CAVALIERE & FULLER

a tool to enable and maximize your product's value

SERVICE GOALS

Enable or enhance the productivity, efficiency and profitability of projects having a mechanical component – for scientists, engineers, designers, inventors, patent attorneys, market analysts and investors.

Increase value for such clients by applying to their projects our expertise in: invention, innovative mechanical engineering, feasibility review, problem-solving and design (from proof-of-concept through production ramp-up).

As an integral part of all services, provide communications that are clear, concise and audience-appropriate, to ensure the most efficient translation of each completed project into products, patents, marketing and investor communications – always focused on achieving return-on-investment.

Cavaliere & Fuller

Strengths

Bill Cavaliere's specialty is inventing equipment and manufacturing techniques for new technologies so they can produce rapid and substantial returns on investment.

Berkeley Fuller assists innovators in many fields by capturing and focusing their output and providing the accurate and appropriate communications required for project success.

References

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Cavaliere & Fuller

Scientists, engineers, inventors, parent attorneys, market analysts –

Use our proven know-how to:

- **Invent, improve or fix mechanical components, methods or processes**
  - *Our history and experience let us talk comfortably with many professions*
  - *We bring in a different point of view to help your team achieve its goals*
  - *Our goal is to make parts, equipment and processes simpler by thinking through all practical options to achieve maximum efficiency*
- **Analyze the pros and cons of a technology for manufacturing**
  - *Can the technology or product be ramped up to support projections?*
  - *What may make manufacturing difficult?*
  - *How best can such issues be addressed?*
- **Communicate to ensure success**
  - *Accurately document the project's design, features and technical benefits*
  - *Tailor information correctly for management, staff, patent counsel, investors*
  - *Help deliver the right information to the right people at the right time*
- **Increase your product or patent value 10X**
  - *Get from lab concept to working prototype*
  - *Prove the practicality to mass-produce*
  - *Develop the working tools to get into production*

Introduction to Case Histories

To maximize the value of any project having a mechanical component, we use four tools: (1) approach every task or problem with a receptive and independent mind; (2) understand the project's big picture – its technical goals and its money-making potential – as well as the details;(3) ask questions from various perspectives and then develop the "user specifications" that completely define the project; and, (4) apply our substantial prior experience to find the best solution. This approach helps achieve "mechanical solutions" whose simplicity and profitability appears "obvious."

To maximize its value, such a solution must be accurately, clearly and concisely communicated – in writing, drawings and other media. From the start of the development process, we leverage good communications to help clarify the project, and then leverage it for maximum added value – as saleable products and processes, as patents, and in persuavie marketing and investor communications.

The following case histories illustrate how we work with these principles and show the benefits of applying them.

Case Histories

Case History #1: Argon-Nitrogen Aerosol Cleaning Ramp-Up
(for IBM Advanced Semiconductor Technology Center)

In the early 1990's, as environmental awareness and regulation increased, the cost to IBM for the safe disposal of toxic and hazardous chemicals was sharply increasing. Management reasoned that one way to reduce costs and protect the environment would be to find a way to clean delicate surfaces during manufacturing, on products such as chip wafers and packaging parts. IBM first looked at using CO^2 as an aerosol for cleaning, to replace the highly volatile liquid cleaning agents then being used. However, CO^2 had three disadvantages: (1) it is very difficult to purify; thus its can leave hydrocarbon contaminants behind on the nanostructure surfaces being cleaned; (2) in some states, CO^2 is reactive and can undesirably modify product surfaces; and (3), CO^2 is a primary greenhouse gas that itself has negative implications for global warming.

An innovative IBM research scientist then proposed a method for using inert argon and nitrogen gas, in a cooled aerosol mixture, to clean ultra-miniature high-value parts. Initial feasibility testing suggested that mixture could be used as a practical aerosol cleaning agent. The nitrogen gas would serve as a high-speed propellant for argon ice crystals that formed when the mixture was cooled. The crystals , to be used as solids to dislodge and transport away contaminants, including sub-micron particles adhered in the boundary layer of delicate chip surfaces.

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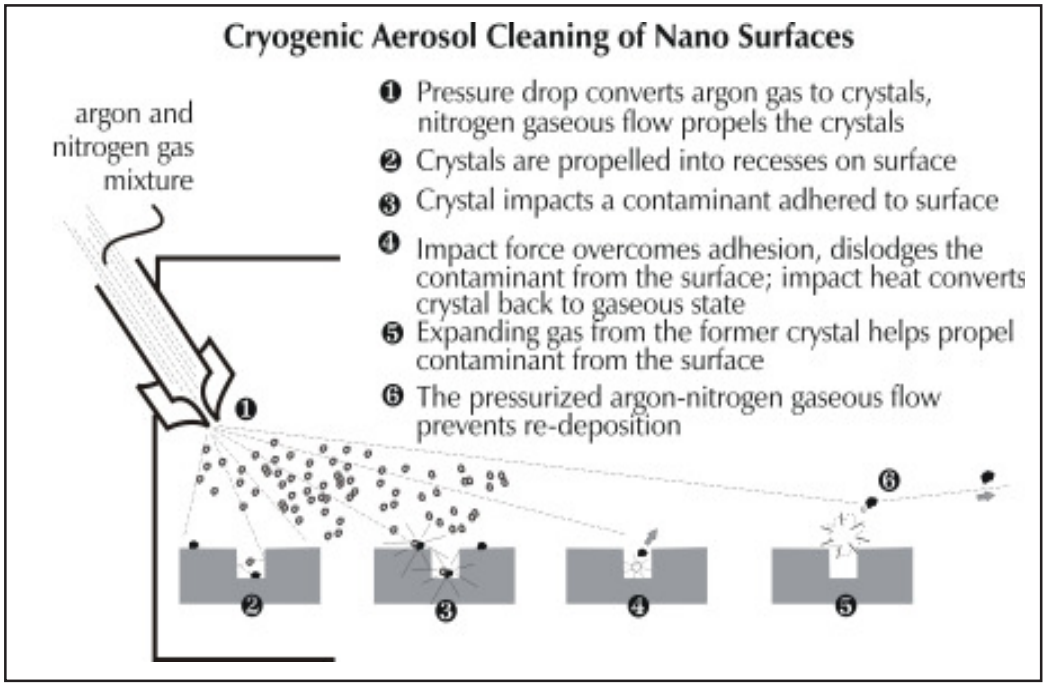


My specific assignment on the aerosol cleaning project was to design and build a working prototype, test it, then build a complete "cluster-compatible" version to integrate with existing, robotic production lines. All three steps were successful. The resulting argon/nitrogen cleaning system became the process of record for many of IBM's advanced semi-conductor products.

When other companies bought or licensed the rights to such products, they often also needed to buy or license the process methods or equipment necessary to do the manufacturing.

The new aerosol cleaning system improved internal manufacturing, generated additional profits from product sales, and produced additional wealth from licensing the cleaning process itself – all while eliminating the risk and cost to IBM, its customers and the environment, of using hazardous cleaning chemicals.

Case History #2: Laser Diode Manufacturing Vise

(for IBM Corporation, Zurich)

The task initially presented to me was to to adapt a known clamping technique for the production of a new laser diode. The clamping fixture would be required to hold a batch of 40 "laser diode bars" and spacers. Each bar, a rod of semi-conducting material half the length of a common straight pin, comprised 40 partially manufactured laser diodes. While held in this fixture, a "mirror modification coating" was applied that would selectively transmit or reflect various wavelengths of light. Extremely fine tolerances were required for this fixture: plus/minus .0001 of an inch. The fixture is analogous to a vise the size of a postage stamp, 1/8 of an inch thick, each of which would cost $5,000 when mass-produced.

I had to thoroughly understand the coating process which the vise was to support. Once understood, I was struck by two areas in the process that could be greatly improved. First, as had always been done previously, each batch of bars and spacers had to be loaded and unloaded into a clamping fixture twice, to apply the mirror coating to two different surfaces . Each time a set of bars was loaded, on average 10% of the product was damaged (19% yield loss per set).

I designed a completely new fixture configuration which allowed all the coatings to be done in one cycle. In addition, this new design used a form of spring clamping instead of the previously-used conventional screw tensioning. Where before, the high heat in the coating process caused metal expansion and over-tensioning, temperature-independent "flexture clamping" in the new design kept vise tension far more constant. These two improvements alone reduced product damage so that yield loss dropped from 19% to 6.46%.

Secondly, in order to "lase" (produce laser light), the laser diodes are made from Gallium Arsenide (GaAr), of which one component is arsenic. This material is highly toxic; line workers in Europe werereceived frequent blood tests to detect arsenic absorption. Because Gallium Arsenide's crystal structure makes it easy to use in ultra-high tolerance parts, the material had also been used to make the spacer bars. These had always been discarded after one use, creating large amounts of hazardous waste.

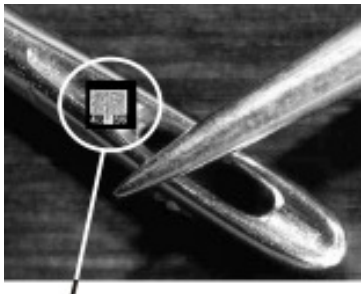
After exploring many questions regarding the spacer bars, I realized they could be made from a non-hazardous instead of using Gallium Arsenide. The new material's molecular structure made it possible to achieve the necessary high tolerances while using a bar five times thinner than the conventional part. The far narrower new spacer bars improved the physical ratio of laser diodes to spacer bars in the vise from 50/50 up to 80/20 – a 60 percent increase in the number of diodes produced per coating cycle. The new, lower-cost material also eliminate the hazardous arsenic waste and permitted recycling of the bars. Alternating the Gallium Arsenide diodes with the new spacer bars made possible for the first time non-continuous mirror coating, which additionally increased product yield.

Once in production, the $61,800 invested in these improved vise and spacer bar designs paid for themselves in 6.1 <u>days</u> and saved $3,692,000 the first year.

Case History #3: <u>Invention of a Practical, High-Production, E2 Laser Diode Tool</u> (initially for IBM Corporation)

Was tasked to make commercially practically a research tool conceived by physicists in a Fortune 100-sponsored, Nobel-prize winning physics lab. This equipment, if successful, would demonstrate and then enable the highly profitable production of a new, ultra-high powered laser diode.

Among the practical problems to be solved to enable manufacturing were: cleaving the crystalline structure of the semiconductor; separating its bottom metal layer; manipulating the separated bar into a position suitable for facet coating; coating multiple surfaces; and, conveying the coated bar into a carrier for further processing. All six of these processes needed to be carried out in rapid succession in situ within an ultra-high vacuum chamber.



The end product: a single laser diode chip

First, I built prototypes based on the Zurich lab's concept. By working on prototypes of this concept, I came to fully understand the differences between the processes that were actually happening versus what the science team had hypothesized would happen. The prototyping work showed that the Zurich tool design was conceptual flawed. Understanding its flaws made clear the real challenges and their solutions. The tool I then invented and patented satisfied all the lab's goals.

This tool, the "E2," created successive waves of earnings and wealth for a series of companies including IBM, Lasertron, Perrelli, Hewlett Packard, Bookham and JDS Uniphase. This highly profitable tool is still in use today.

Professional Backgrounds

William A. Cavaliere

Experience Summary

- Success conceiving, designing and building highly profitable equipment and manufacturing processes in optical, semi-conductor, ultra-high vacuum (UHV) and other venues.
- Expert equipment and process problem analyst, solver and innovator, combining skills and perspectives attained in career path from tool-maker to designer to mechanical engineer.
- Extensive collaboration with Fortune 500 company scientists, engineers and customers to clarify their concepts, goals and user needs. Have invented profitable equipment or processes that have yielded multi-hundred million dollar revenues.
- Prolific inventor, including contributions as inventor of record on commercially productive equipment and process patents for four leading-edge technology Fortune companies.

Career Experience

Development Engineer, Phase Inc., Kamuela, Hawaii 2006 - Present

Reviewed this startup company's existing mechanical technology patents to determine and augment their enforceability and potential value. Strengthened existing, and added new patent advantages. In this analysis, collaborated with the company president and co-developed five additional patent applications. Member of the marketing team presenting the I.P. to international manufacturers.

Development Engineer, Bookham Technology 2002 – 2004
Poughkeepsie, NY-Caswell, England

Developed tooling and equipment to support the manufacture of new optical products. Created a new laser diode handling and facet coating technique, including the assembly line equipment. This process increased through-put five-fold and included techniques which also reduced handling damage by 50%.

Development Engineer, Nortel Networks 2001 – 2002
Poughkeepsie, NY and Zurich, Switzerland

Evaluated the manufacturing processes at many Nortel plants in multiple international locations. Based on accumulated experience with IBM, JDS Uniphase, and Nortel Networks, chose the best-of-breed process from among the various sites, and made this the process of record at all manufacturing locations.

PROFESSIONAL BACKGROUNDS

Development Engineer, JDS Uniphase 1999 - 2001
Poughkeepsie, NY, Ottowa & Zurich

After JDS Uniphase purchased IBM's Zurich lab, was recruited by JDS to further refine commercialization of the lab's laser diode manufacturing process. Certain improvements produced for JDS on the resulting E2 production tool are still held as a trade secret. The tool handles, cleaves, and separates a product in a 1 X 10^{-9} torr level vacuum and then applies a proprietary chemical vapor deposition (CVD) coating in situ to modify the surface of this ultra-small optical product. Received several patents on aspects of the E2 tool. It is still the only viable production tool capable of supporting the E2 process. This tool continues to be used by JDS Uniphase, and licensees.

Advisory Engineer, Mechanical Engineer, Toolmaker, 1979 – 1999
IBM Corporation, Fishkill, NY

For over 10 years, was assigned to support the IBM Zurich Lab (5-10 annual trips to Zurich). There, working with the lab's Nobel Prize-winning physicists, developed laser optic concepts into viable commercial products. Invented and patented the manufacturing equipment and process which enabled commercial production of a breakthrough laser diode chip. Built the manufacturing tools for IBM licensees Lasertron, Pirelli AG and Hewlett Packard.

These products were the catalyst that powered a cascade of wealth. In the first year, the lab earned $15 million in revenues from direct sales, capturing 70% of the pump diode market. Then JDS Uniphase bought the lab for this property for $45 million. 18 months later, Nortol Network paid $3 billion in stock for the lab.

Earlier, as a toolmaker and then as a designer and engineer for IBM, worked on all aspects of dozens of tools. Was promoted from tool-maker through to Advisory Engineer – IBM's highest non-management engineering position. Inventor of record on multiple IBM patents granted for equipment and design inventions. Won a corporate environmental award for a device called the Aerosol Clean tool, which used a cryogenic argon/nitrogen mix to clean sub-micron particles from the surfaces of delicate nanostructures, replacing the use of large amounts of highly reactive, environmentally hazardous chemicals. Helped FSI Corporation commercialize this tool which is now sold as their Antares System.

EDUCATION

- **B.S., Engineering,** IBM-Sponsored Engineering B.S Equivalent, including at *SUNY-New Paltz, Fishkill, NY* 1985
- **A.S., Tool-Making Technology**, *Penn State University,* Williamsport, PA 1979

PROFESSIONAL BACKGROUNDS

BERKELEY F. FULLER

EXPERIENCE SUMMARY

- Clearly present the intentions, goals and details of a complex technology or invention. Combine, organize and polish information from interviews, meetings, rough notes and sketches, to produce accurate, readable and useful documentation.
- Tailor such documentation to retain accuracy and clarity while providing the appropriate level of detail to audiences including staff, board, investors, patent professionals.
- Leadership – inspire and develop trust, hard work and cooperation, through well-timed and appropriate communications.
- Use active listening, writing, editing, drawing, team dynamics, persuasion, facilitation, public speaking, fund-raising, and sales – to help the group reach its objectives.

CAREER EXPERIENCE

President, Director, *Phase Inc., Kamuela, Hawaii* 1999 - Present

Co-founded and managed this water equipment technology company startup. Responsible for development, technical writing and administration for all its patents. Duties as President and in previous roles for Phase have included: technical writing and drawing; effective oral and written communications with investors, board, advisors, staff, engineers, consultants; patent writing, development and administration; investor fundraising.

Chief Executive Officer, Director, *Parting Solutions, Inc., Kamuela, Hawaii* 1997 - 1999

Co-designed corporate purpose and structure, raised investor seed capital, recruited a board and a national board of advisors, conducted daily management. Folded PSI into a new company, Phase Inc.

President, *Weiss Enterprises, Inc., Kamuela, Hawaii* 1994 - 1996

Documented and re-organized product, patenting and marketing efforts for this small limited partnership startup. Raised seed capital funding; developed and began implementation of marketing strategies for the company's fluid-separation technology.

PROFESSIONAL BACKGROUNDS

Sole Proprietor, *Marketing & IT Consulting* 1985 - 1993
Honolulu and Kamuela, Hawaii

Sole-proprietor consultant. Provided marketing strategy development, advertising campaign design and production, technical writing and graphics, and the business use of small computing systems – for 75 Hawaii clients.

Account Executive, *Milici Valenti Park & Gabriel Advertising,* 1986 - 1989
Honolulu, Hawaii

Recruited by Straub's advertising agency (see below) to develop multi-media marketing campaigns for three major clients: Hawaii Medical Service Association (Blue Cross), Foremost Dairies, and a unit of First Hawaiian Bank. Planned and executed campaigns costing over $3M annually, including print, radio and television production. Provided market strategy development training to the agency's clients, using a group planning process from parent company Doyle Dane Bernbach.

Director of Marketing *Straub Clinic &Hospital, Inc.* 1979 - 1986
Honolulu, Hawaii

As the sole marketing professional on a multi-disciplinary medical team, produced all curriculum materials including workbooks and a patented lifestyle/ health assessment software program, for a nationally-pioneering hospital-based patient wellness program. Also built the company's first corporate sales territory, selling wellness programs to 200 Hawaii businesses. This campaign earned Straub's doctors the market-leader position for Hawaii's large business owners. Was then tasked with founding Straub's company-wide marketing department; managed the department for four years.

Director of Community Relations, *Legal Aid Society of Hawaii,* 1976 - 1978
Honolulu, HI

Recruited from FMC Advertising to build a statewide client outreach program for this non-profit, community-service law firm. Learned to communicate effectively (both in person and in writing), with people and audiences as diverse as social-action reformers, Native farmers, state legislators and the business community.

Assistant Director for Public Relations, 1973 - 1976
Fawcett McDermott Cavanagh Advertising, Honolulu, Hawaii

Apprenticed in corporate public relations, serving business clients including Foodland, the Cement and Concrete Products Industry association, SeaLand Ocean Transport, and political candidates. Continually wrote and placed press releases, staged publicity, generating a constant flow of news advantageous to clients.

Combat Historian, *USAF - Strategic Air Command (SAC)* 1969 - 1973
Grand Forks, ND and Takhli, Thailand

After Air Force basic training, was cross-trained to write quarterly, top-secret historical analyses (500-page average length) covering the combat-readiness and nuclear safety of a fifty-aircraft B-52 nuclear-alert bomber base. Position required: formal academic history training, writing and journalism skills, rapid and accurate assimilation of complex data and situations, poise under pressure, and adroit interpersonal and "political" judgment. Each quarterly History, reporting on the performance of the historian's local command staff, was reviewed by a committee of generals at the Joint Chiefs of Staff. Won multiple SAC and USAF history awards. Wrote part of the combat history record of SAC's air-refueling support of the Cambodia bombing campaign (Vietnam theatre).

EDUCATION:

- **M.Ed**. (Masters in Education), "Group Counseling," University of Hawaii (1976-1978).
- **A.B.**, (Bachelor's Degree), "U.S. History Since 1789," Harvard College, (1965-1969).