Publications and Research

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Text:

Editor's Note: The following is the entire document. NATIONAL SKILL STANDARDS FOR COMPUTER AIDED DRAFTING AND DESIGN (CADD) "We must set tough world-class academic and occupational standards for all our children and give our teachers and students the tools they need to meet them." President Clinton, State of the Union Address, January 1994 In the next eighteen months, FIM will develop a national assessment program for individual CADD users. Project staff will aim to accomplish the following tasks: finalize the measurable skills document, write test questions based on these skills, have questions checked for validity and reliability, organize test sites across the country, organize the registration and delivery of the test, and keep the standards updated. At this time, plans are to deliver a multiple choice test via modem to workstations at each test site. This test will be generic so that it is independent of the kind of software the test-taker uses. It will be scored on site and a profile of the individuals results made available if desired. For more information on FIM, call or write: Foundation for Industrial Modernization 1331 Pennsylvania Ave NW, Suite 1410 North Washington, D.C. 20004 Main FIM office (202) 662-8960 CADD Project office (202) 637-3438 Advanced Mfg Project office (202) 662-8967 FOUNDATION FOR INDUSTRIAL MODERNIZATION The Foundation for Industrial Modernization (FIM), in conjunction with business, education and labor organizations, has undertaken a 36-month project under a grant from the U.S. Department of Education to develop skill standards for Computer Aided Drafting and Design (CADD) users and to provide a way of measuring one's competency against these standards. FIM also has a second skill standards project to develop skill standards for advanced high performance manufacturing jobs. The mission and purpose of the Foundation for Industrial Modernization (FIM) is to foster revitalization of America's industrial infrastructure in the interest of the nation's global economic competitiveness, a highly skilled workforce, an improved standard of living, and a cleaner environment. The Foundation pursues this mission through education, research, and services to the industrial modernization community and through fostering closer cooperation between industry, government, and academia. FIM also seeks improved international cooperation in the field of industrial modernization and worker training. A non-profit, non-partisan 501(c)(3) organization, FIM serves as the research and education affiliate of the National

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Coalition for Advanced Manufacturing (NACFAM). PROJECT DIRECTOR'S PREFACE When the Foundation for Industrial Modernization (FIM) staff decided to undertake this project, we quickly recognized the importance and complexity of the challenge. We had selected a rapidly emerging technological area that consisted of many disciplines, many different software versions, and impacted several different industries. There are an estimated 1.5 million CADD users nationwide and an increasing number of organizations realizing the benefits of implementing CADD systems and hiring trained CADD users. We were challenged with bringing the CADD community to consensus on which CADD skills were basic and core to all CADD users. This was accomplished by our Executive Committee and Technical Committee members, who represent a cross section of the CADD community. The task was complicated by the number of disciplines within CADD and the many different types of software on the market. It is therefore gratifying to have developed a list of core CADD skills that have been developed by industry experts and verified by the CADD community. Looking back, the first phase of this project made history as our Executive Committee members predicted it would. Senior executives from major software companies sat at the same table for the first time and reached agreement on project policy issues. Discussions ensued between CADD users and CADD educators as to what skills are really needed in the workplace. And we witnessed staff at the Departments of Education and Labor working together to keep the projects moving forward and creating an opportunity for project directors to share experiences. I now look forward to the next stage of the CADD project during which we will develop a national testing and certification program, to be offered on a voluntary basis to CADD users. Our project coalition will remain open to any organization that would like to provide input to the testing stage of the project. In closing, I would like to acknowledge Teresa Newton-Terres, the Project Associate, for her many hours of hard work on this project, and Leo Reddy, President of FIM, who made this project one of his top priorities and was responsible for organizing the support of the coalition. Special thanks also to Fred Nichols, Vice President of the National Coalition for Advanced Manufacturing (NACFAM) for his overall business management and to Mark Schmit, Grant Manager, for handling our accounts. Our formative evaluator, Dr. Joyce Winterton, provided a continuous evaluation and made certain we did not stray from our project goals. Chris Yanckello, on behalf of Atlantic Resources Corporation, performed the summative evaluation for the project. Barbara Border and Madeleine Hemmings from NAVTEF lent their wealth of experience and contacts as well. Last but not least, my appreciation to our Executive Committee and Technical Committee members, to each person who took the time to verify our standards document, all the NACFAM centers and organizations who provided additional training to project staff. It has been a pleasure. Catherine Jane Beardsworth Project Director CONTENTS Part I: THE CADD SKILL STANDARDS A VISUAL DEFINITION OF THE CADD SKILLS SET Part II: TECHNICAL SKILLS Fundamental Drafting Skills Fundamental Computer Skills Basic CADD Skills Advanced CADD Skills Part III: SUPPLEMENTS Related Academic Skills -- Communication {C} Skill -- Math {M} Skills -- Science {S} Skills Employability Skills Recommended Tools and Equipment for CADD Training Recommended Hours of Instruction Recommended Qualifications of a CADD Instruction Measurable Skills Part IV: ACKNOWLEDGEMENTS PART I: THE CADD SKILL STANDARDS WHAT THEY ARE Voluntary, Industry-Based Skill Standards "Generally, they are job-related and industry-specific. They identify the knowledge, skill and level of ability needed to perform a given job. Voluntary standards can be tailored to any industry to reflect its particular needs and economic environment." U. S. Department of Education U. S. Department of Labor WHY WERE SKILL STANDARDS DEVELOPED The Foundation for Industrial Modernization (FIM) has undertaken a 36-month demonstration project, funded in part by the U.S. Department of Education, to develop national, voluntary skill standards for Computer Aided Drafting and Design (CADD) users. The project

will lead to a voluntary, national, testing and certification program in 1995. Skill standards are intended to help industry by improving the skills of the workforce. They also assist educators and trainers in the development of their curriculum and they ensure that students and workers develop the skills necessary for employment in industry. FIM encourages individuals and organizations interested in improving CADD user skills to use these standards. USE OF THIS STANDARDS DOCUMENT This skill standards document represents skills that are core to all CADD disciplines, generic to all software, and entry-level. In the validation process over eight hundred CADD users had the opportunity to review the skills document. FOR EMPLOYERS, the skills document can be used as: -- criteria for hiring; -- criteria for evaluating job performance; and -- a tool for determining retraining needs. FOR EMPLOYEES, the skills document can be used to: -- provide a list of skills needed to stay current in CADD; -- provide a list of skills to be tested for national certification; and -- provide a list of core skills portable across CADD disciplines. FOR EDUCATORS, the skills document can be used to: -- alert educators to the skills industry needs; -- set student outcomes; -- design curricula; -- incorporate into teacher update material; -- aid administrators to evaluate their programs; and -- guide programs in determining equipment. CADD SKILLS SET All CADD users should use these voluntary national CADD standards to improve their capability to perform in an increasingly high tech, high skills workforce. This includes professionals, and high-school/vocational/university students. Broad use of these CADD skill standards will make an essential contribution to America's global economic competitiveness. CADD is used throughout the U.S. economy. PART II. TECHNICAL SKILLS PREFACE A. The skills contained in the Fundamental Drafting Skills Section are recommended basic knowledge, that must ultimately be demonstrated in a CADD environment. B. CADD skills must be performed in accordance with appropriate industry standards (e.g., ANSI, ISO, building code, individual company standards.) C. Refer to supplement for the related academic skills. The related academic skill(s) required to perform each technical skill listed in our document are contained in braces {} after each item. Skills prefaced by an M are math skills, by a C are communication skills, and by an S are science skills. In some instances, the related academic skill number reference may include all items in its subsection (e.g. {M4} includes M4.1 - M4.4). FUNDAMENTAL DRAFTING SKILLS 1.1. Drafting Skills Related Academic 1.1.1. Use drawing media and related drafting materials (e.g., papers, vellum, mylar; plotter pens, toner cartridges) {C11, C16} 1.1.2. Use basic measurement systems (e.g., fractions, decimals, and metric measurements) {M1, M7.1, M7.4, M13} 1.1.3. Add correct annotation to drawing {C1, C7} 1.1.4. Identify line styles and weights {M8.9} 1.1.5. Prepare title blocks and other drafting formats {C7, M8.9} 1.1.6. Apply metric and/or dual dimensioning drawing standards {S8} 1.1.7. Identify and use appropriate standard symbols {C10, C20, C21} 1.1.8. Reproduction of originals using different methods (e.g., photocopy, plot, blueprint) {M1} 1.1.9. Create freehand technical sketches {M4.2, M6, M8.9} 1.2. ORTHOGRAPHIC PROJECTIONS 1.2.1. Identify, create, and place appropriate orthographic views {M4.4, M8.9} 1.2.2. Identify, create, and place appropriate auxiliary views {M1, M4, M4.4, M6, M8, M8.9} 1.2.3. Identify, create, and place appropriate section views {M6, M8.9} 1.3. PICTORIAL DRAWINGS 1.3.1. Identify and create axonometric drawings (e.g., isometric, dimetric, trimetric) {M1, M6, M8.9} 1.3.2. Identify and create oblique drawings (e.g., cabinet, cavalier) {M1, M6, M8.9} 1.3.3. Identify perspective drawings (e.g., 1-point, 2-point, 3- point) {M8.9} 1.4. DIMENSIONING 1.4.1. Apply dimensioning rules correctly (e.g., avoid redundant dimensioning, avoid dimensioning to hidden lines) {S11} 1.4.2. Use correct dimension line terminators (e.g., arrowheads, ticks, slashes) {S2, S8, S3, S11} 1.4.3. Dimension objects (e.g., lines, arcs, angles, circular) {S2, S3, S8, S11} 1.4.4. Dimension complex shapes (e.g., spheres, cylinders, tapers, pyramids) {S2, S8, S11} 1.4.5. Dimension features from a center line {S2, S3, S8, S11} 1.4.6. Dimension a theoretical point of

intersection {S2, S3, S8, S11} 1.4.7. Use appropriate dual dimensioning standards {S2, S8, S11} 1.4.8. Use size and location dimension practices {S3, S8, S11} 1.4.9. Use various dimensioning styles (e.g., Cartesian, polar, ordinate, datum) {S3, S8, S11} 1.4.10. Place tolerance dimensioning and Geometric Dimensioning and Tolerancing (GD&T) on drawings when appropriate {M1, S2, S3, S8} 2. FUNDAMENTAL COMPUTER SKILLS 2.1. HARDWARE 2.1.1. Demonstrate proper care of equipment {C10, C11, C17, S11} 2.1.2. Operate and adjust input devices (e.g., mouse, keyboard, digitizer) {C10, C11, C17, S11} 2.1.3. Operate and adjust output devices (e.g., printers, plotters) {C10, C11, C17, S11} 2.1.4. Correct handling and operation of storage media {C10, C11, C17, S11} 2.1.5. Start and shut down work station {C10, C11, C17, S11} 2.1.6. Adjust monitor controls for maximum comfort and usability {C10, C11, C17, S11} 2.1.7. Recognize availability of information services (e.g., electronic mail, bulletin boards) {C1, C2, C10, C11, S11} 2.2. PHYSICAL AND SAFETY NEEDS 2.2.1. Demonstrate an understanding of ergonomic considerations (e.g., keyboard position, screen position, lighting) {C10, C11, C17, S11} 2.2.2. Demonstrate personal safety (e.g., electrical and mechanical hazards) {C10, C11, C17, S11} 2.3. OPERATING SYSTEMS 2.3.1. Start and exit a software program as required {C10, C11, C17, S11} 2.3.2. Demonstrate proper file management techniques (e.g., copying, deleting) {C10, C11, C17, S11} 2.3.3. Format floppy disk {C10, C11, C17, S11} 2.3.4. Identify, create, and use directory structure and change directory paths {C10, C11, C17, S11} 2.3.5. Demonstrate proper file maintenance and backup procedures {C10, C11, C17, S11} 2.3.6. Translate, import, and export data files between formats (e.g., IGES, DXF) {C10, C11, C17, S11} 2.3.7. Use on-line help {C10, C11, C17, S11} 2.3.8. Save drawings to storage devices {S11} 3. BASIC CADD SKILLS The following skills must be performed in 2D and/or 3D as appropriate. 3.1. CREATE 3.1.1. Create new drawing {M1, M2, M4, M6, M7, M8.9, S11} 3.1.2. Perform drawing set up {C10, C11, C17, M1, M2, M4, M6, M7, M8.9, S3, S8, S11} 3.1.3. Construct geometric figures (e.g., lines, splines, circles, and arcs) {M1, M4, M6, M7, M8.9, S11} 3.1.4. Create text using appropriate style and size to annotate drawings {M1, S8, S11} 3.1.5. Use and control accuracy enhancement tools (e.g., entity positioning methods such as snap and XYZ) {S3, S8, S11} 3.1.6. Identify, create, store, and use appropriate symbols/libraries {C10, C20, C21, M1, M4, M6, M7, M7.1, M8.9, S2, S3, S8, S11} 3.1.7. Create wireframe/solid models {M1, M4, M6, M7.1, M7.4, M8.9, M12, S2, S3, S8, S11} 3.1.8. Create objects using primitives {S2, S3, S8, S11} 3.1.9. Create 2-D geometry from 3-D models {M8} 3.1.10. Revolve a profile to create a 3-D object {M1, M8.9, S3, S8, S11} 3.1.11. Create 3-D wireframe models from 2-D geometry {M8} 3.2. EDIT 3.2.1. Utilize geometry editing commands (e.g., trimming, extending, scaling) {M1, M8.9, S2, S3, S8, S11} 3.2.2. Utilize non-geometric editing commands (e.g., text, drawing format) {M1, M8.9, S2, S8, S11} 3.3. MANIPULATE 3.3.1. Control coordinates and display scale {M8.9, M9, M10, M11, S2, S3, S8, S11} 3.3.2. Control entity properties (e.g., color, line type) {S3, S8, S11} 3.3.3. Use viewing commands (e.g., dynamic rotation, zooming, panning) {M8.9, S11} 3.3.4. Use display commands (e.g., hidden line removal, shading) {M8.9, S11} 3.3.5. Use standard parts and/or symbol libraries {C8, C10, C11, M1, M8.9, S11} 3.3.6. Plot drawings on media using correct layout and scale {M1, M8.9, S2, S3, S8, S11} 3.3.7. Use layering techniques {S11} 3.3.8. Use grouping techniques {S11} 3.3.9. Minimize file size {S11} 3.4. ANALYZE Use query commands to interrogate database (e.g., entity characteristics, distance, area, status) {C11, M5.1, M5.2, M5.3, M5.4, M5.5, M7.1, S8, S11} 3.5. DIMENSIONING Use associative dimensioning correctly {S11} 4. ADVANCED CADD SKILLS 4.1. CREATE 4.1.1. Create wireframe and/or solid models {S2, S3, S8, S11} 4.1.2. Create non-analytic surfaces using appropriate modeling (e.g., non-analytic: NURBS, B-spline, Gordon, Bezier, Coons) {S2, S3, S8, S11} 4.1.3. Create analytic surfaces using appropriate modeling with planes and analytic curves (e.g., conic, cylinder, revolution, ruled) {S2, S3, S8,

S11} 4.1.4. Create offset surfaces {S2, S3, S8, S11} 4.1.5. Find intersection of two surfaces {S2, S3, S8, S11} 4.1.6. Create joined surfaces {M8.9, S2, S3, S8,S11} 4.1.7. Create a fillet or blend between two surfaces 4.1.8. Create feature based geometry(e.g., holes, slots, rounds) {M8.9} 4.1.9. Create cut sections {M1, M8.9, S2, S3, S8, S11} 4.1.10. Construct and label exploded assembly drawings {C1, C7, M1, M6, M8.9} 4.1.11. Perform Boolean operations (e.g., union, subtraction, intersection) {S2, S3, S8, S11} 4.2. EDIT 4.2.1. Trim surface {M1, M8.9, S3, S8, S11} 4.2.2. Manipulate surface normals {M1, M8.9, S3, S8, S11} 4.2.3. Extend surface {M1, M8.9, S3, S8, S11} 4.2.4. Edit control points (e.g., surfaces, Bezier) {M1, M8.7, S3, S8, S11} 4.2.5. Modify geometry via Boolean operations {S2, S3, S8, S11} 4.2.6. Edit primitives (e.g., moving, copying, resizing) 4.3. MANIPULATE 4.3.1. Perform axis view clipping {M8.9, S2, S3, S8, S11} 4.3.2. Extract wireframe data from surface/solid geometry {S11} 4.3.3. Shade/render object (e.g., reflectivity, opacity) {M1, M8.9, S2, S3, S5, S6, S7, S8, S11} 4.4. ANALYZE 4.4.1. Extract geometric data {C11, S3, S8, S11} 4.4.2. Extract attribute data {S8, S11} 4.4.3. Identify gaps in non-intersecting surfaces {M4.1, M4.3, M4.4, M5, S11} 4.4.4. Obtain surface properties (e.g., area, perimeter, bounded volume) {M4.3, M4.4, M5, S2, S3, S8, S10, S11} 4.4.5. Obtain mass properties data (e.g., moments of inertia, centroids) {S2, S3, S8, S9, S11} 4.5. CADD PRODUCTIVITY AND WORK HABITS 4.5.1. Perform customization to improve productivity (e.g., customize menus, function keys, script files, macros) {C8, C10, C11, S11} 4.5.2. Manipulate associated non-graphical data {C8, C10, C11, S11} 4.5.3. Use template and library files to establish drawing standard presets {C8, C10, C11, S11} 4.5.4. Develop geometry using parametric programs {S2, S3, S8, S11} SUPPLEMENTS Related Academic Skills -- Communication {C} Skill -- Math {M} Skills -- Science {S} Skills Employability Skills Recommended Tools And Equipment for CADD Training Recommended Hours of Instruction Recommended Qualifications of a CADD Instructor Measurable Skills A. The recommended list of related academic skills contains academic knowledge necessary for a CADD user to be proficient. With the acquisition of these skills, it is assumed that the user has writing capabilities, a technical vocabulary, can use the algebraic order of operations to solve problems and generate conclusions, and can use computers to process information for mathematical applications and problem solving. B. The principal source of the related academic skills section is "The Basic Taxonomy of Skills" by Lester Synder. C. The list of employability skills is considered desirable for a CADD user in order to become a better worker. D. The principal source of employability skills section is the document produced by the SCANS Commission (Secretary's Commission on Achieving Necessary Skills). E. The recommendations concerning tools and equipment, hours of instruction, and CADD instructor qualifications were made by a committee of technical experts from organizations on our coalition. These recommendations serve only as guidelines for training programs. RELATED ACADEMIC SKILLS COMMUNICATION SKILLS Assumption of basic reading skills. Assumption of basic keyboard skills C1 Compose and edit using correct punctuation C1.1 sentences C1.2 paragraphs C1.3 written drafts C1.4 oral drafts C2 Compose and edit sentences or paragraphs for completeness/irregular expressions/modifiers/cause and effect relationships/ paragraph coherence/paragraph transitions C3 Compose and edit reports, essays, information requests, persuasive text, proofs and revisions, summaries, social communications and business letters C4 Compose and edit general forms or documents C5 Compose and edit audio-visual aids C6 Compose and edit notes C7 Spelling and vocabulary C7.1 compose and edit sentences using correct spelling C7.2 identify information and written abbreviations C7.3 apply and use definitions C8 Use text resource table of contents, resource glossaries, resource indexes C9 Collect, organize, and research oral and written information C10 Use reference books, manufacturers' manuals, library resources, and trade publications C11 Read and comprehend written

information C11.1 the main idea C11.2 the purpose C11.3 the conclusion C15 Evaluate written facts and opinions C16 Identify written information when reading C17 Adapt strategic listening by adhering to directions, tasks, nonverbal and verbal cues C18 Apply informal oral communications from employee to supervisor, supervisor to employee, peer to peer, with customers and others C19 Adapt communication techniques to cultural differences C20 Use library resource card catalogs C21 Use library resource guides C22 Collect and organize information to adapt to strategy writing for oral and written presentations C23 Comprehend information when reading C24 Adapt listening skills and attend verbal and nonverbal cues C25 Evaluate information when listening for clarity and appropriateness C26 Present speech for formal and/or informal information request MATH SKILLS M1 Basic arithmetic operations - compute addition, subtraction, multiplication, division (mentally and/or calculator) for the following categories: whole numbers, decimals, fractions, and mixed numbers M2 Basic arithmetic operations - conversions: units, square units, identify English measures length/volume/weight, convert units metric/English, convert units and time M3 Basic arithmetic operations - probability and statistics: interpret charts/tables/graphs M4 Geometry - reasoning and logic: M4.1 understand definitions, conditions M4.2 formulate and verifies conclusions M4.3 solve problems, generate conclusions, deductive reasoning M4.4 calculate and evaluate reasoning- invalidate arguments M5 Geometry - calculate and evaluate geometric figures: M5.1 perimeter M5.2 circumference M5.3 area M5.4 surface M5.5 volume M5.6 congruent triangles M6 Geometry - construct geometric figures: lines, angles, congruent angles, congruent segments, angle bisectors, parallel/perpendicular, geometric figures, and three dimensional figures M7 Geometry - measurement: M7.1 measure direct - distance M7.2 calculate and evaluate measurement precisely, M7.3 formulate and verify angles - acute/obtuse/right M7.4 measure direct angles M7.5 estimate and round M7.6 classify triangles by sides and angles M8 Geometry - identify geometric figures and symbols: M8.1 interpret symbols M8.2 identify lines M8.3 identify lines - vertical/horizontal M8.4 identify lines-parallel/perpendicular M8.5 identify lines - ray/segment M8.6 distinguish angles/circle/arcs M8.7 identify geometric figures circles/angles/arcs/polygons M8.8 identify geometric figures M8.9 understand geometric figures: visual perception M9 Algebra - graphing: calculate and evaluate Cartesian midpoints M10 Algebra - graphing: solve problems - coordinate geometry and conic sections M11 Algebra - graphing: solve problems - coordinate geometry and distance formula M12 Trigonometry - use calculator to compute trigonometric functions (e.g., cosines/sines/tangents) M13 Convert decimals/fractions/ratios/percentages SCIENCE SKILLS S1 Apply and use maps/charts/tables/graphs S2 Convert measurement units S3 Measure direct distance and/or length S4 Measure direct angles S5 Describe and explain color in general, related to blindness, cones, pigmentation, rainbows, rods, and spectra S6 Describe and explain lenses including concave, convex, and focal length S7 Describe and explain light including angle of incidence and reflection, critical angle -- fiber optics, diffraction, electromagnetic radiation, electromagnetic spectrum, fluorescent, incandescent, lasers, opaque, photoelectric, photons, polarization, refraction, speed, translucent and transparent, and ultraviolet S8 Identify measurement units S9 Measure mass and weight S10 Measure volume including liquids and solids S11 Use computers to process information, for mathematical applications and problem solving EMPLOYABILITY SKILLS These are defined as skills and behaviors that are known, valued, and practiced in the workplace. RESOURCES: -- Identify, organize, plan, and allocate resources; -- Select drawing relevant activity, allocate time, keep records and follow schedule; and -- Use company resources responsibly (e.g., supplies, equipment). INTERPERSONAL: -- Work with others; -- Participate as member of team (e.g., following instructions, providing feedback, cooperating with established team goals); -- Serve Clients/Customers - work to satisfy customers'

expectations (internal and external customers); -- Maintain professional respect for co-workers and customers without prejudice; -- Understand how the structure of the organization works and work effectively within it; -- Communicate effectively with work related personnel; and -- Provide job-related instruction to others. INFORMATION: -- Acquire and use information; -- Acquire and evaluate job-related documents; -- Organize and maintain files; -- Interpret and communicate job-related information; and -- Use computers to process information in the work environment. SYSTEMS: -- Understand complex terminology; -- Is familiar with inter-relationships used in the profession; -- Understand the technical aspects of everyday life on the job and the tools that relate to the profession; and -- Suggest modifications to existing processes and develop new or alternative methodologies to improve performance . TECHNOLOGY: -- Work with a variety of technologies; and -- Apply current and appropriate technology to specific tasks . THINKING SKILLS: -- Think creatively; -- Make intelligent decisions; -- Solve problems; -- Visualize, organize and process symbols, pictures, graphs, objects, and other information; -- Use efficient learning techniques to acquire and apply new knowledge and skills; and -- Practice deductive and inductive reasoning skills . PERSONAL QUALITIES: -- Practice individual responsibility; -- Have good self-esteem, believe in own self-worth, and maintain a positive view of self; -- Relate well to others; -- Set personal goals, monitor progress, and exhibit self- control; -- Possess integrity; -- Maintain a professional image; -- Demonstrate dependability; -- Demonstrate a good work ethic; -- Demonstrate willingness to learn; -- Provide constructive praise or criticism; -- Demonstrate flexibility; -- Work safely; and -- Balance work, family, and personal life. GENERAL KNOWLEDGE OF THE INDUSTRY: -- Know the scope of the industry and how parts interrelate; -- Understand the economics pertinent to the department (e.g., supply costs, productivity, business financial decisions); and -- Read, analyze and interpret examples of industry reports and specifications and standards. TOOLS and EQUIPMENT for CADD TRAINING Recommendation CADD software is designed to run on a wide range of hardware platforms such as personal computers, engineering workstations, mini-computers or mainframes. Most CADD software can be run on a variety of hardware platforms, each of which has advantages and disadvantages in terms of price and performance. Due to the rapidly evolving computer technology and related software capabilities, specific component designations must be made on an individual basis. The key factor to success is to match needs with abilities, performance, and cost. Considering these factors, the following guidelines are provided. CADD system hardware selection will have to consider the following components in the selection process: -- CPU (e.g. processor, RAM); -- Display system (e.g. monitor, graphic cards); -- Input peripherals (e.g. mouse, graphics tablet); -- Output peripherals (e.g. plotter, laser printer); -- Mass storage devices (e.g. floppy disk, hard disk); -- Back-up devices (e.g. tape drive, WORM drive); -- Accessories (e.g. CD-ROM drive, UPS, modem); -- Network (e.g. data); and -- Training accessories (e.g. video network, projection devices). The recommended process for selecting a CADD system is: 1. Review the Core CADD Skills document and determine the CADD skills to be learned. 2. Investigate/choose the CADD software that will best accomplish the learning of these skills selected. 3. Select appropriate computer hardware for the CADD software selected. Thus, the hardware should always be selected LAST. The ideal training environment will have one learner per work station. HOURS of INSTRUCTION Recommendation The following is an estimate of the number of hours required to teach the different segments of each core CADD technical skill area, excluding the related academic skills. Portions of these areas can be taught concurrently. Hours include lab and classroom hours. SECTION RANGE HOURS OF INSTRUCTION MIN to MAX Fundamental Drafting Skills 80 to 130 hours Fundamental Computer Skills 10 to 30 hours Basic CADD Skills 80 to 130 hours Advanced CADD Skills 120 to 220 hours QUALIFICATIONS of a CADD INSTRUCTOR Recommendation These guidelines are

informational only. It is understood that some instructors may be qualified with less than minimum recommended criteria; and some instructors may be unqualified regardless of education or experience. Guidelines for Qualifications of a CADD Instructor -- Must demonstrate a mastery of content as outlined by the CADD skill standards document. Mastery can be demonstrated by passing the national voluntary CADD test; -- Demonstrate the ability to teach using curriculum and lesson planning guide; -- Be able to update experience through internship, software training, etc.; and -- A related degree or equivalent work experience according to chart below. No Degree - 8 yrs of related work experience with 2 years being recent CADD experience AS Degree - 4 years of related work experience with 2 years being recent CADD experience BS/MS/PhD - 2 years of related work experience with 2 years being recent CADD experience MEASURABLE SKILLS To add more value to the CADD Skill Standards, work was done by committee members to make the skills measurable. In other words, it was determined to what extent each skill should be accomplished. The measurable skills supplement needs to be finalized but is available now in working draft form. To receive a copy of this working draft, please contact FIM in writing and request a copy of the "Measurable Skills Supplement." COMMITTEE MEMBERS Executive Committee Elliot Actor, ALTIUM, an IBM Company and Computervision Dave Arnsdorf, Industrial Technology Institute Livingston Davies, CADKEY and Cutting Edge Technologies Deane Dayton, INTERGRAPH Phyllis Eisen, National Association of Manufacturers Richard Funke, Allen-Bradley Mike Galloway, Merck Manufacturing Division Don Goodwin, Texas State Technical College System Tom Hackley, National Center for Manufacturing Sciences Madeleine Hemmings, National Vocational Technical Education Foundation Wayne Hodgins, AUTODESK Rachel Howard, American Design Drafting Association Dr. Carole Johnson, NASDVTE and Minnesota Technical College System Alan Kalameja, IBM CIMHE Alliance Charles Klement, National Electronics Manufacturing Productivity Center, Inc. Harold Lewis, VICA Virginia Lopez, Aerospace Industries Association Bill Martin, Martin Marietta Energy Systems, Inc. John McCleary, National Center for Manufacturing Sciences Jimm Meloy, AUTODESK Fred Nichols, NACFAM Joel Orr, League for Engineering Automation Productivity Leo Reddy, NACFAM/FIM Mike Seely, Dataquest Jacqueline Sullivan, ALTIUM, an IBM Company Brian Turner, Work and Technology Institute Barry Umbs, Allen-Bradley Jim Weaver, Alliance for Manufacturing Productivity Bill Weiser, Minnesota Technical College System Sharon Woollard, MI Dept of Commerce Dr. Carl Wyatt, U.S. Army Training and Doctrine Command Technical Committee Members Kendall Alton, The University of Southwestern Louisiana and Louisiana Productivity Center Dave Arnsdorf, Industrial Technology Institute Joe Brunetti, KAYDON and IAM (International Association of Machinists) Frank Dagostino, Trident Technical College Dean Daily, Allen-Bradley Bruce Downing, New England Institute of Technology Gerry Erwin, General Motors and IAM Carol Harper, Texas State Technical College Cheryl Hinkle, INTERGRAPH Wayne Hodgins, AUTODESK D.K. Irick, Martin Marietta Energy Systems, Inc. Dave Johnson, Hughes/Beattie and Associates, Architects Harry Kohlbrenner, Lincoln Technical Institute and Career College Association Dave LaRue, ITT Technical Institute Philip Leverault, Fox Valley Technical College and IBM CIMHE Alliance Paul Mailhot, CADKEY, Inc. James McGuire, VICA Moustafa Moustafa, Old Dominion University Pat O'Connor, Texas State Technical College Jim Poarch, Augusta Technical Institute and AMP David Powell, Oakland Community College Walter Silva, Industrial Devices and CADKEY, Inc. William Smeltzer, Martin Marietta Energy Systems, Inc. Albert Storms, Maser Sosinski Associates Jack Thompson, Macomb Community College Mike Wong, ALTIUM and IBM Company Editing Task Force Kendall Alton, The University of Southwestern Louisiana and Louisiana Productivity Center Dave Arnsdorf, Industrial Technology Institute Bob Attarian, MOTECH, Inc. Joe Brunetti, KAYDON and IAM Dean Daily, Allen-Bradley Dick DeBolt, Motorola Cheryl Hinkle, INTERGRAPH Wayne Hodgins, AUTODESK D.K. Irick, Martin Marietta

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