

MEMORIAL RESOLUTION
PHILIP BARKAN
(1925-1996)

Philip Barkan, Professor Emeritus of Mechanical Engineering, died in Mountain View, California on June 21, 1996 at the age of 71. His distinguished engineering career spanned nearly fifty years, both in the private sector and in academia. He was internationally recognized as a “master design engineer” in high speed machinery. More recently, he became internationally well known for pioneering what is probably the first and most extensive graduate curriculum on design for manufacturability and the product design process.

Born in Boston, Phil earned his BS in Mechanical Engineering at Tufts University in 1946, an MS from the University of Michigan in 1948, and his PhD from Pennsylvania State University in 1953. During his PhD studies, he served at Penn State as a Research Assistant, and later as an Assistant Professor of Engineering Research from 1948 to 1951. Phil also served in the US Navy while completing his PhD In 1953; he was honorably discharged with the rank of Lt. (J.G.). His PhD research provided the first successful dynamic simulation of the high-speed valve motions in internal combustion engines. This work led to Phil’s reputation as an international expert on dynamic analysis and design of high-speed machinery.

Upon completing his PhD, Phil joined the General Electric Company (GE) and began his outstanding career with the company’s Switchgear Equipment Business Division in Philadelphia. His areas of expertise covered electro-mechanical systems, dynamics of high-speed machinery, fluid mechanics, magneto-hydrodynamic applications, and electro-magnetic devices. He held various positions related to product design research and development and gained an international reputation in the area of circuit breaker design. He developed and was granted 53 U. S. patents in related areas and was widely regarded throughout the company as one of their most outstanding mechanical engineers. In recognition of his considerable contributions he was

awarded the first General Electric Charles P. Steinmetz Medal for technical excellence in 1973. These contributions included basic research on contact phenomena in switchgear, study of impact phenomena, development of high-speed mechanisms, investigation of arc interruption in oil circuit breakers, analysis of the dynamic behavior of transformer windings during short circuits, determination of failure modes in suspension insulators and bushings, and seismic analysis of electrical equipment. In 1964, Phil prepared an invited chapter on "Impact" phenomena for *Mechanical Design and Systems Handbook*, published by McGraw-Hill and widely used by mechanical engineers. Over 30 years later, his chapter is still so relevant that the publisher recently tried to contact Phil to request a revision.

His many important technical contributions in the field of circuit breakers also earned him the Fellow Grade of the Institute of Electrical and Electronic Engineers (IEEE) in 1972. He was also an active member of the American Society of Mechanical Engineers (ASME), the Society of Manufacturing Engineers and Sigma Xi. According to one of his former supervisors at GE, Phil was always assigned the most challenging tasks requiring a thorough knowledge of mechanical engineering fundamentals, analytical ability, creativity, and a practical viewpoint. His solutions to difficult problems were invariably innovative, usually simple in concept, cost effective, and most important of all, they were practical. Phil had a talent for quickly getting to the heart of any problem he investigated and was equally skilled at using analytical tools or experimental procedures to validate his solutions. In 1980 Phil was elected to the National Academy of Engineering (NAE) for his significant contributions to the field of mechanical engineering, and specifically his pioneering work on circuit breakers.

While at GE, he developed an interest in design education. In 1958, he organized and taught comprehensive review courses for GE mechanical engineers preparing for Pennsylvania State professional engineers license examination. In 1961, he taught to GE engineers a 20-week course on analysis and synthesis of high-speed mechanisms and circuit breakers.

Phil took a sabbatical leave from GE in 1971 and served as Visiting Professor of Mechanical Engineering at The Israel Institute of Technology. During this 14-month period, he completely revised and led the instruction of a major course that is compulsory for third-year mechanical engineering students. The course included both design theory and substantial projects of design practice. By all measures, from the students' view and that of the faculty, this was a highly successful course that replaced a seriously deficient prior course. He also taught an elective course for seniors and graduate students entitled "Analysis, Synthesis, and Design of Cam-actuated Systems." In recognition of his teaching contributions, the Board of Regents of the Israel Institute of Technology offered to appoint him as a senior Professor of Mechanical Engineering in 1973. This was particularly significant because no other full professors had ever been appointed in that area of the department.

From 1973, Phil served as Chairman of the ASME Design Education Committee. Under his leadership, this largely inactive national committee has become vigorous and productive. While he had intended to step down at the completion of a three-year term in office, he continued for another term in response to the urging of several educators on the committee. He remained active on the committee until his retirement in 1993 and brought in many practicing engineers to participate in the committee. A member he recruited in the 1970s is now a Vice President of ASME.

After an exhaustive national search, Stanford University offered Phil a full professor position in recognition of his impressive qualifications and accomplishments as a "master design engineer." He accepted the challenge and moved to the Design Division of the Mechanical Engineering Department at Stanford University in 1977. Phil saw very early, long before it was evident to most observers, that US industrial performance in design and manufacturing was beginning to deteriorate. Phil reasoned that to implement the changes that were necessary to get America back on track in manufacturing, he would be more successful in a university teaching environment.

After his highly successful years at GE, Phil started over again. At a time when many might begin to relax their efforts, or stay focused in their area of expertise, Phil

continued to innovate and look for new challenges. He quickly responded to the Design Division's expectations by enhancing its graduate engineering design project curriculum. He brought in more industrial contacts, solicited companies to provide real life examples, and linked design theory and methodology with actual design project experience. His three-quarter course sequence ME210, was the most memorable experience for many of the masters students in the Design Division. In twelve years, over 500 students took Phil's ME210 course, many of them winning awards in the prestigious Lincoln Arc Welding Foundation Design Project Competition. ME210 entries were so strong in this national competition that they routinely won over half of the awards given, a tradition that continues today. His course has now been emulated at numerous other US universities.

Like all pioneers, he was ahead of his time, and it is only recently that the magnitude of his contribution to the field of design-for-manufacturability is becoming clear. After solidifying Stanford's excellence in design-oriented courses with close industrial interaction, he looked for more innovations in design education. Since 1985, he focused on the development of courses linking design to manufacturing and management issues. The US industrial enterprise has been in the process of a renaissance, and university engineering education likewise has been undergoing structural changes in values and in content. His determination, courage, and energy have been fundamental and pivotal in producing these changes. In 1985, he began collaborating with General Motors (GM) in developing a comprehensive graduate curriculum on design for manufacturability. He worked with Professor Mark Cutkosky in developing what is probably the first graduate course on this subject in the world. The course, whose original focus was "how to design products that were easy to manufacture," quickly expanded its focus. With Professor James Jucker's participation and further interest from GM, the curriculum grew into a three-quarter course sequence that addressed not only ease of manufacture, but overall product competitiveness and "World-class Product Design Process."

There were three major innovations in his curriculum for ME217, Design for Manufacturability. First was the expanded, more comprehensive definition of

competitiveness. Most people associate competitiveness with performance and cost. Phil added another axis of competitiveness, “speed.” Speed refers to time-to-market issues, both in development time, and delivery time. Most industry experts now agree that for many products, speed is the most important ingredient. Phil argued that different industries and products demand a different mix of the three elements of competitiveness: performance, cost, and speed. Phil insisted that engineers need to thoroughly understand this mix before proceeding with design.

The second innovation was stressing the importance of product planning. Most practitioners and educators agreed that by the time design is completed, 80% of the product cost is committed, whereas only 20% has been actually expended on the project. Phil argued further that product profitability was determined even before design, at the stage of product planning. He named this stage of product development “product definition” and argued that 95% of product profitability was determined even before engineers started sketching conceptual designs. Phil firmly believed that the most critical element of product development is a clear understanding of the competitiveness ingredients and the product requirements.

The third innovation lies in the integrated use of formal design methodologies. In the past decade, many design researchers and educators have created various tools and formal design methodologies, often claiming their methods to be a panacea for every problem. Phil studied these methodologies carefully: Value Engineering, Quality Function Deployment, Functional Analysis, Design for Assembly, Failure Modes and Effects Analysis, Concept Generation and Selection, Taguchi Method for Robust Design, Conformance Quality, Six-Sigma Tolerancing, and many more. He then concluded that what people were missing was a systematic procedure in the integrated use of these methods and tools. Phil argued that a screw driver may be useful in many tasks, but is totally inadequate in building a house. One needs to strategically combine the use of all the tools in one’s toolbox. His ME217 curriculum stresses how engineers can determine the need for the various tools and plan for strategic combination and timing of their use. A major difference between ME217 and other courses of its kind is that Phil did not allow students to “start designing” until the second quarter of the

curriculum. He insisted that students thoroughly study the competitiveness issues and spend ample time and effort in clarifying “product definition” and setting strategy for the integrated use of different methods and tools.

ME217 embodies all three of Phil’s innovations and the course has been enormously successful. Phil taught over 500 on-campus students through ME217 during 1986-1993. Perhaps more strikingly, ME217 was delivered through Stanford Instructional Television Network (SITN) to over 1000 students working for more than 20 companies during the same period. Many companies report tangible profit improvements through ME217. Students at Boeing applied Phil’s principles to its 737 aircraft and saw millions of dollars of cost savings. The Dean of GM’s Technical Education Program claims that GM has documented millions of dollars in savings that can be attributed directly to the lessons learned from this course. GM credits Phil and his ME217 course with “changing the way we think about design.” By 1992, Phil was hailed by many companies as one of the leaders who helped change and improve the direction of US manufacturing. Behind Phil’s success was his relentless zeal to make a direct impact on US industries through his course. He traveled monthly to the ME217 SITN sites in Detroit, Seattle, Rochester, and many other locations. By his frequent trips, Phil stayed completely in tune with industry needs and continually improved his curriculum. From 1993 until his death, he was a Member of the Board of Directors for the Xerox Design Excellence Institute.

Both his scholarship and teaching in design-for-manufacturability are world-class in quality and reflect extraordinary vision. It is truly remarkable that an individual with so many accomplishments in industry and *after* making a significant mark in university education, set out at the age of 60 to develop what we now recognize as a landmark design for manufacturability curriculum. In 1995, Phil passed on his successful design course sequence to one of his former doctoral students, Kosuke Ishii, now an Associate Professor at Stanford. Until his death, Phil remained active in improving the ME217 curriculum. Recent years have seen many universities adopt Phil’s curriculum in developing design-for-manufacturability courses. In 1996, just before his death, students at General Motors voted ME217 the best distance learning course out of over

200 courses offered by GM's Technical Education Program. The current ME217 teaching staff attributes Phil's efforts during the past ten years as the major reason for Stanford winning this award.

For someone entering academia relatively late in his career, Phil was quite successful in delivering PhD graduates to carry on his objectives. He attracted and successfully advised over ten PhD graduates, many with similar qualities to his own—those who combined practical design experience with cutting edge theory and methodology. Phil led the design and manufacturing research community in guiding PhD dissertations in advanced topics such as artificial intelligence in engineering design, high-speed machinery design-for-manufacturability, conceptual design-for-robustness, quality design and processing of plastic parts, and product definition. One dissertation he guided in 1992 on the topic of “quality-by-design” received nationwide attention and is now a company-wide initiative at his former employer General Electric. The 1993 paper he co-authored with Martin Hinckley, “The Benefits and Limitations of Structured Methodologies,” appeared in *ASME Manufacturing Review*, Vol.6, No.3 and received national attention. In training PhD students, Phil was always quite demanding and expected the best effort from his students. All of his students appreciate Phil's guidance and attribute their success to the high standards demanded by Phil. They all remember him as a “master design engineer.” Three of his PhD graduates entered academia and established strong design-for-manufacturability programs from coast to coast: San Jose State University, The Ohio State University, and University of Massachusetts–Amherst. Others have successfully implemented Phil's methodology in government labs and industry. The philosophy Phil embodied in ME217 is alive and well and continues to grow. To his students and friends, Phil was a man of the highest integrity. He was honest, direct, and caring. Everyone around Phil remembers him for his genuine interest in his students' and friends' success.

Phil is survived by his wife Susan, daughter Ruth Barkan of Berkeley, son David and daughter-in-law Nancy Melrose of Forest Knolls, California. Phil loved the outdoors and was an avid hiker. While at Stanford, he regularly went on strenuous backpacking trips in the Sierras. More recently, Phil and Susan enjoyed the outdoor landscape and

natural history of the Bay Area foothills. Many of his friends will forever remember Phil's happy face during day hikes complaining about how he could never find a well-engineered backpack. He was a born design engineer, lived through several careers all with extraordinary accomplishments, and will forever be remembered as a true "master designer and educator."

Kosuke Ishii, Chair
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