



Mike Johanns
Governor

Building a 21st Century Nebraska

Electronics Manufacturing

- Industrial & Analytical Instruments
- Telecommunications Equipment
- Electronic Components

Introduction

In 2000, a partnership composed of Fannie Mae, Nebraska Chamber of Commerce and Industry, Nebraska Department of Economic Development, Nebraska Development Network, Nebraska Diplomats, Nebraska Economic Developers Association, Nebraska Investment Finance Authority, Nebraska Municipal Power Pool, Nebraska Public Power District, and Omaha Public Power District commissioned Deloitte & Touche Fantus to conduct a targeted industry study for Nebraska. Deloitte & Touche Fantus was charged with identifying business clusters that make sense for Nebraska and that meet four criteria:

- Greater than average capital investments
- Growth industry
- Greater than average payroll and benefits
- Produce products or services that are high value-added

The Deloitte & Touche Fantus study, available on the Department of Economic Development web site (www.neded.org) identifies six business clusters. Three clusters with maintain existing Nebraska strengths: agribusiness, metal products manufacturing, and financial services. The other three provide areas of growth opportunity focused on the knowledge-based economy: biotechnology, electronics manufacturing, and information technology software development.

For Nebraska to successfully develop the targeted industries, communities within the state must have the infrastructure to support growth. The Department of Economic Development's initiative encourages communities to develop an inventory of pre-zoned, ready-to-build sites and ready-to-occupy industrial and commercial buildings.

This publication is a guide for development of shovel-ready sites and read-to-occupy or near ready-to-occupy buildings meeting the needs of the electronics manufacturing industry, primarily associated with industrial and analytical instruments, telecommunications equipment, and electronic components industries. (See Nebraska Targeted Industry Study for background information regarding these industries.) Generic business examples include producers of laboratory instruments and apparatus, measuring and controlling instruments, electrical test and measuring instruments, network equipment, customer premises equipment, fiber optics, wireless communications equipment, satellite communications systems, electronic capacitors, resistors, connectors and other technically advanced products. Manufacturing electronic components is electric power sensitive, demanding reliable power at a competitive price.

The Department of Economic Development's intent is to provide communities a variety of building and site choices. The communities can select the building size and type based on the employment needs and skills which best fit their needs.

To capture the opportunities offered by electronic industries, Nebraska communities need to develop sites and facilities that meet their specific requirements. There is no denying that developing manufacturing sites and buildings translates into a substantial investment for communities. Beyond financing the site and the building, there are carrying, finishing, and incentive costs that need to be factored into developing the overall financial package. However, equally important considerations are the long-term rewards that communities enjoy from attracting new manufacturers and employees and the solid relationship that develop and grow as a result.

Warning: During the fall and winter of 2000, the electronics industry slipped into a worldwide recession, primarily driven by the excess inventories. While the industry currently looks bleak, almost everyone agrees the electronics industry will be a major part of the U.S. economy's expansion during this century.

Tax Climate:

Capital investment incentives for electronics companies are important; however, it is unlikely that electronics manufacturers will qualify for the same level of assistance that manufacturers in other industries typically receive. A great deal of the investment these companies make is in terms of human resources and the training provided to employees. However, both property and income taxes will be issues for this group. In general, Nebraska's sales only factor for state income tax and its personal property tax depreciation schedules are advantageous for electronic firms.

Electronics manufacturing sector may qualify for state assistance of:

- Business Incentives
 - Statutory Incentives
 - The Nebraska Employment, Investment and Incentives Act
 - The Nebraska Growth and Investment Act
 - Rural Economic Opportunities Act
 - The Invest Nebraska Act
 - Details of the statutory incentives are available on the Department of

Economic Development website (www.neded.org).

- Job Training Assistance (minimum-qualifying wages of \$8.25 per hour plus benefits).
- Community Development Block Grant Low Interest Loan Program (up to \$500,000 – minimum-qualifying wages of \$8.50 per hour plus benefits). OR
- Department of Economic Development Spec. Building Program (up to \$250,000 per project)

Other Benefits for Electronics Manufacturers

To encourage the growth of the electronics industry in Nebraska the Nebraska Center for Excellence in Electronics (NCEE) was recently established. The NCEE is a unique partnership between Nebraska's electronics industry, state government, and institutions of higher education. NCEE will provide training, product development support, and testing for regulatory compliance of electronic products.

The 15,700 square foot facility includes:

- 10-meter anechoic chamber certified for FCC, Canada and EC regulatory testing.
- Environmental testing capabilities for EC and MIL 810, C, D, and E certifications.
- Surface mount production equipment for training and fast prototype builds capable of placing 0402 size parts.

General Site Information

Electronics manufacturers can be best located in industrial and technology parks. Companies producing components, intermediate, and finished goods tend to locate near each other because close proximity allows access to better innovations. Because of this a technology park is the most desirable place for them to locate. However, these businesses could be located in most areas that are suitable for commercial buildings. With the exception electronic components manufacturing, electronics production tends to produce few pollutants and be relatively quiet. The main pollutant that component manufacturers produce is waste water, which may require a Pre-Treatment WasteWater permit from the state. In some cases large components manufacturers may also have to get a Hazardous Waste permit. A Hazardous Waste permit is necessary when electronics component manufacturers dispose of significant amounts of chemicals and/or waste metal products.

In general, the topography of the site should be flat with little change in elevation. The site should also be large enough so that the building can be expanded. The electronics industry is rapidly changing and companies need buildings and sites that are flexible. For this same reason most electronics manufacturers prefer to own rather than lease their buildings.

Site considerations for electronics sites and parks include:

- Easy access to airport and air shipping: Many of the customers for industrial electronics are not in Nebraska, and many are not in the country. Additionally, these customers often demand receipt of their product in one or two days. Accommodating such demands requires access to t over night shipping services.

- Easy highway access: Even though most electronics manufacturers do not ship products in large truckloads, good access to highways and the interstate is needed.
- Proximity to odors and vibrations: The site/technology park should not be in close proximity to waste water treatment plants, landfills, livestock confinement operations, sewage lagoons, railroad tracks, or anything else that cause excessive vibrations.

Building Specifications

In today's economy, site and building searches often happen quickly. Having a developed site and an availability building may give a community an advantage.

Most buildings for electronics companies are either pre-manufactured metal buildings or tilt-up concrete. In general, electronics companies require a single story building. Electronics companies do not want to be located with other businesses in a multistory or multitenant building. Lighting is important for electronics manufacturers. The products being manufactured have to be carefully inspected and tested. Minimal build-out is preferred, offering large, open floors for flexible design. Factors to consider when sizing and configuring speculative buildings targeted to electronics companies are:

- Typically buildings are 20,000 to 75,000 square feet.
- Design is as square as possible.
- Sidewalls need to be no higher than 20 feet for manufacturing areas and can be as low as 10 feet for office and research and development areas.
- Air conditioning is a necessity.
- Sprinkler system is required.
- The building should be designed for structural integrity so that at least one sidewall can be removed to accommodate future expansion. The building should be situated on the site so as to allow for future expansion.
- Office space is typically 20% of the overall square footage.
- Parking space should allow for 2.5 stalls per 1000 square feet of building. Asphalt covering for the passenger vehicle parking is acceptable.
- Buildings will need one dock for the first 20,000 square feet. Most of these building will have a minimum of three docks and at least one drive-in door.

Utilities

Electric Service – Most electronics manufacturers will want phase 3 electrical service.

Water Service – Manufacturers of electronic components have an average water main size of 8 inches. They have a line size of between 1 and 2 inches. Other electronics manufacturers not involved in producing components will only need 4 to 6 inch water mains and lines of 1 inch.

Sewer Access – Many electronic manufacturers have no special sewer system requirements. However, those that produce great amounts of wastewater, particularly component manufacturers, will need sewer access. The size of the

sewer main will depend on how much wastewater is produced. For example one components manufacturer located in Iowa had a 16,000 square foot building with a 12-inch sewer main and 4-inch lines.

Natural Gas – Most electronics manufacturers want access to natural gas, but do not have any special needs, a 4-inch main is usually enough.

Telecommunication

- T1 service
- Capacity needs to accommodate e-business and electronic commerce, including Internet access
- Dedicated voice and data line may be required

Transportation Requirements

- Good road access within the technology park and good highway or interstate access outside the site/park are necessary for the delivery of raw materials and the transportation of finished products. Electronics companies are not sensitive to transportation cost. Finished products are often expensive and delicate, but small.
- Overnight package delivery services are required. The most important transportation factor is the ability to quickly ship material, often requiring delivery in one or two days.
- Private airport and commercial air service are greatly preferred.
- Rail service is not needed and rarely used by electronics manufacturers.

Labor/Workforce Requirements

As a rule of thumb, electronics companies require about 400 square feet per employee working the busiest shift. This type of high tech business requires access to both a skilled and semi-skilled workforce. Businesses that are heavily involved with research and development will need access to the most highly skilled workers such as chemists, microbiologist, mechanical, electrical, chemical, and software engineers.

Following are job title descriptions of three Nebraska firms:

Scenario 1: Computer Assembly

This company employs 28 people and has a 50,000 square foot facility. About 1500 square feet are used for office space and the remaining is divided roughly in half between manufacturing and warehousing.

Position Title	# of employees
General Manager	1
Engineer	1
Shipping and Receiving Manager	1
Shipping and Receiving Technicians	2

Receptionist/Secretary	1
Maintenance	1
Office Manager	1
Production Manager	1
Inventory Clerk / Purchasing Agent	1
Production Workers	18
Total # of Employees	28

Scenario 2: This company is involved in the areas of Moldmaking, Tool and Die Machining and in producing Level Controls

The company employs 99 people in a 75,000 square foot facility. The building has 18 feet high sidewalls in the manufacturing area and 22 feet high walls for the warehouse.

Position Title	# of employees
Accounts Payable Clerk	1
Assemblers	7
CEO	1
CNC Manager	1
CNC Operator	4
CNC Programmer	2
Controller	1
Custodians	3
Customer Service Rep	2
Drafter	1
Electrical Engineers	2
Human Resources Manager	1
Information Systems	1
Machine Custodian	1
Machinists	4
Maintenance	2
Master Scheduler	1
Material Handler	1
Materials Manager	1
Mechanical Engineer	1
Mold Tender	24
Molding Department Manager	1
Molding Technician/Supervisor	6
Office Administrator	1
Payroll Clerk	1
Plant Manager	1
President	1
Production Manager	1
Purchasing Assistant	1
Quality Assurance Manager	1
Quality Control Auditor	4
Quality Control Technician	3
Receptionist	1
Sales Staff	8

Sales Support	4
Shipping/Receiving Clerk	2
Tooling Designer	1
Toolmakers	16
Toolroom Manager	1
Warehouse/Driver	1
Welder	1
Total	120

Scenario 3: Company Produces Products in the Areas of Engineering & Scientific Instruments, Pollution & Process Monitoring Equipment.

The company has 430 employees and 156,000 square foot facility. It is located on 33-acre site, which has allowed the company to expand.

Position Title	# of employees
Administration	
Professional	1
Management	6
Engineering	
Engineers	21
Technicians	6
Management	5
Clerical	1
Human Resources	
Professional	4
Technicians	1
Management	1
Finance	
Accountants	2
Clerical	8
Management	5
Information Technology	
Programmers	4
Clerical	2
Technicians	1
Management	2
Manufacturing Assembly	
Management	8
Technicians	15
Assemblers	84
Machine Shop	
Management	4
Machinists	20
Operators	22
NC Programmers	2
Molding	
Management	2
Assemblers	3

Operators	15
Shipping/Receiving/Stocking	
Management	2
Material Handlers	6
Shipping Clerks	7
Receiving Clerks	2
Clerical	9
Assemblers	2
Manufacturing Administration	
Management	6
Technicians	6
Clerical	5
Professional	12
Marketing	
Management	11
Professional	12
Technicians	2
Clerical	3
Sales and Service	
Management	20
Outside Sales	13
Insides Sales	6
Clerical	12
Technicians	22
Service Engineers	16
Field Service Engineers	1
Customer Service Representatives	10
Total	430

Wage data for some electronics manufacturing positions:

Nebraska Wage Estimates

Occupation Title	Employment	Median Hourly	Mean Hourly	Mean Annual (1)	U.S. Mean Annual (1)
Accountants and Auditors (2)	3,790	\$16.84	\$19.06	\$39,630	\$44,320
Administrative Services Managers	1,750	\$20.24	\$22.80	\$47,430	\$48,580
Biological Technicians	260	\$11.61	\$12.18	\$25,330	\$32,060
Biomedical Engineers	50	\$18.97	\$21.71	\$45,150	\$52,430
Chemical Engineers (2)	(5)	\$27.66	\$26.92	\$55,990	\$64,250
Chemical Technicians	150	\$12.51	\$12.77	\$26,560	\$36,080
Chemists (2)	580	\$19.06	\$20.05	\$41,710	\$51,580
Computer and Information Scientists, Research	90	\$16.34	\$19.75	\$41,080	\$67,180
Computer Programmers (2)	3,390	\$20.40	\$21.79	\$45,330	\$54,960
Computer Software Engineers, Applications	1,740	\$28.40	\$27.19	\$56,550	\$65,780
Computer Software Engineers, Systems Software	3,640	\$25.68	\$27.37	\$56,930	\$66,230
Computer Support Specialists	2,660	\$16.01	\$17.28	\$35,940	\$39,410
Computer Systems Analysts	3,810	\$25.24	\$24.98	\$51,950	\$57,920
Customer Service Representatives	18,560	\$8.82	\$9.67	\$20,120	\$25,360
Database Administrators (2)	610	\$24.00	\$24.28	\$50,500	\$52,550

Electrical and Electronic Engineering Technicians	550	\$17.16	\$16.82	\$34,980	\$39,390
Electrical and Electronic Equipment Assemblers	4,900	\$8.22	\$9.92	\$20,630	\$21,840
Electrical Engineers	710	\$26.36	\$27.32	\$56,820	\$61,520
Electromechanical Equipment Assemblers	160	\$14.41	\$13.63	\$28,360	\$23,830
Electro-Mechanical Technicians	90	\$17.93	\$19.26	\$40,060	\$37,250
First-Line Supervisors of Production	5,250	\$15.72	\$16.73	\$34,790	\$41,250
Human Resources Managers (3)	1,140	\$23.74	\$25.19	\$52,400	\$56,880
Janitors	14,290	\$7.86	\$8.19	\$17,030	\$18,220
Materials Engineers (2)	70	\$24.39	\$24.41	\$50,770	\$59,370
Mechanical Engineering Technicians	160	\$18.58	\$20.08	\$41,770	\$40,560
Mechanical Engineers (2)	370	\$23.15	\$24.23	\$50,390	\$57,010
Network and Computer Systems Administrators	960	\$21.92	\$23.04	\$47,920	\$50,090
Order Clerks	2,910	\$8.09	\$9.05	\$18,820	\$23,950
Purchasing Agents (3)	940	\$17.15	\$18.43	\$38,330	\$42,510
Receptionists and Information Clerks (2)	5720	\$8.41	\$8.64	\$17,960	\$19,870
Sales Managers	2,480	\$25.23	\$26.83	\$55,810	\$69,560
Sales Representatives	9,000	\$19.11	\$21.25	\$44,185	\$52,140
Stock Clerks and Order Fillers (3)	10,290	\$8.18	\$8.94	\$18,590	\$19,650

The data was obtained from the department of labor's 1999 State Occupational Employment and Wage Estimates

- (1) Annual wages have been calculated by multiplying the hourly mean wage by a "year-round, full-time" hours figure of 2,080 hours; for those occupations where there is not an hourly mean wage published, the annual wage has been directly calculated from the reported survey data.
- (2) = Wage rates are calculated using three years of data: 1997, 1998, and 1999.

Community Challenges

- Availability of suitable buildings
- Availability of worker training programs
- Local incentives
- Housing
- Quality of life, including educational, health care, and other community services will be much more important for this group of companies. The quality of life offered by a community will directly relate the ability of business to attract skilled workers.

Proximity to other technology-based industries is important. Typically, electronic manufacturers cluster, providing some synergies and making it easier to recruit workers. For example, an electrical engineer may be reluctant to move to a community, which has limited electrical engineering employment opportunities. Increased professional job opportunities reduce the risk associated with relocating to an area.

- Like most companies, electronic firms prefer to be located close to their suppliers. Close proximity to suppliers not only reduces transportation costs but, more importantly, lessens overhead.
- A close proximity to educational facilities or access (online or video) to educational facilities related to computer science, engineering, and related

technical disciplines will be a plus for these companies which hire sophisticated workers.

- **Availability of incubator facilities:**
Most companies in the industry are small. The history of innovation in the industry fosters a culture of start-up firms. Nebraska has a somewhat limited ability to attract outside companies to the state, and the vast majority of electronic manufacturers in the state are Nebraska born. Incubator facilities are a great way of encouraging these companies to be developed. Incubator facilities that house more than one of these types of businesses are assets in positive location decisions. The companies and their employees like to exchange ideas. Concentrating them in one area facilitates the exchange of ideas.
- **Proximity to testing and R&D facilities:**
The rapid pace of innovation in electronics technology puts a great emphasis on R&D.
- **Labor Availability:**
For most communities, the availability of general labor is a challenge, but the lack of highly skilled workers such as chemists, biologists, and engineers, as well as semi-skilled workers like electronic and electromechanical assemblers make it difficult for manufacturers to locate and/or grow their business. While some use on-the-job training to develop their semi-skilled workers, such training cannot be done for engineers who have intricate knowledge of engineering principles, theories, and equations.

The following table shows the Occupational Work Key scores for the kinds of positions hired by electronics manufacturers.

Position	Applied Math	Applied Technology	Listening	Locating Information	Reading for Information	Teamwork	Writing
ACCOUNT-INFORMATION CLERK	4		4	4	4	4	4
ACCOUNTANT	6	4	4	5	5	4	3
ADMINISTRATIVE ASSISTANT	5	3	4	4	5	4	4
ADMINISTRATIVE CLERK	4		4	4	5	4	4
ASSEMBLER	4	4	3	4	4	4	3
BORING-MACHINE OPERATOR, PRODUCTION	7	5			4		4
CHEMICAL-ENGINEERING TECHNICIAN	6	4		4	5		
COMPUTER PROGRAMMER	6		4	5	5	4	4
COMPUTER SYSTEMS HARDWARE ANALYST	5	5	4	5	5	4	4
CUSTOMER SERVICE REPRESENTATIVE	4	3	4	4	4	4	4
DATA BASE ADMINISTRATOR	5	4	5	5	5	5	4
DRAFTER, ELECTRONIC	6	4	4	5	5	5	4
DRAFTER, MECHANICAL	6	5	4	5	5	4	3
ELECTRICAL ENGINEER	7	5	4	6	6	5	4
ELECTRICAL TECHNICIAN	5	5	4	5	6	5	3
ELECTROMECHANICAL TECHNICIAN	5	5	3	5	5	6	4

ELECTRONICS ASSEMBLER	4	4	4	4	4	4	4
ELECTRONICS TESTER	5	4	3	4	5	4	3
FABRICATOR-ASSEMBLER, METAL PRODUCTS	4	4	4	5	4	5	2
HUMAN RESOURCES	4		4	4	6	5	4
INJECTION-MOLDING-MACHINE OPERATOR	3	4	3	4	4	3	3
JANITOR	3	3	4	4	4	4	3
MACHINE ASSEMBLER	4	4	2	4	4	4	2
MACHINE OPERATOR, GENERAL	4	4	4	3	4	3	3
MACHINE REPAIRER, MAINTENANCE	5	5	4	5	5	4	3
MACHINIST	5	4	4	5	4	4	3
MECHANICAL ENGINEER	6	6	4	5	6	5	4
MECHANICAL-ENGINEERING TECHNICIAN	6	5	5	6	5	5	4
PURCHASING AGENT	5	5	5	5	5	5	4
SALES REPRESENTATIVE, ELECTRONICS PARTS	4	3	3	4	3	3	1
SOFTWARE ENGINEER	6	5	4	5	6	4	5

Data for the Work Keys Scores was obtained from the ACT Workforce Development Website <http://www.act.org/workkeys/>

Appendix A uses the Electronics Assembler's scores as an example of what skills are required for the different levels.

Musts

- Available skilled and semi-skilled work force
- Quality, trainable workforce
- Site free of flood plain, wetlands, and other environmental issues
- Site free of excessive noise and vibrations
- Adequate utility service
- Shovel-ready site (pre-zoned)
- Overnight shipping capabilities

Wants

- Competitive recurring costs
- Favorable site/building characteristics
- Ability to attract and train workers
- Ability to attract and retain professional and technical employees (quality of life issues)
- Local education facilities
- Proximity to colleges and universities
- Proximity to testing facilities
- Compatible surrounding land use
- Limited competition from related industries for employees

Sample Building Specifications

Building One

This building was used for the assembly and packaging of simple electronics. The design of this building is a general outline of what a small electronics assembler's building looks like. This type of building and company could best be located along the I-80 Corridor. This is because companies who specialize in electronics assembly have to be able to easily receive shipments of electronic components from manufacturers, and they have to be able to easily ship out the finished product to distributors and consumers. Communities located on the I-80 Corridor will have an even greater advantage if they have access to overnight shipping capabilities and a near by airport. However, communities in the Industrial and Metropolitan areas of the state may be able to attract electronics assemblers if they can provide them with suppliers and buyers within the community.

15,000 Square Feet Available

Guilford County

onQ Technology

246-E Burgess Road

Greensboro, NC 27409

Former Use: Electronics Assembly & Packaging

Zoning: LI

Price: Lease: \$8.25

Terms: Triple Net

Features	Square Footage	Ceiling Ht. Center (ft)	Ceiling Ht. Eaves (ft)	Floor Thickness (in)	Air Conditioned	Sprinkler System
Manufacturing	8,000	20	20		Yes	Yes
Warehouse	3,990	20	20		Yes	
Office	3,010	N/A	N/A	N/A	Yes	

Specifications

Total Square Feet: 15,000
 In City Limits: Yes
 Multiple Tenants: No
 Spec/Shell Building: No
 Acres/Additional Acres: 1.00/

Utilities

Electrical Service: Duke Power
 Water Service: City of Greensboro
 Wastewater Service: City of Greensboro
 Natural Gas Service: Piedmont Natural Gas
 Telecom Service: Bell South

Construction

Built: 1987
 Additions:
 Exterior: Tilt up concrete
 Interior:
 Roof:

Access

Closest Hwy/Interstate: I-40
 Miles to Hwy/Interstate: 1.5
 Access Road: Burgess Road
 Rail Service: No
 Closest Airport(s): Piedmont International

Facilities

Dock High Doors: 2
 Dimensions: 10' x 8'
 Drive-In Doors:
 Dimensions:
 Overhead Cranes:
 Parking Spaces: 20
 Primary Lighting:

Building Two

This building was built in 2001 to meet the **manufacturing and assembly needs of a company that has three functions in one facility: tool and die making, plastic injection molding and electronic products manufacturing.**

City:	Lincoln	Utilities	
Region:		Electric	Lincoln Electric System
State:	Nebraska	Primary voltage:	277/480
Zoning:	Light Industrial	Single- or three-phase:	3
Surrounding land use:	Industrial	Amperage:	4000
Within city limits?	Yes	Internal distribution:	120/208/ 277/480
Size	75,000	Natural Gas	Peoples Natural Gas
Available contiguous square footage:		Gas main at road?	Yes
Manufacturing:	60,000	Gas line to building?	Yes
Office:	15,000	Main size (inches):	2
Characteristics		Main pressure (PSI):	
Building type:	Industrial	Line size (inches):	2
Previous/current building use:	Manufacturing	Water	Well
Stories:	1	Main size (inches):	2
Year built:	2001	Line size (inches):	2
Number of tenants possible:	1	PSI static:	85
Designed to be expandable?	yes	PSI residual:	0
Highest ceiling (ft.):	25	Flow rate (GPM):	40
Highest sidewall (ft.):	26	Sanitation	Septic/ Lagoon
Column spacing:	50	Sewer main size (inches):	12
Number of drive-in doors:	2	Sewer line size (inches):	4
Number of rail docks:	0	Telecommunications	DSL/fiber backbone
Number of truck docks:	3	Telephone company:	Alltel
Dock door dimensions:	8'X9'	Land	
Truck dock height (inches):	48	Acres for sale with building:	30
Floor thickness (inches):	6	Additional acres available:	0
Sprinkler type:	dry	Number of parking spaces:	128
Building wall type:	Tilt up Concrete	Parking surface:	Asphalt
A/C in office?	Yes	Transportation	
A/C in manufacturing area?	Yes	Rail service?	No
Heating type:	forced air	Minutes to commercial air service:	20
Sale/Lease/Taxes		Minutes to interstate:	5
Own	Yes		

Additional Information

Building features: Epoxy coated floors, fully equipped lunch and break facilities, 20' clearance to roof joist.
Overhead doors: 9X12; Number of rest rooms: 2

Appendix A

The Electronics assembler received the following Work Key Scores.

Position	Applied Math	Applied Technology	Listening	Locating Information	Reading for Information	Teamwork	Writing
ELECTRONICS ASSEMBLER	4	4	4	4	4	4	4

WorkKeys® offers an innovative approach to bridge the gap between levels of job skills needed in the workplace and the actual skill levels of prospective employees. WorkKeys gives students and workers alike reliable information about their workplace skill levels and the skill levels required for jobs, enabling them to make better career and educational decisions. The WorkKeys system currently measures seven workplace skills. A distinct skill scale describes each skill.

The Applied Mathematics assessment measures a person's skill in using mathematical reasoning to solve work-related problems. People who score at Level 4 must be able to performing one or two mathematical operations, such as addition, subtraction, or multiplication, on several positive or negative numbers. (Division of negative numbers is not covered until Level 5.) Problems may require adding commonly known fractions, decimals, or percentages (e.g., $\frac{1}{2}$, .75, 25%), or adding three fractions that share a common denominator. At this level, the person is also required to calculate averages, simple ratios, proportions, and rates, using whole numbers and decimals. Problems at this level require the person to reorder verbal information before performing calculations. The person must read the entire problem carefully to determine which operation(s) to perform and in what order. For some problems, persons must read a simple chart or graph to obtain the information needed to solve the problem.

The **Applied Technology** assessment measures a person's skill in using the basic principles of mechanics, electricity, fluid dynamics, and thermodynamics to solve problems with machines, equipment, and structures found in the workplace. People scoring at Level 4 must be able to solve problems involving a moderately complex system or more than one uncomplicated system. In solving these problems, the person must apply elementary physical principles, such as heat transfer or the flow of fluids through pipes. A Level 4 person is required to understand the operation of moderately complex tools, machines, and systems, such as appliances, pulley-driven equipment, or piping systems that carry more than one fluid and apply elementary principles underlying the operation of physical systems, such as a block and tackle or cooling fins

The **Listening** portion of the Listening and Writing assessment measures a person's skill in listening to and conveying information. People with Level 4 skills can correctly record all the important information and the relationships among pieces of information, in addition to accurately conveying the central idea of a spoken message. However, they may miss or incorrectly record some details, or include irrelevant information.

The **Locating Information** assessment measures a person's skill in using workplace graphics such as diagrams, floor plans, tables, charts, graphs, forms, and instrument gauges. People at Level 4 should be able to use straightforward workplace graphics such as basic order forms, line graphs, tables, instrument gauges, maps, flowcharts, and diagrams. A person scoring at level 4 can find several pieces of information in these types of graphics. In addition, the person can summarize and/or compare information and trends in a single graphic and summarize and/or compare information and trends presented in more than one workplace graphic, such as a charge slip and an invoice showing related information. In order to accomplish this, the person must determine the relationships among the graphics.

The **Reading for Information** assessment measures a person's skill in reading and using work-related information including instructions, policies, memos, bulletins, notices, letters, manuals,

and governmental regulations. At Level 4 the person can read passages that contain more detail and describe procedures which involve a greater number of steps. Some passages describe policies and procedures with a variety of factors that must be considered in order to decide on appropriate behavior. The vocabulary, while elementary, includes words that are more difficult than those at Level 3. For example, the word "immediately" may be used at this level, whereas at Level 3 the phrase "right away" would be used. In addition to the skills tested at the preceding levels, questions at Level 4 require the person to identify important details that are less obvious than those in Level 3 and recognize the application of more complex instructions, some of which involve several steps, to described situations recognize cause-effect relationships determine the meaning of words that are not defined in the reading material.

The **Teamwork** assessment measures a person's skill in choosing behaviors and/or actions that simultaneously support relationships within a team and lead toward the accomplishment of work tasks. A person at level 4 should be able to recognize behaviors or actions that would best support a team and contribute to work performance in situations involving several problems or sources of difficulty. In these work situations, the goals and consequences are not altogether clear, some of the resources may be limited, and/or the team members have diverse needs. The person must be able to identify the organization of tasks and the time schedule that would help the team reach goals efficiently, creatively, and effectively select approaches that accept direction from other team members in order to complete tasks and to build and keep up good team relations identify behaviors that show appreciation for the personal and professional qualities of other team members and respect for their diversity recognize the need for commitment to quality and sensitivity to customers while pursuing the team goal.

The **Writing** portion of the Listening and Writing assessment measures a person's skill in writing work-related messages. People with Level 4 skills can write messages that are clear and generally consistent with standard business English. Such messages contain complete sentences but may include a few minor errors in grammar and punctuation, and/or the writing style may lack clear organization and appropriate transitions.