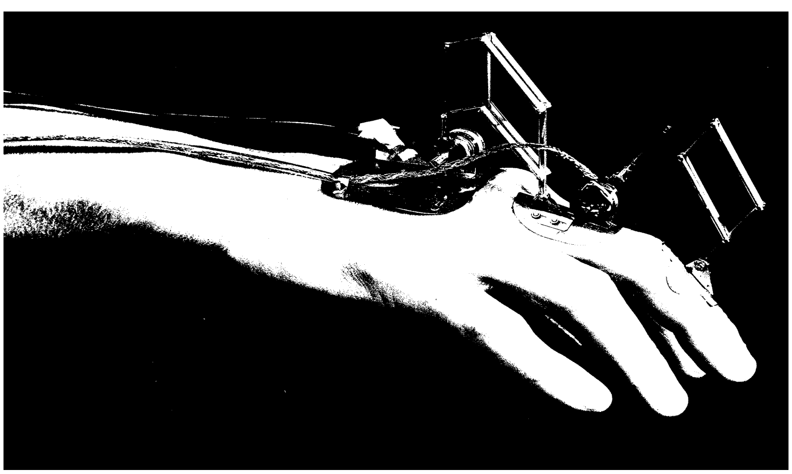

Figure 3 shows a device to study the hand movement providing the base of the development of a prosthetic system

1970-1976 – Transition Period of Engineering Design Center

The advance of the technology and the changes in practical needs and demands modified the research and development efforts of the Center. Emphasis and focus shifted towards more biomedical engineering applications and, solid-state and integrated circuit technology in this period. Major research activities in the Center were:

- Medical Engineering
  - Cybernetic Systems, Arm Aide, Hand Study, Pain Suppression, Percutaneous Electrodes
  - Biomechanics
  - Dental
  - Artificial Kidneys
- Solid State Electronics
  - Integrated Circuit Technology – Metal Oxide Semiconductor Varactor
  - Active Electrodes
  - Transducers
- Control System – Fluid logic devices

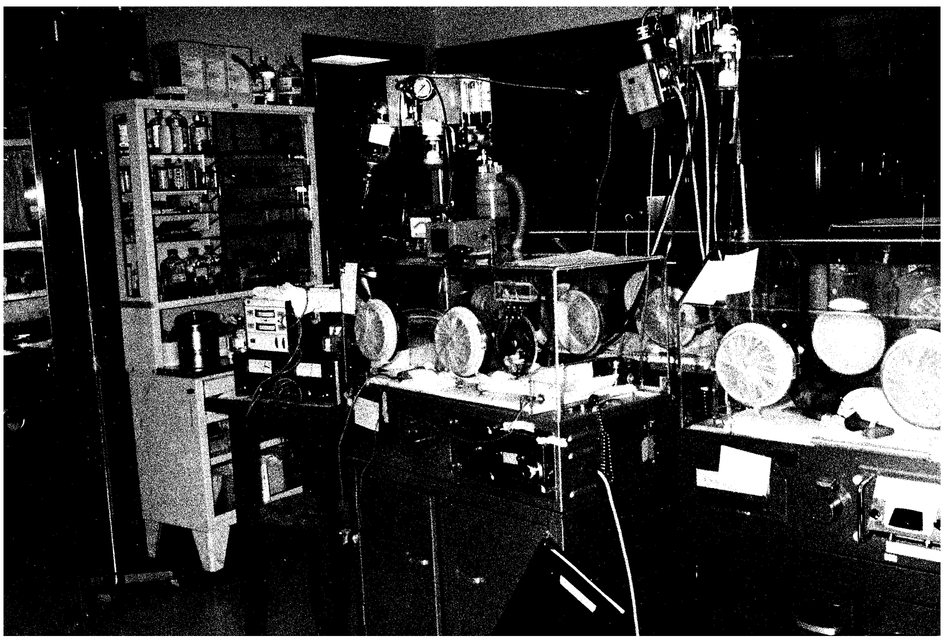

Figure 4. The facility for the special-needed newborns and sick infants in the intensive care division of the Cleveland Metropolitan General Hospital

Special Care Nursery
Cleveland Metropolitan General Hospital – circa late 1970s
Research and development of an electronic monitoring of the premature and sick newborn was conducted by the faculty, staff, and students in the Microelectronics Laboratory for Biomedical Sciences in the Engineering Design Center. This project involved the special care nursery at Cleveland Metropolitan General Hospital, an intensive care facility for newborn babies. The facility maintained temperature and humidity controlled isolettes with special services such as oxygen, suction, electrical power, infusion and electronic monitoring of temperature, blood pressure, respiration rate, and heart rate available at each isolette.

Dr. M.R. Neuman of EDC was the PI of this multi-disciplinary research endeavor.

1977-1981 – Expansion Period of Engineering Design Center

EDC and its faculty, as well as CWRU, were recognized as the foremost innovative and collaborative investigators in research and development related to biomedical electronic applications. Thus, the Division of Research Resources of NIH provided a 5-year grant (1977-1982) to establish a nationwide Biomedical Electronics Resource at the EDC. In recognition of the new mission of the Center, the name of the Engineering Design Center changed to the Electronics Design Center (1981-1982) emphasizing on biomedical electronics applications.

Figure 5 shows a High-Sensitivity Integrated-Circuit Capacitive Pressure Transducer – fabricated at the EDC in the early 1980s by a faculty member and the Director of the Center at that time, Dr. Wen H. Ko, for potential biomedical applications.

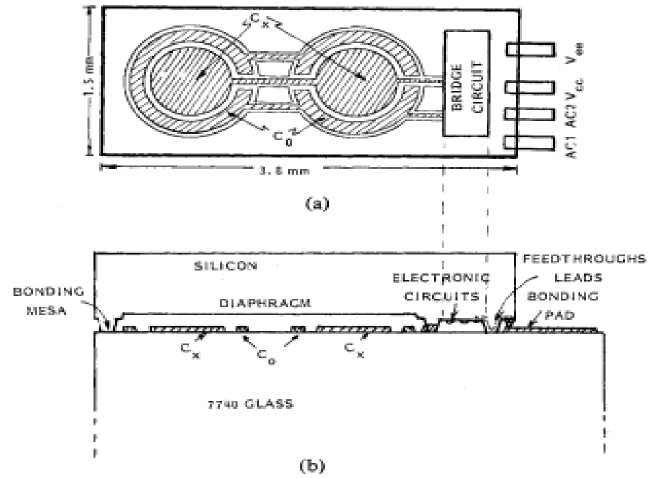

Fig. 8. Structure of the capacitive pressure transducer CP7. (a) Top view. (b) Cross section.

1983-1985 – Second Phase Expansion of Electronics Design Center

Keeping up with the continued rapid change in technology, new research and development interests increased in this period as well as the continuation of many previous principal areas of research. Biomedical related interests focused more heavily on sensors and transducers in the Center. Integrated circuit technology and solid-state electronics were used to design and fabricate miniature, high performance transducers especially pressure sensors. Pressure sensors for monitoring bladder pressure for use in bladder functional stimulation and monitoring cerebrospinal fluid control systems underwent extensive development during this time.

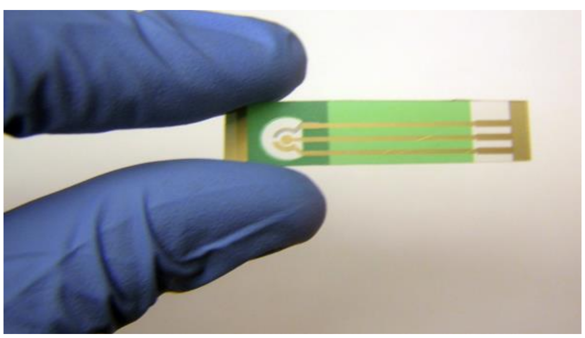

Figure 6 shows a Single-Use, In Vitro Biosensor for the Detection of T-Tau Protein, A Biomarker of Neuro-Degenerative Disorders, in PBS and Human Serum Using Differential Pulse Voltammetry (DPV) by Chemical Engineering faculty member and Director of the Center at that time, Dr. C.C. Liu for potential biomedical applications.

1985-2022 – Third Phase Expansion of Electronics Design Center

The EDC emphasized producing devices by thick and thin film microfabrication technologies. Both fabrication techniques were used for the development of microfabricated electronic devices, sensors, and transducers. These methodologies were utilized to develop tiny, sensitive, silicon Schottky diode hydrogen sensors for NASA, a sensor suite for detecting the degradation of lubrication oil and small hydrogen powered fuel cells. One main area of study was the development of single use, disposable biosensors for the detection of neuro-degenerative disorders, prostate cancer, and the screening for types of liver diseases.

In this period, advanced biochemical immobilization and gene editing techniques, such bioconjugation methods and CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) were employed to develop biosensing systems for various biomarker(s) of cancer and diseases. These biochemical techniques combined with silicon based thick and thin film microfabrication manufacturing methods produced industrial scale, practical, single-use, disposable biosensing systems for biomedical applications.

2022-Present – Fourth Expansion and Current Phase of Electronics Design Center

The EDC remains an especially important academic and research center for multi-disciplinary and innovative research and development enterprises at CWRU. It provides unique equipment and facilities and technical staff support, as well as faculty mentoring and advising. Dr. Rohan Akolkar of the Department of Chemical & Biomolecular Engineering is the current Director of the Center. New research and development directions focus on electrochemistry and electrochemical engineering, microelectronic materials, and fabrication processes.

Figure 7 shows the Current EDC Class 1000 – Thin Film Deposition Cleanroom facility.

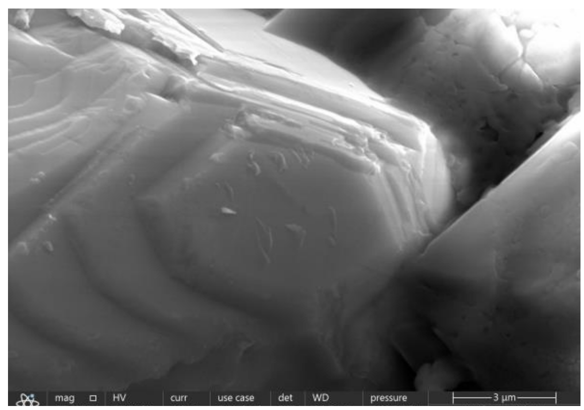

Figure 8 – a picture of current EDC research, Neodymium deposits produced using molten salt electrolysis