Index

Advanced Computing Laboratory, 40 Advanced Micro Devices, Inc., 42,61, 78 Advanced Research Projects Agency electronics manufacturing technology funding, 56 flexible manufacturing systems, 77 funding sources, 3 GILD process, 44 lithography funding, 19 NCAICM project funding, 50 SEMATECH relationship, 10-11, 16,67 Advanced Technology Program, 4,29,48 Advisory panels, 9 Air Force, use of ICs in Minuteman 11 guidance system, 57 AMD. See Advanced Micro Devices, Inc. American Electronics Association, 40-41 Application-specific integrated circuits, 58 ARPA, See Advanced Research Projects Agency AT&T, 42 Bardeen, John, 57 Beam technologies, Los Alamos National Laboratories and, 41-42 Bell Laboratories, 56, 77 Bilateral trade agreements, between U.S. and Japan, 68 Brattain, Walter H., 57 Bush administration, National Technology Initiative, 7

CALEOT. See Center for Applications of Laser and Electro-Optic Technologies Canon, 17-18 Capital availability, U.S. and Japan comparison, 59-61

"Captive" suppliers, 61 Center for Applications of Laser and Electro-Optic Technologies, 43 Center for Contamination-Free Manufacturing, 37-38 Center for Microelectronics Technology, 35, 37-38 CFM. See Center for Contamination-Free Manufacturing Chemical vapor deposition technology, 39-40,50 Clinton administration NIST budget, 29-30 trade commitments from Japan, 68 Closed-loop process control, 73 CMOS. See Complementary metal oxide semiconductor technology CMT See Center for Microelectronics Technology Cold War end, 12,20,55-56,77,78-79 Competitive history of semiconductor industry early U.S. dominance, 56-57 Japanese industry, 57-64 U.S. response to Japanese challenge, 64-68 Complementary metal oxide semiconductor technology, 32 Compound Semiconductor Research Laboratory, 33 Computer-aided design, Los Alamos National Laboratories and, 38 Computer Systems Policy Project, 68 Contamination-free manufacturing, 37-38,74-75 Cooperative research and development agreements description, 3-4 laboratory resources devoted to, 24 Lawrence Livermore National Laboratory, 42 Los Alamos National Laboratories, 38 management structure and, 8

National Institute of Standards and Technology, 21, 48 negotiating with DOE labs, 4-7, 20-21, 25 Sandia National Laboratories, 34-35 CRADAs. See Cooperative research and development agreements CVD. See Chemical vapor deposition technology Defense Conversion: Redirecting R&D, 7, 8 Department of Commerce, 3,68 Department of Defense funding for semiconductor projects, 3,53 SEMATECH funding, 2 Department of Energy Defense Program laboratories. See DOE Defense Program laboratories DoD. See Department of Defense DOE Defense Program laboratories areas of expertise, 21, 25-28 authority to execute CRADAs, 3-4 collaboration with industry, 25-28, 79 competition among labs for research funding, 13-14 coordination of activities, 48-50 core competencies, 26-28 CRADAs signed, 27-28 evaluation criteria for, 14-16 functions, 25 funding sources, 20 funds committed to CRADAs, 4 lithography expenditures, 19 negotiating CRADAs with, 4-7, 20-21, 25 nondefense resource allocation, 28 operational budgets, 27, 28 semiconductor program description, 30-32 Downstream markets shifting location of, 63 U.S. economy and, 55-56 DRAM chips. See Dynamic random access memory chips DuPont, 42 Dynamic random access memory chips design of, 65 dumping by Japanese manufacturers, 61,68 Japanese market share, 57 strategic alliances, 78

Ellipsometers, 45-46 Environmental Protection Agency, 40 Environmental safety and health

Lawrence Livermore National Laboratory programs, 50 Los Alamos National Laboratory programs, 40-41, 50 Sandia National Laboratories programs, 50 EPA. See Environmental Protection Agency EPROMs. See Erasable programmable read-only memories Erasable programmable read-only memories, Japanese dumping of, 61,68 ES&H. See Environmental Safety & Health Evaluation criteria for national laboratories, 14-16 Fairchild Camera, 57 Federal Technology Transfer Act, 6 Flash memories, 78 Flexible manufacturing systems, 77 FTTA. See Federal Technology Transfer Act Fujitsu Ltd., 78 Gas immersion laser doping, 43-44 GCA, 17-18 GCA-Tropel, 42 General Signal, 17 GILD. See Gas immersion laser doping GOGOs. See Government-owned, government-

operated labs Government-owned, government-operated labs, CRADAs and, 6-7

Hampshire Instruments, 43 Hitachi, 60 Hollings, Sen. Ernest, 7

IBM

captive supplier role, 61 pilot line donation, 32,36 R&D expenditures, 77 strategic alliances, 78 use of transistors rather than ICs, 57 ICs. See Integrated circuits Industrial Waste Reduction Program, 40 Industry/government collaboration, 3,78-79 Integrated circuits costs, 75-77 DOE labs and, 25 early dominance of industry by U. S., 57 invention of, 56-57 Japanese market share, 57,58 technology challenges, 69-75 U.S. market share, 57-58 Intel Corp., 61 strategic alliances, 78 ITC, See U.S. International Trade Commission

ITC. See U.S. International Trade Commission
Jamar, 42
Japan

availability of capital, 59-61
bilateral trade agreements with U. S., 68
challenge to U.S. industry, 57-64
dumping of DRAMs, 61,68
keiretsu banks, 60
market share, 18, 57, 58
production yields compared to U. S., 67
strategic alliances with U. S., 77-78
structure of semiconductor industry, 17, 60-61
suppliers' market share, 63-64
trade practices, 61-63
U.S. response to challenge, 64-68

Joint Association for the Advancement of Supercritical Fluids, 40

Keiretsu banks, 60 Kilby, Jack, 57 KLA, 42

Laboratory/industry collaboration Department of Energy laboratories, 25-28 focus areas for Federal labs, 48-50 National Institute of Standards and Technology, 28-30 success factors, 6 Laser technology, Lawrence Livermore National Laboratory and, 43-44 Lawrence-Berkeley Laboratory, 42 Lawrence Livermore National Laboratory areas of expertise, 21, 24, 25, 31 CRADAs in microelectronics, 42,44 defense activity budget, 28 environmental safety and health programs, 50 IC experience, 25 laser applications, 4344 modeling capabilities, 50 operating budget, 42 semiconductor programs, 42-44 soft x-ray projection lithography, 42-43 Life Cycle Activities project, 40 Lithography, 13, 16-20,72-73

LLNL. See Lawrence Livermore National Laboratory Los Alamos National Laboratory areas of expertise, 21, 24, 25 beam technologies, 41-42 defense activity budget, 28 environmental safety and health programs, 40-41,50 High-Performance Computing Research Center designation, 40 IC experience, 25 microelectronics CRADAs, 38 modeling and simulation programs, 38-40, 41, 50 semiconductor programs, 38-42 Management structure of laboratories, 8-12 Materials needs for ICs, 70 MDL. See Microelectronics Development Lab Memorandum of agreement between NIST and Sandia, 4,50 "Merchant' manufacturers, 61 Metrology, 70, 72-73. See also National Institute of Standards and Technology Micrascan, 17-18 Micrion Inc., 42 Microelectronic Manufacturing Science and Technology, 77 Microelectronics and Computer Technology Corporation, 3,40,65 Microelectronics Design Laboratory, 33 Microelectronics Development Laboratory, 32,35 Microelectronics Quality and Reliability Center, 33 MicroTech 2000 workshop, 5,66 Ministry of International Trade and Industry alliances between Japanese firms versus international joint ventures, 62 funding of semiconductor industry, 57 influence over businesses, 18-19 loan recommendations, 60 MITI. See Ministry of International Trade and Industry Modeling and simulation, 3840,41,50,74 Moore's law, 69 Motorola, 40,67 NACS, See National Advisory Committee on Semiconductors NASA. See National Aeronautics and Space Administration

National Advisory Committee on Semiconductors, 5, 10

National Aeronautics and Space Administration, use of ICs in Apollo Program, 57 National Bureau of Standards. See National Institute of Standards and Technology National Center for Advanced Information Component Manufacturing, 50 National Competitiveness Technology Transfer Act, 6 National Institute of Standards and Technology areas of expertise, 24, 31-32 collaboration with industry, 25, 28-30, 79 coordination of activities, 48-50 core competencies, 31 CRADA process, 4,7,21 CRADAs signed, 48 ellipsometer development, 45-46 evaluation criteria for, 14-16 extramural programs, 44-45,48 functions, 28-29 funding sources, 20 IC experience, 25 intramural programs, 30, 44,4546,48 lithography expenditures, 19 Materials Technology group, 45 memorandum of agreement with Sandia, 4, 50 metrology and SIA technology roadmaps, 32 metrology technologies, 12-13,21,24,28-30,31-32 Office of Microelectronics Programs, 46 operating budget, 7, 29-30 resistivity measurement, 47 SEMATECH-sponsored projects, 46,48 Semiconductor Electronics Division, 45,48 semiconductor programs, 30-32, 44-48 National Research Council, 78 National security issues, 55-56 National Technology Initiative, 7 NCAICM. See National Center for Advanced Information Component Manufacturing NCTTA. See National Competitiveness Technology Transfer Act Nikon, 17, 18 Nippon Electric Corp., 60 NIST. See National Institute of Standards and Technology Nonvolatile Electronics, Inc., 48 Noyce, Robert, 57 Omnibus Trade and Competitiveness Act of 1988

NIST mission, 29

Super 301 provisions, 68 Overlap among the four laboratories, 2,21,50 Partnership for Total Quality, 67 Perkin-Elmer, 17 Policy issues assuring effective hand-offs, 2, 16-20 establishing evaluation criteria, 2, 14-16 focusing the efforts of the laboratories, 2, 12-14 funding, 2,20-21 management structure, 1, 8-12 overlap among the four laboratories, 2, 21, 50 semiconductor industry support, 52-53 Process Design Laboratory, 33 Rapid thermal processing, 73 Reagan, Ronald, sanctions against Japanese electronics producers, 68 Reliability Analysis and Modeling Program, 36 RTP. See Rapid thermal processing Sandia National Laboratories areas of expertise, 24, 25, 31 commercial semiconductor programs, 34-35 complement metal oxide semiconductor technology, 32 contamination-free manufacturing, 37-38 CRADAs for semiconductor manufacturing, 34-35 CRADAs with SEMATECH, 4,34-35, 37 defense activity budget, 28 environmental safety and health programs, 50 equipment design and modeling, 36-37 IC experience, 25, 32 magnetically levitated stage for wafer steppers project, 37 memorandum of agreement with NIST, 4, 50 microelectronics facilities, 32-34 mission, 32 modeling capabilities, 50 pilot line services, 35-36 plasma processing project, 36-37 reliability modeling project, 36 semiconductor programs, 32-38 soft x-ray projection lithography, 42 SEMATECH ARPA relationships, 10-11, 16,67 CRADAs with Sandia, 4,34-35,37 description, 66-67 Focus Technical Advisory Boards, 10

formation of, 65 funding sources, 2-3, 10, 16 investments in GCA, 17 lithography expenditures, 19 management structure, 8, 11-12 NIST projects sponsor, 46,48 partnership with SEMI, 18 partnerships with U.S. equipment manufacturers, 67 SETEC sponsorship, 36 **SEMI**, 18 Semiconductor Equipment Technology Center, 36-37 Semiconductor industry competitive history of U.S. industry, 56-68 future challenges to U.S. industry, 68-77 industry/government collaboration, 78-79 national security considerations, 55-56 production facility costs, 2 strategic alliances, 77-78 strategic position, 53-56 U.S. economy considerations, 53-55 U.S. market share, 18 U.S. policy support, 52-53 Semiconductor Industry Association areas critical to success of U.S. industry, 24 dumping petition, 68 formation of, 65 generational change assumption, 2 lithography expectations, 19 roadmaps, 5, 71 Semiconductor Manufacturing Technology consortium. See SEMATECH Semiconductor Research Corporation CRADAs with DOE labs, 4,39 description, 65 formation of, 2, 65 management structure, 8 university research and, 66 Semiconductor Technology Council, 9-10 Semiconductor Trade Agreement, 16,53,65,68 Senate Commerce Committee, 7 Senate Committee on Appropriations, 7 Sensors for process control, 73-74 SETEC. See Semiconductor Equipment Technology Center Shockley, William, 57 SIA. See Semiconductor Industry Association

Siemens A. G., 78 Silicon Valley Group Lithography, 17-18 Soft x-ray projection lithography Lawrence Livermore National Laboratory and, 42-43 Sandia National Laboratories and, 42 Software design for ICs, 75 Spire Corp., 48 SRC. See Semiconductor Research Corporation STA. See Semiconductor Trade Agreement Steppers, 17-20 Strategic alliances, 77-78 Superconductivity Pilot Center Agreement, 5-6 Suppliers "captive' suppliers, 61 U.S. and Japan comparison, 63-64 SVGL. See Silicon Valley Group Lithography TCAD. See Technology CAD Technology CAD, 39 Technology challenges to U.S. semiconductor industry contamination-free manufacturing, 74-75 manufacturing-critical software engineering, 75 materials, 70 metrology, 70, 72-73 modeling and simulation, 74 reliability y and quality, 74 roadmap technology characteristics, 70 sensors for process control, 73-74 Technology Insertion Program, 66 Texas Instruments, Inc., 57, 61 Toshiba, 61,78 Trade practices, U.S. and Japan comparison, 61-63 Transistor invention, 56-57 Ultratech Stepper, 17,42 University research, 66 U.S. economy downstream markets, 54-55 industry employment of U.S. workers, 53-54, 55 suppliers and, 54 U.S. International Trade Commission, 61

Wafer fabrication costs, 2,75-76 Weapons labs. See DOE Defense Program Laboratories