

Name: GREG L. OWEN, P.E.

Title: Cleanroom Design Principal

Education: B.S., 1974, Mechanical Engineering, Purdue University

Registration: Professional Engineer, Pennsylvania, Maryland, Colorado
Professional Mechanical Engineer, Idaho, Oregon

Affiliations: American Society of Mechanical Engineers
National Society of Professional Engineers



I have over 40 years' experience in project management, engineering management, design and construction of facilities in the semiconductor, food, pharmaceutical, industrial, and advanced technology areas. I have held design and construction positions as a Cleanroom Planning and Design Consultant, Project Engineer, Project Manager, and Engineering Manager.

Representative assignments include:

- University of Texas at Austin Montopolis Cleanroom Project, Technical Consultant to the Universities Planning, Design and Construction Group addressing cleanroom design and construction issues related to the Montopolis Project.
- University of Texas at Austin Montopolis Cleanroom Project, Technical Consultant to the Universities Planning, Design and Construction Group addressing cleanroom design and construction issues related to the Microelectronics & Engineering Research Center Cleanroom Expansion Project
- University of Texas, Arlington Montopolis Cleanroom Project, Cleanroom Consultant responsible for the development of a basis of design document for upgrading the existing 1988 Cleanroom (originally built for Sematech) for use by the University for research in advanced packaging technologies.
- Penn State University, State Collage, Pennsylvania, Cleanroom consultant for the CHIMES project Programming, Schematic Design, Design Development, and providing technical guidance Construction Documentation Preparation. Provide Cleanroom related Bid evaluation and Services During Construction addressing cleanroom related issues. Project involved the addition of 2300 sf of class 10, 100 and 10,000 cleanroom space to the existing Millennium Science Center Cleanroom and the renovation of 4300sf of abandoned research laboratories in the West Electrical Engineering building into a class 100/1000 bay and chase cleanroom.
- Leonardo Electronics, USA, Inc Tucson,, AZ, Cleanroom Consultant, provided an assessment of the if the existing cleanroom facility, warehouse and associated spaces to determine upgrades required to provide the manufacturing environment needed to support the manufacturing process and assess viability of on-site expansion.
- Leonardo Electronics, USA, Inc Oro Valley, AZ. Cleanroom Consultant for the Design of a green field Approximately 120,000 SF facility support corporate management, Research / product development and vertically integrated manufacturing of Laser Diodes and component systems starting with bare wafers and culminating with a tested component for installation in a larger system by others. The Facility consists of three distinct clean room areas, a 16,450SF H5 Occupancy Wafer Fab Cleanroom with Class 100, 1000 and 10,000 spaces, 6,700SF B Occupancy Clean Electronic assembly and testing with Class 100 and 1000 spaces and a 5700SF B Occupancy final product assembly / test area with isolated Class 10,000 test cells. The facility uses multiple gas and liquid pyrophorics' as well as unstable

reactives' requiring unique and isolated storage. Also, Sensitivities in the manufacturing and assembly process required that the air stream for portions of the facility be isolated to preclude molecular contamination.

- University of Colorado, Anschutz Health Sciences Building, Colorado Center for Personalized Medicine & Behavioral Health: Cleanroom Consultant for the Compounding Pharmacy Cleanroom Suite (ISO Class 5 or Better) designed and constructed to meet the requirements of USP General Chapter 800, Hazardous Drugs – Handling in Health Care Settings.
- Linear Coherent Light Source (LCLS) Project, U.S. Department of Energy (Stanford Linear Accelerator Center), California. Cleanroom Consultant and Engineering Manager for preliminary design, development of construction documents, and construction support services associated with construction of a \$250 million facility that delivers coherent laser radiation in the x-ray region of the electromagnetic spectrum ten billion times greater in peak power and peak brightness than any existing x-ray light source. The LCLS facility includes extensive site modifications, along with an underground research tunnel in excess of 1000 meters long. Along the tunnel are research hatches, administrative space for 200 scientists and support staff, and utility systems required to maintain tight temperature tolerances ($\pm 0.2^{\circ}\text{C}$) in portions of the underground facility. As a result of the intended use of this facility, tight seismic and radiological design criteria were followed in conjunction with design activities.
- nLIGHT, a Laser Manufacturing Facility Located in Vancouver, Washington. Evaluation of facility for compliance with the Factory Mutual design Guidelines and Building / Fire Code compliance related to the Storage and Dispense of Hazardous Chemicals.
- Chamber A Clean Air System, Johnson Space Center, Houston, Texas. Cleanroom Consultant and Project Manager for Chamber A modifications for testing the James Webb Space Telescope including design and testing activities performed under a phased approach in order to modify and utilize Chamber A HVAC Systems located in Building 32 of the Johnson Space Center. The Project involved development of a system to provide Class 3 cleanliness inside an existing cryovac test chamber under atmospheric conditions.
- National Ignition Facility, Lawrence Livermore National Laboratory. Provided third party review of HVAC system design and Cleanroom design for Laser Assembly Area.
- Carnegie Mellon University (CMU), Scott Hall Nano-Bio-Energy-Technologies Building, Pittsburgh, Pennsylvania. Cleanroom Consultant for tool support systems and tool engineering services for the Claire and John Bertucci Nanotechnology Laboratory. The energy efficient facility contains Class 10 and 100 Cleanroom environments and is LEED Gold certified. Provide industrial interior design for the cleanroom and chemical and gas storage and dispensing rooms with incidental engineering. This included cleanroom Architectural concept, recirculation air system – ceiling plenum and recirculation fans; gas distribution devices (gas cabinets, VMBs, gas panels, and cylinder restraints); ultrapure stainless-steel piping specification and line sizing – cleanroom cylinder gases only. Provide design support for the development of the shell and allocation of footprint during programming and schematic design, moving to more detailed work products in design development and then to detailed construction documents. Support during the bidding phase of the project and during execution of construction.
- University of Chicago Pritzker Nanofabrication Facility, part of WERC Institute of Molecular Engineering, Chicago, Illinois. Project Engineer. A design-build research cleanroom project with a local contractor. We provided full tenant improvement design for a 10,000SF cleanroom with 6,000SF of support area within a multi-story research facility being designed concurrently by others. A BIM based design was developed over a five-month period in close cooperation with the user group and base building design team. Responsible for providing design guidance for Jacobs' design leads as well as the client user group from experience on many other similar projects. Overall responsibility for including contract scope into the

design, coordinating design between disciplines and quality control. This Design-Build Project included a bay-and-chase, low wall return design cleanroom with over 12,000 GSF in area and ranging from class 1,000 to class 100 performance

- Khrisna P. Singh Center for Nanotechnology, Philadelphia, Pennsylvania. Design Manager. Architectural and engineering peer review of new 65,000 SF, 3-story and basement nanotechnology facility consisting of 6,200 SF research and development labs, 9,200 SF cleanroom area (bays and chases), HPM storage rooms, atrium (galleria), lobby areas, conference rooms, and office support areas. Responsibility included performing comprehensive technical reviews of the A/E design, with emphases on code compliance, constructability, and cost reduction of the Design Development documents.
- Rice University, Houston Texas: Architectural and Engineering peer review for new Nanofabrication cleanroom suite and associated areas to be constructed in the Space Science & Technology building on the Houston Campus. The cleanroom suite and associated spaces occupy 5,900 SF of the building, including 2,500 SF of "B" Occupancy Class 1000 cleanroom area located in the basement of the building and 535 SF of ground floor level HPM storage rooms. Responsibility included performing comprehensive technical reviews of the A/E design, with emphasis on Value Engineering, Function capabilities, code compliance, constructability, and energy efficiency of the design as indicated in the Design Development documents. Served as the third-party reviewer of the Mechanical / Electrical / Process design development construction documents for the project.
- City University of New York, Research Building, Nanotech Research Cleanroom. Cleanroom Consultant with the University, Lab Planner, Project Architect and Engineering consultants on the design of the Nano Science cleanrooms (Class 1000 / 100). Activities included Development of cleanroom concepts and air management systems, Tool Utility Matrix development, Conceptual development of Process Support systems and development of design approaches to address Code Compliance, HPM delivery, storage and dispense with-in the confines of the new CUNY building being constructed in Manhattan.
- University of California, Los Angeles, California Nanosystems Institute, Court of Sciences, Los Angeles, California. Cleanroom Consultant with the Lab Planner, Project Architect and Mechanical Engineer in the design and construction of the facilities Material Science and Biological cleanrooms (Class 10 / 100). Activities included Development of cleanroom concepts and air management systems, Tool Utility Matrix development, draft HMMP Preparation and development of design approaches to address HPM delivery, storage and dispense with-in the confines of the UCLA Campus setting.
- University of Houston, Science and Engineering Classroom Building, Nanotech Research Cleanroom. Cleanroom Consultant with the Lab Planner, Project Architect and Mechanical Engineer in the design and construction of the facilities Material Science cleanrooms (Class 1000 / 100). Activities included Development of cleanroom concepts and air management systems, Tool Utility Matrix development, Conceptual development of Process Support systems and development of design approaches to address HPM delivery, storage and dispense with-in the confines of the U of H Campus setting. Site observations during construction and cleanroom specific contractor submittals were reviewed and final facility acceptance recommendations were provided.
- University of Texas – Austin, Engineering Education and Research Center. Cleanroom Consultant providing full, all discipline schematic design and design review for the 1400sf class 1000 and 10,000 Instructional Cleanroom.
- University of KwaZulu – Natal, Durban, South Africa. Cleanroom consultant providing full, all discipline schematic design, design development and design review for a 700sf class 10,000 Soft Litho / Microfluidics cleanroom located in the K-Rith Medical Research Building. The

GREG L. OWEN

construction documents were completed by an in-country AE firm. Also provided were construction specifications-based materials easily obtainable in South Africa

- Mechanical / Cleanroom Reviewer, Argonne National Laboratories, Argonne, Illinois, Center for Nanoscale Materials for the Title II review of the A/E's design. This review focused on the cleanroom Air Management System, Clean Classification and responsibility for coordinating the Title II review, including report preparation.
- Nexolon Cell Module Project, Nexolon America, San Antonio, Texas, Project Manager. Full architectural and engineering services for new solar panel production plan. Collaboration and work-share with Jacobs San Antonio office. The project has a total installed cost (including equipment) of approximately \$100 Million. it will include a 276,000 SF manufacturing plant and administrative building; a 10,000 SF warehouse; an 8,000 SF chemical storage building; an 8,000 SF waste storage building; and expansion space for two future buildings.
- SunPower Line 1 Building 1, SunPower Corporation, Philippines. Responsible for Programming and concept development for a PV production Line in an existing building in the Philippines. The work included P&ID development, and specifications for tanks, pumps and chemical distribution systems