ELECTROCHEMICAL SUPPORT

AN ENGINEERING SOURCE BOOK

FOREWORD

THIS BOOK CAN BE USED IN CONJUNCTION WITH THE ENGINEERING "WHO, WHAT, WHERE, WHEN, HOW" BOOK. ITS PRIMARY FUNCTION IS TO ACQUAINT YOU WITH ELECTROCHEMICAL SUPPORT AND ITS FUNCTIONS. IT IS AN EASY REFERENCE BOOK FOR ANY INQUIRY YOU MAY HAVE.

TINO ORNELAS
OPERATIONS MGR.
EXT. 1851, 92-331
MAY 28, 1980

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ELECTROCHEMICAL SUPPORT

WALLACE DOELING, MGR.
EXT. 4613, 50-354

STAFF

LARRY BURGESS, MANAGER, DEVELOPMENT ENGINEERING

PRIOR TO TEKTRONIX, WAS EMPLOYED IN MONTANA. ACQUIRED A B.S. DEGREE IN CHEMISTRY FROM LEWIS AND CLARK COLLEGE IN 1966.

FRANCES COOK, MANAGER II, Q.B. LINE

EMPLOYED BY TEKTRONIX IN 1973. BEGAN WORKING IN THE PROTOTYPE LAB IN 1974. BECAME MANAGER IN 1976.

DAVID DAVIS, MANAGER II, CAD/GRAPHICS

EMPLOYED BY TEKTRONIX IN 1961. ACQUIRED A B.S. DEGREE FROM PACIFIC UNIVERSITY IN 1960.

JERRY JACKY, CHEMICAL ENGINEER IV, ADVANCE PROCESS DEVELOPMENT

JERRY HAS A MASTERS DEGREE IN CHEMICAL ENGINEERING. HE HAS BEEN WITH TEKTRONIX SINCE 1965.

TINO ORNELAS, MANAGER II, OPERATIONS

EMPLOYED BY TEKTRONIX IN 1970. BECAME MANAGER OF THE PROTOTYPE LAB IN 1974. ASSUMED RESPONSIBILITY OF OPERATIONS IN 1977.

ADMINISTRATIVE STAFF

GRACE WILSON, DEPARTMENT SECRETARY, ELECTROCHEMICAL SUPPORT
EXT. 7988, 50-354

KAREN MILEWSKI, SECRETARY, ELECTROCHEMICAL SUPPORT
EXT. 7988, 50-354

BEVERLY LAFFERTY, TECHNICAL AIDE, OPERATIONS
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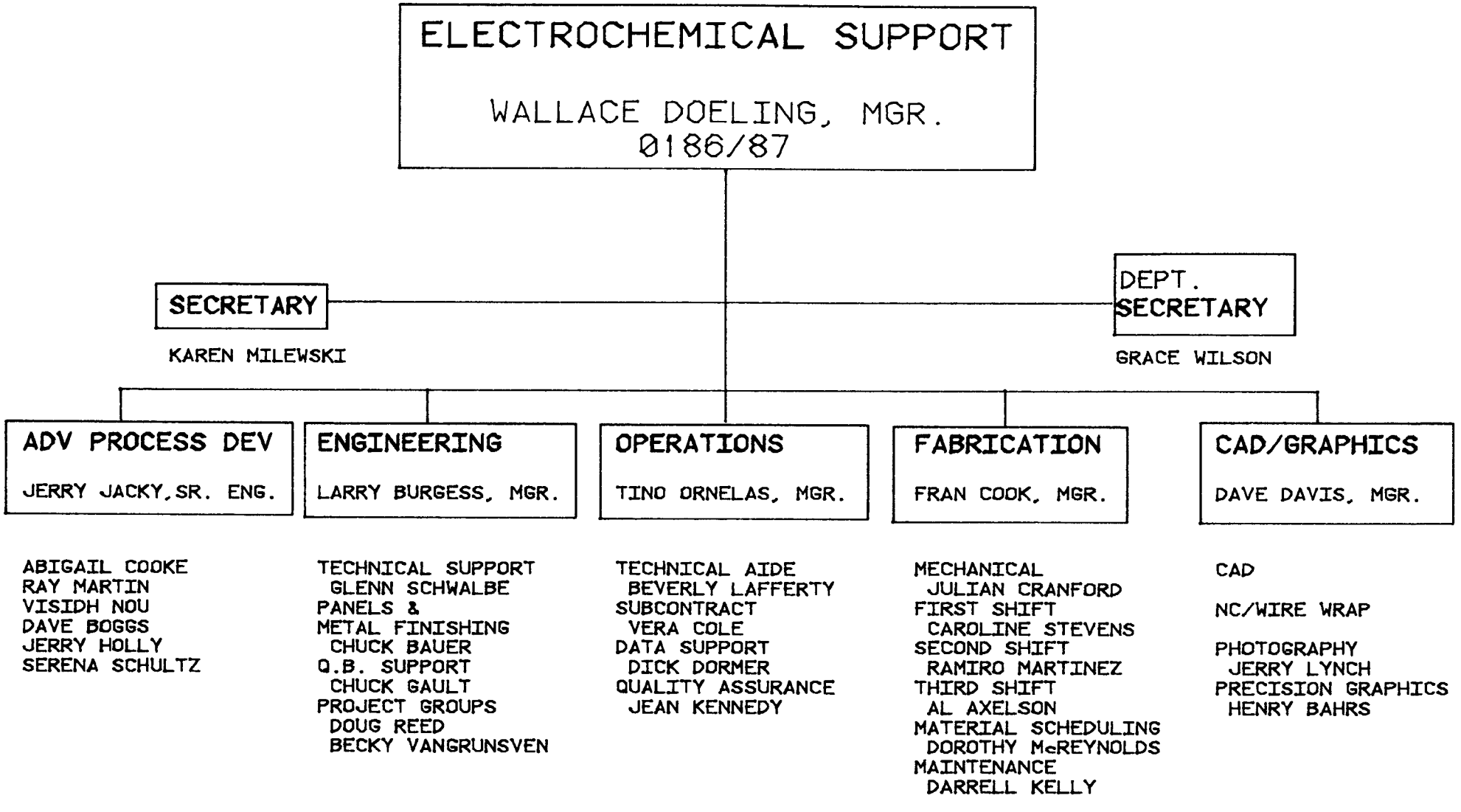
SHANNON BENSON, PROCESS WRITER, DEVELOPMENT ENG.
EXT. 6581, 38-350


ELECTROCHEMICAL SUPPORT
WALLACE DOELING, MGR.
0186/87
SECRETARY
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DEPT. SECRETARY
GRACE WILSON
ADV PROCESS DEV
JERRY JACKY, SR. ENG.
ENGINEERING
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OPERATIONS
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GLENN SCHWALBE
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METAL FINISHING
CHUCK BAUER
Q.B. SUPPORT
CHUCK GAULT
PROJECT GROUPS
DOUG REED
BECKY VANGRUNSVEN
TECHNICAL AIDE
BEVERLY LAFFERTY
SUBCONTRACT
VERA COLE
DATA SUPPORT
DICK DORMER
QUALITY ASSURANCE
JEAN KENNEDY
MECHANICAL
JULIAN CRANFORD
FIRST SHIFT
CAROLINE STEVENS
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AL AXELSON
MATERIAL SCHEDULING
DOROTHY McREYNOLDS
MAINTENANCE
DARRELL KELLY
CAD
NC/WIRE WRAP
PHOTOGRAPHY
JERRY LYNCH
PRECISION GRAPHICS
HENRY BAHRS

28 MAY 80

ADVANCE PROCESS DEVELOPMENT

JERRY JACKY
CHEMICAL ENGINEER IV
EXT. 7830, 38-350

ADVANCE PROCESS DEVELOPMENT IS CHARTERED TO PROVIDE TEKTRONIX WITH STATE-OF-THE-ART HARDWARE FINISHING AND CHEMICAL PROCESSING TECHNOLOGY.

Advance Process Development Staff

Abby Cooke, Chemical Engineer
Ext. 7830, Delivery Station 38-350

Ray Martin, Technician
Ext. 7830, Delivery Station 38-350

Visidh Nou, Technician
Ext. 7830, Delivery Station 38-350

Dave Boggs, Technician
Ext. 7830, Delivery Station 38-350

Jerry Holly, Chemical Engineer
Ext. 7830, Delivery Station 38-350

Serena Schultz, Technician
Ext. 7830, Delivery Station 38-350

Betty Jean Rodriguez, Chemical Eng. II
Ext. 7830, Delivery Station 38-350

Advance Process Development Scope

Provide expertise and facilities for research and development in the following areas:

1. Electroplating and chemplating on metals, plastics, ceramics.
2. Chemical cleaning and etching.
3. Precious metal deposition.
4. Mechanical finishing.
5. Chemical processing, including water conservation.
6. Soldering and other joining methods.
7. Materials evaluation.

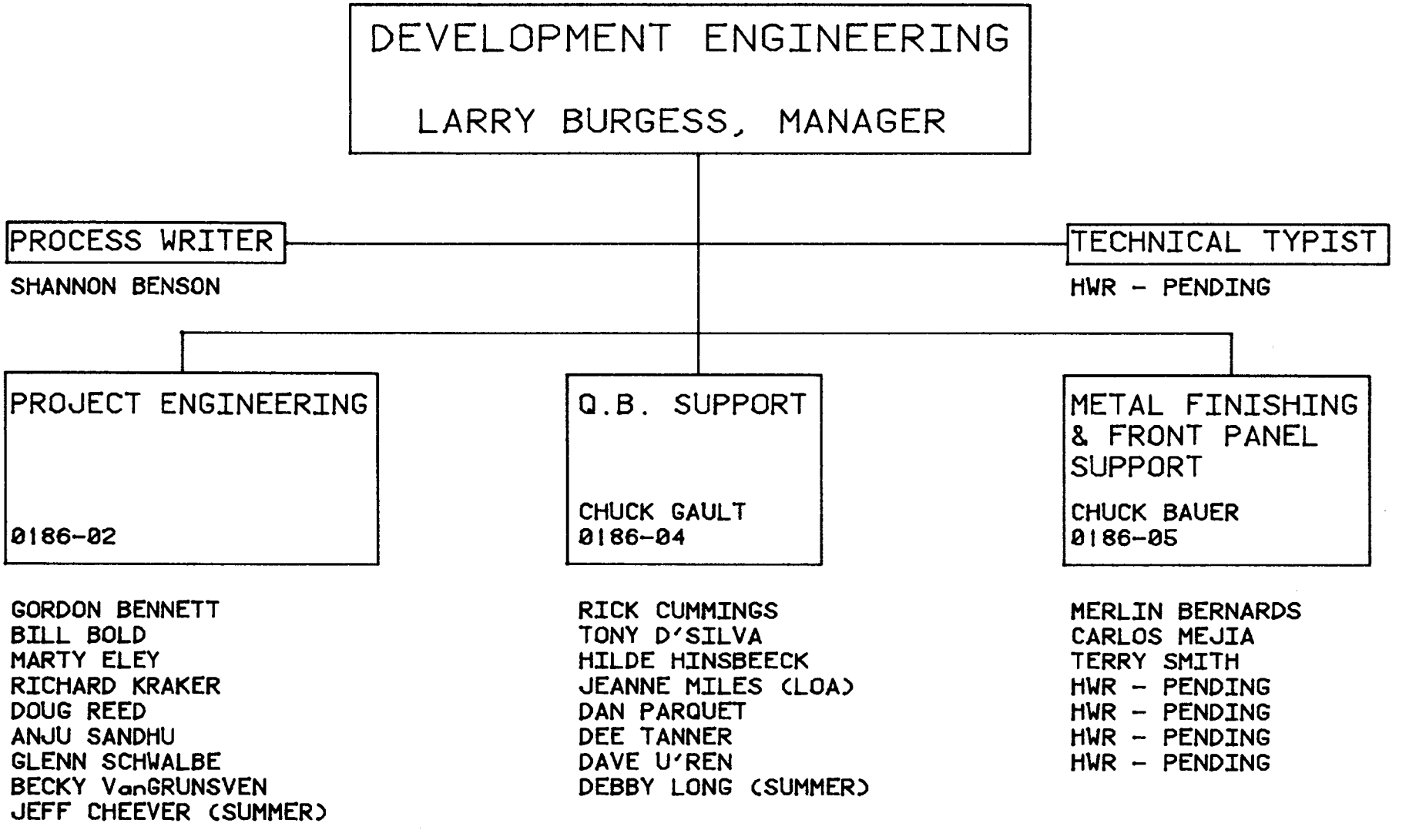
In addition, we work with vendors to provide materials and processing methods which are not available in-house. We also provide consulting services at the design stage to assure process availability at the produciton stage.

Please contact us as early as possible in the design stage concerning any part, material, or process that is not standard. Material selection, design, finishing, buildability, and functional requirements must be coordinated as early as possible.

Development Engineering

Larry Burgess, Manager
Ext. 6581, 38-350

Development Engineering is responsible for providing technical support to the Q.B. Line, Chem Machining, Panel/Metal Finishing, Q.C., Scheduling, and Photography. It must also provide Tektronix with state-of-the-art components and processes using Electrochemical Technology through the use of Engineering Project Groups.


DEVELOPMENT ENGINEERING
LARRY BURGESS, MANAGER
PROCESS WRITER
SHANNON BENSON
TECHNICAL TYPIST
HWR - PENDING
PROJECT ENGINEERING
0186-02
GORDON BENNETT
BILL BOLD
MARTY ELEY
RICHARD KRAKER
DOUG REED
ANJU SANDHU
GLENN SCHWALBE
BECKY VanGRUNSVEN
JEFF CHEEVER (SUMMER)
Q.B. SUPPORT
CHUCK GAULT
0186-04
RICK CUMMINGS
TONY D'SILVA
HILDE HINSBEECK
JEANNE MILES (LOA)
DAN PARQUET
DEE TANNER
DAVE U'REN
DEBBY LONG (SUMMER)
METAL FINISHING & FRONT PANEL SUPPORT
CHUCK BAUER
0186-05
MERLIN BERNARDS
CARLOS MEJIA
TERRY SMITH
HWR - PENDING
HWR - PENDING
HWR - PENDING
HWR - PENDING

ELECTROCHEMICAL DEVELOPMENT ENGINEERING CHARTER

I. TECHNICAL SUPPORT

A. Q.B. SUPPORT

PROVIDES TECHNICAL SUPPORT, INCLUDING CHEMICAL ANALYSIS, TRAINING, TROUBLESHOOTING, SPECIAL PROCESSING, NEW Q.B. PROCESS INTRODUCTION, PROCESS CONTROL, AND OTHER TECHNICAL SUPPORT FUNCTIONS TO THE Q.B. LINE

B. CHEM MILL SUPPORT

PROVIDE TECHNICAL SUPPORT TO THE PRECISION GRAPHICS GROUP, INCLUDING NEW CHEM MILL PROCESS INTRODUCTION, SPECIAL PROCESSING, TROUBLESHOOTING, TRAINING, TECHNICAL LIAISON, AND OTHER TECHNICAL SUPPORT FUNCTIONS.

C. PANEL/METAL FINISHING SUPPORT

PROVIDES TECHNICAL SUPPORT TO THE METAL FINISHING ENGINEERING GROUP, INCLUDING NEW PANEL, POWDER COATING, AND PLATING PROCESS INTRODUCTION, SPECIAL PROCESSING, TROUBLESHOOTING, TRAINING, TECHNICAL LIAISON, AND OTHER TECHNICAL SUPPORT FUNCTIONS.

I. TECHNICAL SUPPORT

D. Q.C./SCHEDULING SUPPORT

PROVIDES TECHNICAL SUPPORT TO Q.C./SCHEDULING, INCLUDING TROUBLESHOOTING OF PRINTS, DRAWINGS, AND SPECIFICATIONS AS REQUESTED BY DESIGN PEOPLE, TRAINING AND TECHNICAL LIAISON.

E. PHOTOGRAPHIC SUPPORT

PROVIDES TECHNICAL SUPPORT TO PHOTOGRAPHY, INCLUDING TROUBLESHOOTING, TRAINING AND TECHNICAL LIAISON, ALONG WITH OTHER TECHNICAL SUPPORT FUNCTIONS.

II. ENGINEERING PROJECTS

PROVIDES TEKTRONIX WITH STATE-OF-THE-ART COMPONENTS AND PROCESSES USING ELECTROCHEMICAL TECHNOLOGY.

KEY PEOPLE

Technical Support Groups

Q.B. Support

Chuck Gault, Ext. 6237, 38-350

Chem Machine, Q.C./Scheduling, Photographic Support

Glenn Schwalbe, Ext. 6045, 50-126

Panel/Metal Finishing Support

Chuck Bauer, Ext. 5468, 16-475

Project Leaders

Flex ECB's

Glenn Schwalbe, Ext. 6045, 50-126

Unilayer

Doug Reed, Ext. 7817, 38-350

Becky VanGrunsven, Ext. 5182, 38-350

Powder Coating

Chuck Bauer, Ext. 5468, 16-475

Plastic Front Panel

Chuck Bauer, Ext. 5468, 16-475

Metal Finishing

Chuck Bauer, Ext. 5468, 16-475

ECB Materials

Becky VanGrunsven, Ext. 5182, 38-250

All Copper ECB

Glenn Schwalbe, Ext. 6045, 50-126

Modular Packaging (Electrochem Processes)

Chuck Bauer, Ext. 5468, 16-475

KEY PEOPLE

ELECTROCHEMICAL DEVELOPMENT ENGINEERING LIAISON

NPI COORDINATOR

GORDON BENNETT, EXT. 6045, 50-126

OPERATIONS

TINO ORNELAS, MANAGER
EXT. 1851, 92-331

OPERATIONS IS THE COMMUNICATIONS GROUP FOR ELECTROCHEMICAL SUPPORT. IT IS COMPOSED OF A VARIETY OF GROUPS THAT DIRECTLY RELATE TO THE BUSINESS UNITS AND TO ELECTROCHEMICAL SUPPORT.

Operations Staff

Richard Dormer, Manager

Has the responsibility of Data Support, which contains: Management Information Systems, Standards, Liaison, and Scheduling. Dick is on Ext. 1852, 92-331.

Jean Kennedy, Manager

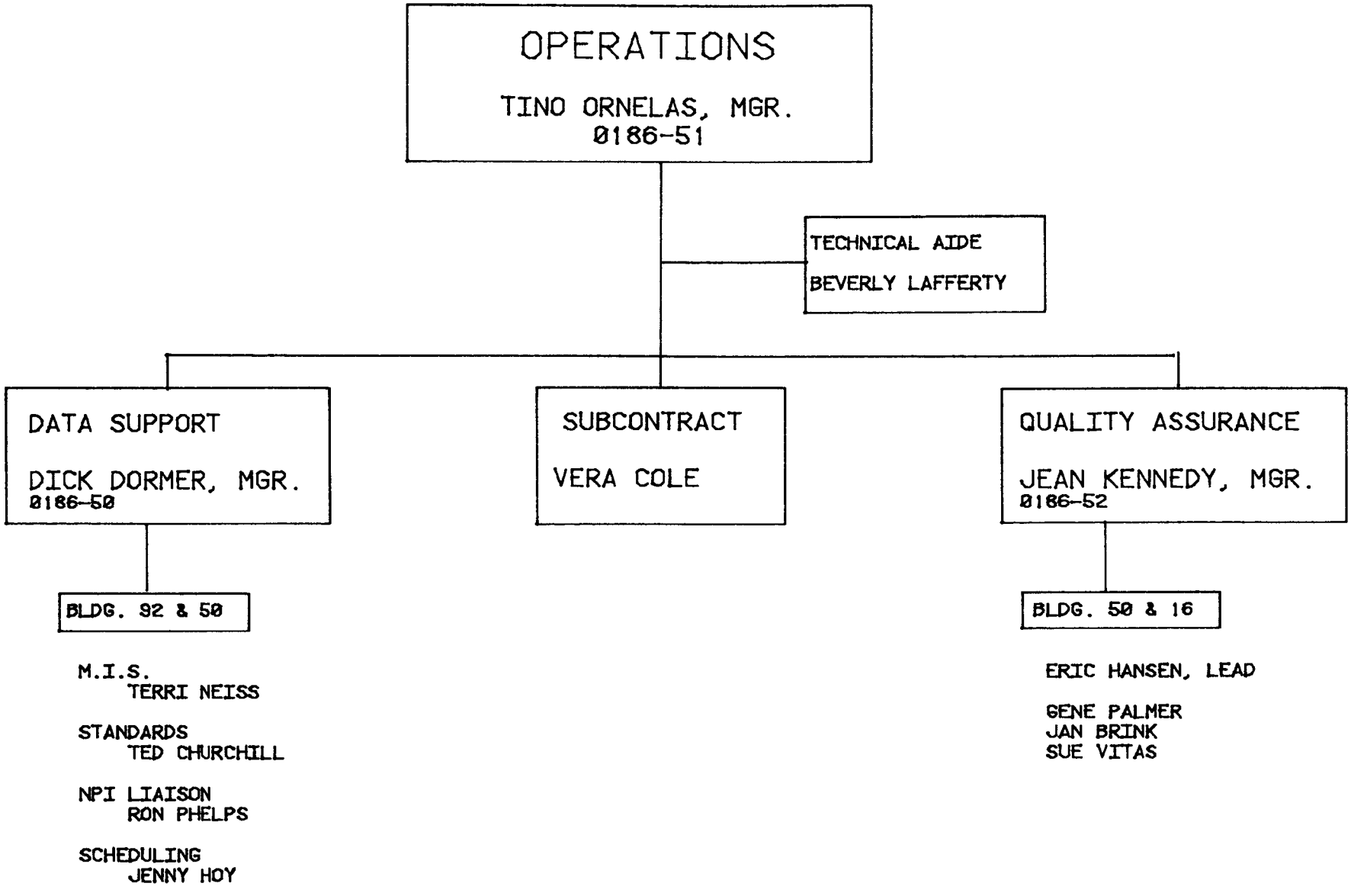
Manages all the Q.A. functions for Electrochemical Support, including Incoming Inspection (mock-ups and artwork), and Final Inspection. Jean is on Ext. 5666, 50-116.

Vera Cole, Subcontract Coordinator

Ext. 1726, 92-331

Beverly Lafferty, Technical Aide

Ext. 1732, 92-331


OPERATIONS
TINO ORNELAS, MGR.
0186-51
TECHNICAL AIDE
BEVERLY LAFFERTY
DATA SUPPORT
DICK DORMER, MGR.
0186-50
SUBCONTRACT
VERA COLE
QUALITY ASSURANCE
JEAN KENNEDY, MGR.
0186-52
BLDG. 92 & 50
M.I.S.
TERRI NEISS
STANDARDS
TED CHURCHILL
NPI LIAISON
RON PHELPS
SCHEDULING
JENNY HOY
BLDG. 50 & 16
ERIC HANSEN, LEAD
GENE PALMER
JAN BRINK
SUE VITAS

Management Information Systems

This section of Operations correlates and distributes all circuit board data using computer programs.

Utilizing System 2000, we distribute a monthly, quarterly, and an annual report. Some of the items in these reports are:

1. Board Quantity
2. Date started and completed
3. Mock-up Number
4. Board Costs
5. Instrument

In addition, the System 2000 data base stores every item that is written or placed on a circuit board order. A complete composite of each order processed can be retrieved quickly.

We have a "Service Level Report", which reveals the actual VS scheduled data for each period.

There are various other programs that aid Electrochemical Support and, in turn, the Business Units.

The center for all data processing is in Building 92. We have a network of terminals in Buildings 92, 50, 16, and 38.

Key People

Dick Dormer is the manager, and can be reached at Ext. 1852, Delivery Station 92-331.

Terri Neiss is the Data Processor. Terri has the responsibility of inputting and retrieving all data. Her Ext. is 5059, Delivery Station 50-116.

Standards

The main function of Standards is to design master dollies for either CAD library or for hand taped designs, to be used by the Business Units. Standards also keep everyone informed of new or revised standards, changes in fabrication processes, component revisions, and any change that will affect the design and/or processing of a circuit board.

Standards is also responsible for coordinating space requirements (Industrial Engineering) for Electrochemical Support and the Corporate Space Committee.

Key People

Ted Churchill, Standards

Ext. 1707, Delivery Station 92-331

NPI Liaison

Our goal in Operations is to continually and effectively communicate with all Business Units, and also, within Electrochemical Support. This objective is achieved through Steering Meetings, personal visits to the Business Unit operating areas, by telephone and memos, and by other modes of communication.

Key People

Ron Phelps, N.P.I.

Ext. 1826, Delivery Station 92-331

SCHEDULING

THE BUSINESS UNITS AND THE Q.B. LINE PUT SCHEDULING IN A VERY PRECARIOUS POSITION. ONE ASKS FOR SHORT TURN-AROUND, WHILE THE OTHER ASKS FOR LONGER TURN-AROUND.

WHENEVER A PRODUCT IS MANUFACTURED FOR A CONSUMER, A SCHEDULING SYSTEM IS NEEDED. WHEN THE SYSTEM WAS FIRST STARTED, WE USED "CIRCUIT BOARD" AS OUR CRITERIA. THIS PROVED TO BE UNACCEPTABLE, SINCE A CIRCUIT BOARD MAY BE A 1" X 1" IMAGE WITH TWO HOLES, OR IT MAY BE AN 18" X 24" WITH THOUSANDS OF HOLES. THE COMPLEXITY VARIED DRASTICALLY. TODAY WE ARE SCHEDULING USING "DOLLARS" AS THE CRITERIA.

FIRST, AN ORDER IS COSTED IN TOTAL DOLLARS. THEN, COMBINED WITH THE ORDER COMPLEXITY, WE CAN LOAD THE Q.B. LINE (I.E., $8,000/DAY) AND ALMOST GUARANTEE MEETING SCHEDULES. OF COURSE, THERE IS NO CONTROL OVER UNSCHEDULED DOWN TIME.

KEY PEOPLE

JENNY HOY, SCHEDULER

EXT. 5059, DELIVERY STATION 50-116

Quality Assurance

Incoming

Quality Control is an important function within Electrochemical Support. Its sole purpose is to increase the finished products quality. In order to meet this goal, the quality of the artwork package must be increased, data on the work order must be accurate, and the finished product must meet Tektronix Standards.

Since quality is the axiom, a Q.C. Technician must have either a design or fabrication background, preferably both. The Technician must have all circuit boards standards memorized, understand what they mean, and use this knowledge daily.

Even though most design groups have a mock-up checker, a very high percentage of incoming artwork packages cannot be processed because of errors, either on the artwork, the order form, or the mechanical drawing. This is one of the reasons that ALL orders are Q.C.'d.

Final

Final inspection for circuit boards is centered in Building 16. On small quantity orders (1-12 boards), a 100% inspection is done. On large quantities (13 boards and above), a 10% inspection is done. If an error is found in the 10% sample, a 100% inspection is automatically imposed.

FINAL, (CON'T.)

THE FINAL PRODUCT IS INSPECTED FOR:

1. PROPER HOLE SIZE
2. PROPER PLATING
3. MATERIAL TYPE
4. MATERIAL THICKNESS
5. PLATE ADHESION
6. RUN WIDTHS
7. PLATING THICKNESS
8. MULTILAYER LAY-UP
9. MULTILAYER ADHESION
10. OTHERS, AS NEEDED.

KEY PEOPLE

JEAN KENNEDY, MANAGER

EXT. 5666, DELIVERY STATION 50-116

ERIC HANSEN, LEAD

EXT. 5666, DELIVERY STATION 50-116

Subcontract

The Subcontract program was initiated in 1977 for the specific purpose of finding a source that would produce quality circuit boards when the Tektronix Q.B. Line facilities were overloaded or incapacitated.

The program has been a success. We have various vendors who can produce circuit boards of good quality with a relatively fast turn-around.

An order is processed in the same manner as an order through the Q.B. Line: the order is price quoted, quality checked, shipped, received, inspected, and distributed to the Business Unit.

One difference in ordering boards through the Subcontract program is costs. Costs are directly transferred to the user area. This is stated very clearly <u>before</u> an order is subcontracted.

Key People

Vera Cole, Subcontract Coordinator

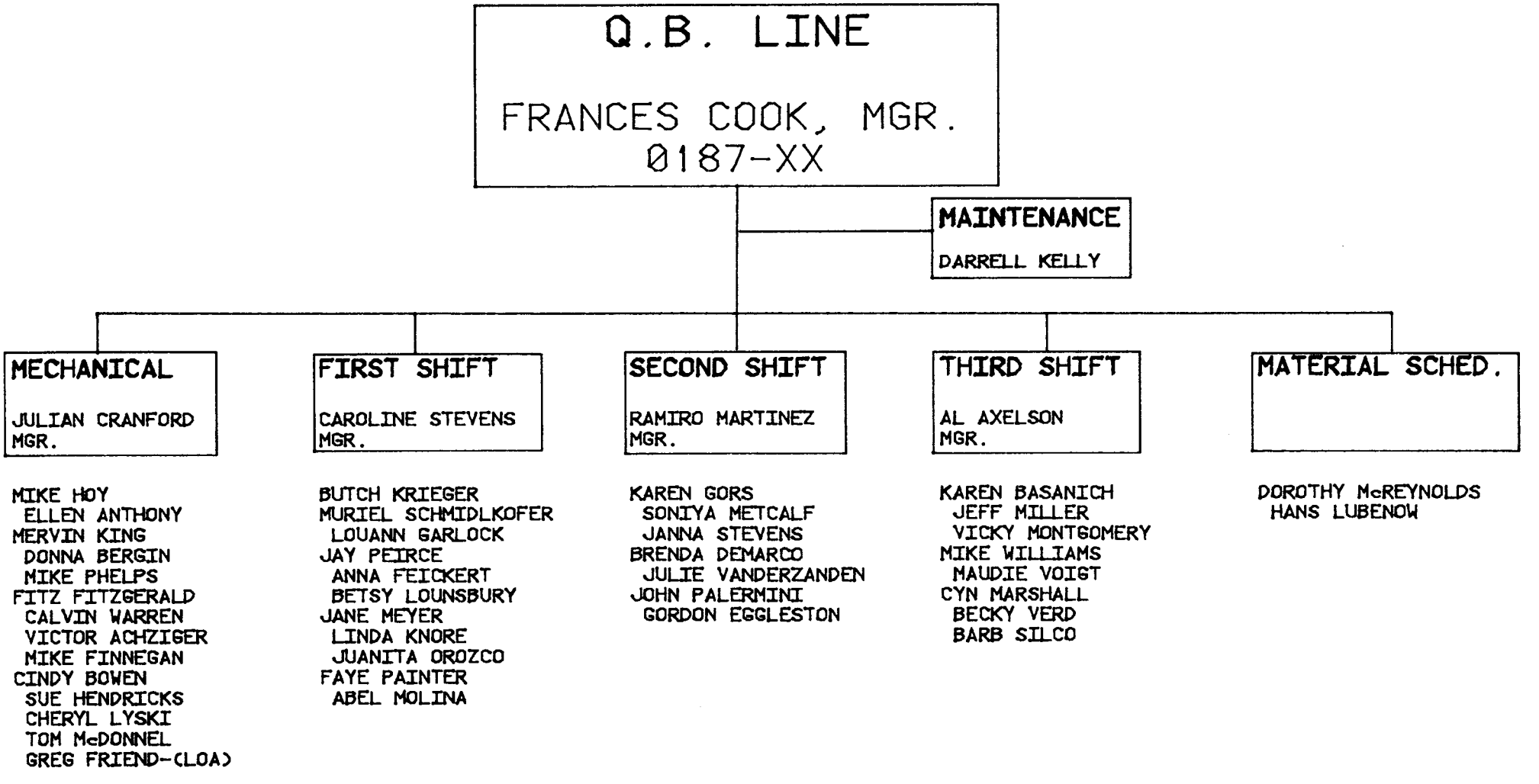
Ext. 1726 WR, Delivery Station 92-331

Q.B. LINE

FRANCES COOK
EXT. 6238, 38-350

OF THE FIVE SECTIONS IN ELECTROCHEMICAL SUPPORT, THE Q.B. LINE HOLDS THE MOST COMPANY-WIDE INTEREST, FOR IT FABRICATES THE ENGINEERING CIRCUIT BOARDS.

THE CHARTER OF THE Q.B. LINE, AND THE NUMBER ONE CONCERN OF THE BUSINESS UNITS, IS A FAST TURN-AROUND. THE Q.B. LINE CONTINUALLY STRIVES TO MEET THIS GOAL AND RECORDS INDICATE IT IS ATTAINING BETTER THAN 90% OF ITS COMMITTMENTS.


Q.B. LINE
FRANCES COOK, MGR.
0187-XX
MAINTENANCE
DARRELL KELLY
MECHANICAL
JULIAN CRANFORD
MGR.
FIRST SHIFT
CAROLINE STEVENS
MGR.
SECOND SHIFT
RAMIRO MARTINEZ
MGR.
THIRD SHIFT
AL AXELSON
MGR.
MATERIAL SCHED.
MIKE HOY
ELLEN ANTHONY
MERVIN KING
DONNA BERGIN
MIKE PHELPS
FITZ FITZGERALD
CALVIN WARREN
VICTOR ACHZIGER
MIKE FINNEGAN
CINDY BOWEN
SUE HENDRICKS
CHERYL LYSKI
TOM McDONNEL
GREG FRIEND-(LOA)
BUTCH KRIEGER
MURIEL SCHMIDLKOFER
LOUANN GARLOCK
JAY PEIRCE
ANNA FEICKERT
BETSY LOUNSBURY
JANE MEYER
LINDA KNORE
JUANITA OROZCO
FAYE PAINTER
ABEL MOLINA
KAREN GORS
SONIYA METCALF
JANNA STEVENS
BRENDA DEMARCO
JULIE VANDERZANDEN
JOHN PALERMINI
GORDON EGGLESTON
KAREN BASANICH
JEFF MILLER
VICKY MONTGOMERY
MIKE WILLIAMS
MAUDIE VOIGT
CYN MARSHALL
BECKY VERD
BARB SILCO
DOROTHY McREYNOLDS
HANS LUBENOW

Q.B. ADMINISTRATION

FRANCES COOK, MGR.
38-350 X6238

DOROTHY McREYNOLDS
MATERIALS ADMIN.
DAY SHIFT 16-259 X7972

MATERIAL SCHED. DAY
STOCKHANDLER DAY
STOCKHANDLER SWING
STOCKHANDLER GRAVEYARD

DARRELL KELLY
SR. MAINT. TECH.
DAY SHIFT 38-205 X5697
ON CALL

GENERAL MAINTENANCE

CAROLINE STEVENS
DAY SHIFT, MGR. PROCESS
38-205 X4612

PLATING LEAD
IMAGE LEAD
MULTILAYER LEAD
SCREEN LEAD

RAMIRO MARTINEZ
SWING SHIFT, MGR. PROCESS
38-205 X4612

PLATING LEAD
IMAGE LEAD
MULTILAYER LEAD

AL AXELSON
GRAVEYARD SHIFT, MGR. PROCESS
38-205 X4612

PLATING LEAD
IMAGE LEAD
MULTILAYER LEAD

JULIAN CRANFORD
MECH AREA PROCESS, MGR.
16-259 X6748

DAY LEAD
SWING LEAD
GRAVEYARD LEAD

NOTE:

THE FOLLOWING DATA IS THE STEP-BY-STEP FABRICATION SEQUENCE ON BUILDING A CIRCUIT BOARD.

Mechanical

The Mechanical area, situated in Building 16, consists of drilling and profiling (cut-out) circuit boards either manually or by using numerical controlled machines.

Manual Drilling

All manual or hand drilling is done on the Uni-drill, a drilling machine that drills from the bottom side of the board. The top or front side is used, with an image of the circuit printed on it, for registering the center of the pad to a 10X scope. The Uni-drill may drill up to 4 flats deep, registered to each other by using steel pins in the tooling holes on the flats.

Hand drilling is intended for fast turn-around boards that do not require critcal hole location, usually the pre-DC, non-saleable type. There are three Uni-drills, each capable of drilling approximately 20 holes per minute.

N.C. Drilling

Boards with critical hole location are drilled on the Tru-drills using N.C. Tapes. Currently, there are three Tru-drills in the Mechanical area, and each is capable of drilling 300 holes per minute. Each machine has three stations capable of drilling four flats each (total of 12 - 12"X18" flats) simultaneously.

N.C. Drilling, (con't.)

The N.C. Tape is checked for hole location and hole diameter accuracy by first drilling a template, which is then checked against the artwork or drawing.

Profiling

Profiling is done manually or by N.C. Tape. The N.C. Tapes are primarily used for the more complex boards.

The N.C. Tape boards are profiled on the Tru-Drill, while the hand cut-out boards are sheared. The N.C. Tape is made from the dimensions on the drawing, while the sheared board uses the corner marks on the artwork.

Other

The Mechanical area also does the slotting of edge connectors, roll beveling, counter-sinking of holes, and other mechanical operations as needed.

Key People

Julian Cranford, Manager

Ext. 6748, Delivery Station 16-259

Mike Hoy, Day Shift Lead

Ext. 6748, Delivery Station 16-259

Wayne Fitzgerald, Swing Shift Lead

Ext. 6748, Delivery Station 16-259

Cindy Bowen, Graveyard Shift Lead

Ext. 6748, Delivery Station 16-259

Image Area

Image, as pertains to circuit boards, may be defined as:

> A geometric form (the circuit board design) as it is reproduced in an exposed and developed state, on a substrate (copper clad laminate).

Cleaning

The copper clad laminate (drilled or undrilled) is run through a cleaning cycle in a scrubbing machine. The flat is baked for 15 minutes at 140°F in a hot air convection oven. It is removed and, while still hot, run through a negative photo resist laminator.

Laminating

The laminating machine applies the photo resist to both sides of the flat simultaneously. This resist is commonly called "dry film" because it is applied in a dry state. The dry film comes in wide rolls, and the resist itself is sandwiched between a thin layer of mylar and polyethylene - front and back. As the flat moves between two heated rollers (230°F), the polyethylene is pulled off one side of the resist - the resist that is directly pressed on the flat. The flat is then cooled to room temperature.

Printing

The image is printed on the flat using the pre-registered positive film (the flat has tooling holes in each corner). The flat is exposed to high intensity ultra-violet lights, which takes about 12 seconds. The flat is subjected to a developing solution where any resist not exposed to the ultra-violet lights is washed off.

Key People

Jane Meyer, Day Shift Lead

Ext. 4612, Delivery Station 38-205

Brenda DeMarco, Swing Shift Lead

Ext. 4612, Delivery Station 38-205

Cyn Marshall, Graveyard Shift Lead

Ext. 4612, Delivery Station 38-205

PLATING

PLATING IS TO COVER A SPECIFIC MATERIAL WITH AN ADHERENT METAL LAYER EITHER MECHANICALLY, CHEMICALLY, OR ELECTRICALLY.

THE Q.B. PLATING LINE, SITUATED IN BUILDING 38, USES TWO BASIC MEANS OF PLATING: ELECTROLESS (CHEMICAL) AND ELECTROLYTIC (ELECTRICAL).

ELECTROLESS (COPPER)

AFTER A CIRCUIT BOARD FLAT IS DRILLED, THE HOLES MUST BE CHEMICALLY TREATED TO HAVE ELECTRICAL CONTINUITY BETWEEN FRONT AND BACK. ELECTROLESS IS THE FIRST STEP IN PROVIDING THIS. THE DRILLED FLAT IS SUBJECTED TO VARIOUS CLEANING AND SENSITIZING SOLUTIONS, THEN DIPPED INTO AN ELECTROLESS COPPER BATH (20 MINUTES). THIS BATH CHEMICALLY BONDS A THIN LAYER OF COPPER (10-20 MICRO-INCHES) TO THE HOLE WALLS, AS WELL AS THE SURFACE.

ELECTROLYTIC

AFTER ELECTROLESS COPPER, A THIN COAT (200 MICRO-INCHES) OF ELECTROLYTIC COPPER IS DEPOSITED, AGAIN ON THE HOLE WALLS AND SURFACE.

THE FLAT IS CLEANED AND SENT TO IMAGE. AFTER IMAGE, THE FLAT IS SUBJECTED TO VARIOUS CLEANING SOLUTIONS AND PLACED INTO THE ELECTROLYTIC COPPER BATH. AT LEAST ONE (1) MIL (1,000 MICRO-INCHES) OF COPPER IS DEPOSITED ON THE HOLE WALLS AND EXPOSED AREAS (RUNS, PADS, ETC.). THIS PROCESS IS CALLED "PATTERN PLATE".

ELECTROLYTIC, (CON'T.)

IMMEDIATELY AFTER PATTERN PLATE, THE FLAT IS PLATED WITH THE SPECIFIED THICKNESS OF NICKEL, THEN WITH EITHER A LAYER OF BRIGHT ACID TIN OR GOLD (SEE TEKTRONIX SPECIFICATIONS 062-1723-00, PARAGRAPH 6.1, PAGE 7; OR 062-1727-00, PARAGRAPH 6.1, PAGE 5).

ETCHING, OR REMOVAL OF COPPER, IS ALSO DONE IN THE PLATING AREA. AFTER PATTERN PLATE, THE IMAGE (DRY FILM RESIST) IS CHEMICALLY DISSOLVED EXPOSING ALL UNWANTED COPPER. THIS COPPER IS DISSOLVED BY THE ETCHING SOLUTION, LEAVING ONLY THE AREAS THAT WERE PLATED WITH ACID TIN OR GOLD.

THE FLAT IS MOVED TO MECHANICAL FOR CUT-OUT, OR SILKSCREENED, IF ORDERED.

IMMERSION (CHEMICAL DEPOSITION) TIN IS ALSO AVAILABLE.

EXPERTISE

PLATING IS A MOST DIFFICULT JOB. ONLY BY EXPERIENCE CAN A PLATER, WITH A QUICK STUDY OF THE PLATED FLAT, TELL IF THE CHEMICAL COMPOSITION OF THE BATH IS OUT OF BALANCE.

KEY PEOPLE

CAROLINE STEVENS, DAY SHIFT MANAGER, EXT. 4612, DEL. STA. 38-205
BUTCH KRIEGER, DAY SHIFT LEAD, EXT. 4612, DEL. STA. 38-305

RAMIRO MARTINEZ, SWING SHIFT MANAGER, EXT. 4612, DEL. STA. 38-205
JOHN PALERMINI, SWING SHIFT LEAD, EXT. 4612, DEL. STA. 38-205

AL AXELSON, GRAVEYARD SHIFT MANAGER, EXT. 4612, DEL. STA. 38-205
MIKE WILLIAMS, GRAVEYARD SHIFT LEAD, EXT. 4612, DEL. STA. 38-205

Multilayer Area

The difference in processing a multilayer board and a 2-sided board represents a large sequence in technology, expertise, and material.

Standard procedure is to align the multilayer filmwork to a flat or template. All filmwork for a hand-drilled multilayer is aligned and taped together, i.e., layers 1, 2, 3, 4, and then aligned to a sheet of 0.062 FR-4 material. The tooling holes are then punched. The N.C. Tape multilayer filmwork is aligned to a pre-drilled template. Each piece of film is exactly registered to the drilled holes, and the tooling holes are punched.

After the filmwork is registered and punched, the laminate to be used is measured, cleaned and baked. The inner layers are imaged (only a <u>negative</u> is used instead of the normal positive film).

Etching

After Image, the layers to be laminated are subjected to a chemical solution, which dissolves all exposed copper. The type of solution varies throughout the printed circuit industry. This solution is used at 120°F, and it takes about 1.5 minutes to dissolve one (1) ounce (approximately 1.4 mils) of copper. (This solution is used for both inner layers and for final etching - after plating.)

Black Oxide

After etching, the inner layers are stripped of resist and chemically cleaned. The inner layer is immersed (1-4 minutes) in a solution (190°F) that reacts with the copper to form copper oxide. This oxide is black in color, and its function is to increase the bonding strength, or adherence, in lamination.

Lamination

Under clean conditions, the inner-layer laminate is layed-up using press plates. The lay-up is according to standardized procedures. The pre-preg or "B" stage, used for bonding and thickness, is actually epoxy and woven glass that needs heat for final solidification. When the pre-preg and laminate are pressed (350° at 300-400 lb/sq. inch for 1 hour), the epoxy in the pre-preg becomes soft, flows around the circuitry, and bonds to the laminate. After this bonding cycle, the boards are trimmed and cleaned, and are ready for drilling.

Key People

Muriel Schmidlkofer, Day Shift Lead
Ext. 5697, Delivery Station 38-205

Karen Gors, Swing Shift Lead
Ext. 5697, Delivery Station 38-205

Karlene Basanich, Graveyard Shift Lead
Ext. 5697, Delivery Station 38-205

SILKSCREEN

A LARGE PERCENTAGE OF ENGINEERING CIRCUIT BOARDS ARE SOLDER-MASKED AND NOMENCLATURED. AFTER FINAL PLATE AND ETCH, THE BOARDS (STILL IN THE FLAT) ARE CLEANED AND INSPECTED AND MOVED TO THE SCREEN AREA.

SCREENS

THE BLANK SCREENS ARE MADE BY STRETCHING A POLYESTER MESH OVER WOODEN FRAMES, WHICH IS THEN STAPLED TO THE FRAME. THE ELASTICITY, OR TENSION, OVER THE FRAME IS MEASURED BY A TENSIO-METER. THE BLANKS ARE THEN WASHED, DRIED, AND A PHOTO SENSITIVE EMULSION IS APPLIED AND THEN DRIED.

SCREENING

USING THE FILMWORK SUPPLIED, AN IMAGE IS PRINTED ON THE SCREEN. A BOARD IS REGISTERED TO THE SCREEN AND, USING REGISTRATION PINS, THE SCREEN IS USED TO SOLDERMASK ALL THE BOARDS IN THAT PARTICULAR ORDER. THE SOLDERMASK RESIST IS SQUEEGEED THROUGH THE SCREEN ONTO THE BOARDS. FIRST ONE SIDE OF THE BOARD IS SCREENED, THEN CURED USING ULTRA-VIOLET LIGHT; THEN THE BACKSIDE IS SCREENED, CURED, AND OVEN BAKED.

NOMENCLATURE MARKINGS ARE APPLIED IN THE SAME MANNER AFTER THE SOLDERMASK IS CURED. NOMENCLATURE INKS DO NOT USE U.V. LIGHT, BUT ARE CURED BY BAKING. THE BOARDS ARE MOVED TO THE MECHANICAL AREA FOR PROFILING OR HAND CUT-OUT. THE USED SCREENS ARE RECYCLED BY STRIPPING THE EMULSION WITH BLEACH AND RECOATED FOR LATER USE.

KEY PEOPLE

JAY PEIRCE, LEAD OPERATOR, EXT. 4822, DELIVERY STATION 16-259

Material Scheduling and Transportation

With the large quantity of circuit boards now being built, and with Q.B. operating in two Buildings (38 and 16), the scheduling of materials became mandantory.

Material

All materials used to produce a circuit board are ordered and stocked in Building 16. The magnitude of this operation cannot be over-emphasized. The quantity, quality, ship date, and receive date all play an important role in the overall operation of the Q.B. Line.

Transportation

Since the processes a circuit board travels through are performed in Buildings 50, 38, and 16, some type of transportation is <u>continually</u> needed to move an order from one area to the next. The orders are transported by stock handlers, one on each shift, who make scheduled runs (four times each shift); they are also available for special handling.

Key People

Dorothy McReynolds, Material Administrator

Ext. 7972, Delivery Station 16-259

Maintenance

With millions of dollars of capital equipment in constant use to provide circuit boards, a sound maintenance program is vital.

The maintenance crew is directly responsible for the condition of all equipment. They make repairs as needed, see that the equipment is properly used, assist in purchasing new equipment, conduct preventative maintenance, and maintain a parts inventory.

Key People

Darrell Kelly

Ext. 5697, Delivery Station 38-205

CAD/GRAPHICS

DAVE DAVIS
EXT. 4825, 50-126

CAD/GRAPHICS IS A MULTI-GROUP OPERATION THAT PRIMARILY DEALS WITH THE GRAPHICS, OR ARTWORK, OF A CIRCUIT BOARD.

CAD/Graphics Staff

, Manager, CAD

Has the responsibility of the Applicon System, situated in Building 92.

, Manager, N.C. Tooling & Wire Wrap

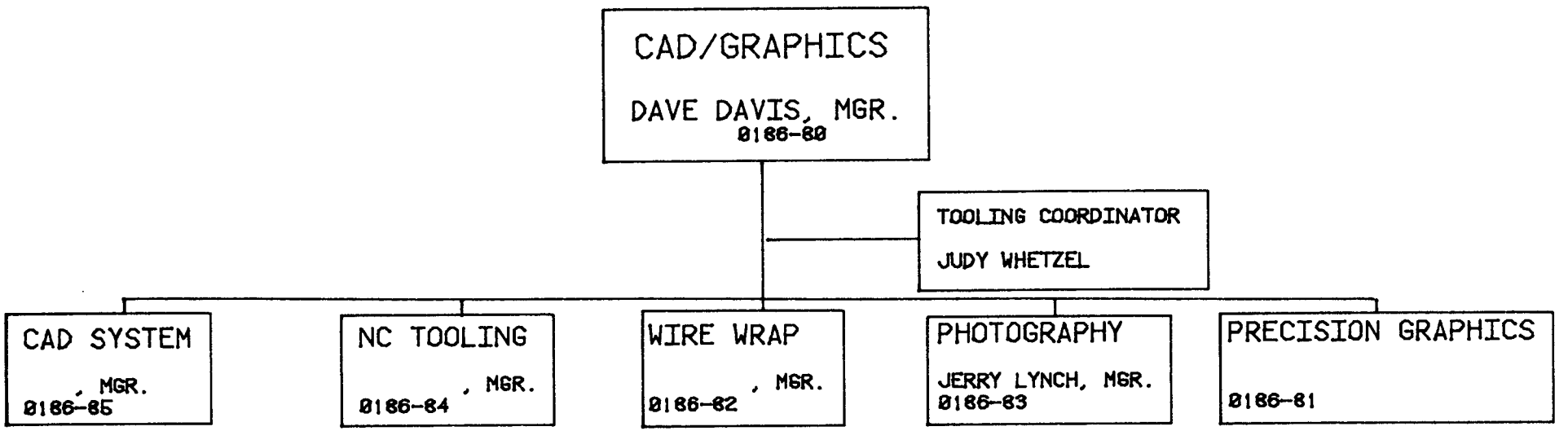
Manages the N.C. Tooling area and the Wire Wrap area. Both are in Building 50.

Jerry Lynch, Manager, Photography

Has the responsibility of the Engineering Photography area, which is in Building 50.

Henry Bahrs, Precision Graphics

Provides Chem-machined parts, front panel lay-outs, and graticule patterns. Located in Building 50.



ART PUTNEY
JERI BARNES
MIKE TALVISTE
ROY GARDNER
JANICE GANGER
MIKE PICKETT
ED WOLEVER
TOM BARNETT
DEBBIE LAM
DUC VAN BUI*
RANDY THOMAS*

JOHN BRADSHAW
RICK JOHNSON
DAWN KAUFMAN
MARY KLAUS
DAHN NGUYEN

GLENNA JONES
M. McKINLEY
JILL TRAMP

GARY HAVERSON
JAN STUART
NORITHY SMUOEK
MIKE WRIGHT
DUDLEY HEMSTREET
BOB FOREMAN
MARIANNE BRESHEARS

HENRY BAHRS
KAY GEIS

*ON LOAN TO TOOLING

CAD

(Computer-Aided Design)

Applicon System

Circuit board lay-outs used to be relatively simple, with large pads, wide spacing and wide runs. Today, with the introduction of microprocessor technology, circuit board design has become very complex. Future considerations include one to three mil runs, one mil spacing, etc. Such complex boards cannot be designed manually, hence the Computer-Aided Design system will play a very important role in producing circuit boards.

Using a scale-drawn master, or mock-up, provided by the designer, the CAD operator enters, or digitizes, the data into the computer. The computer, in turn, generates film, N.C. Tapes, and pen plots. The pen plots are drawn on paper and are used to check the image against the master.

As with hand-taped boards, a library of components are created and kept on file.

Key People

, Manager

Ext. 1990, Delivery Station 92-321

Art Putney, First Shift Supervisor

Ext. 1988, Delivery Station 92-321

Jeri Barnes, CAD Specialist

Ext. 1978, Delivery Station 92-321

N.C. Tooling

As the complexity of circuit boards increases, so do the processes used to produce the circuit boards. N.C. Tooling is one area that was created for the specific purpose of producing N.C. Tapes for drilling and profiling (cut-out) of hand-taped boards.

The Tooling area uses a computer graphics system to generate the N.C. Tapes. The Tektronix 4081 and the Applicon (CAD) System are used in a process very similar to the process used for "CAD" boards.

Each of the above systems are complex and cannot be adequately described on paper; therefore, the Tooling area is more than willing to provide guided tours and individual instructions.

Key People

, Manager
Ext. 5781, Delivery Station 50-126

Rick Johnson, First Shift Lead
Ext. 5781, Delivery Station 50-126

Mary Klaus, Second Shift Lead
Ext. 5781, Delivery Station 50-126

John Bradshaw, Software Support
Ext. 5781, Delivery Station 50-126

Wire Wrap

Wire Wrap is an interconnection scheme that provides circuit board transmission paths with wire rather than etched runs. Wire Wrap is used in evaluation and design-staged boards.

Using the semi-automatic technique (see Engineering News, June 1979), the Wire Wrap area has proved that wire wrap is a successful alternative to etched circuit boards.

Because the technique is very involved, the best way to get information is to visit the area.

Key People

, Manager

Ext. 5781, Delivery Station 50-126

Glenna Jones, Lead

Ext. 5783, Delivery Station 50-126

Engineering Photography

All film tooling packages for prototype circuit boards are generated in Engineering Photography. They produce these packages either from hand-taped mock-ups, or from film generated on their Gerber Photoplotters.

Engineering Photography also provides photographic support for a wide range of engineering functions throughout Tektronix. Examples of some of these are: front panel filmwork for Industrial Design, graticule filmwork for CRT Faceplate Development, schematics filmwork of Draftings for Manuals, and mock-up parts and Kodagraphs for circuit board designers.

Key People

Jerry Lynch, Manager

Ext. 4825, Delivery Station 50-115

Gary Halverson, Lead Person

Ext. 6491, Delivery Station 50-115

Precision Graphics

Precision Graphics, commonly known as Chem-Mill, is an important part of Electrochemical Support that few people know about.

Using a Coordinatograph (a precision artwork machine), Precision Graphics will produce a very precise pattern, or artwork, from a mechanical drawing. From this artwork, Precision Graphics will produce chem-machined parts, usually from the copper alloy family, that are chemically etched (and sometimes plated) much more accurately than if the parts were mechanically milled. They also produce front panel lay-outs, graticule patterns, switch patterns, overlays for gauges, CRT overlays, dial tapes, and indicators.

Key People

Henry Bahrs, Engineering Assistant
Ext. 4930, Delivery Station 50-126

Kay Geis, Engineering Assistant
Ext. 4930, Delivery Station 50-126

NAME	EXTN.	DEL/STA	SHIFT
ACHZIGER, VICTOR	5697	38-205	1
ANTHONY, ELLEN	7972	16-259	1
ARCE, JUAN*	6748	16-259	3
AXELSON, AL	4612	38-205	3
BAHRS, HENRY	4930	50-126	1
BARNES, JERI	1978	92-321	1
BARNETT, THOMAS	1987	92-321	2
BASANICH, KARLENE	5697	38-205	3
BATEMAN, ALICE	LEAVE OF ABSENCE		
BAUER, CHUCK	5468	16-475	1
BENNETT, GORDON	6045	50-126	1
BENSON, SHANNON	6581	38-350	1
BERNARDS, MERLIN	5468	16-475	1
BOGGS, DAVE	7904	38-350	1
BOLD, WILLIAM	5182	38-350	1
BOWEN, CINDY	6748	16-259	3
BRADSHAW, JOHN	5781	50-126	1
BRESHEARS, MARIANNE	6491	50-126	3
BRINK, JAN	7473	16-259	1
BUI, DUC	1987	92-321	2
BURGESS, LARRY	6581	38-350	1
CHEEVER, JEFF [s]	5182	38-350	1
CHURCHILL, TED	1707	92-331	1
COLE, VERA	1726	92-331	1
COOKE, ABBY	7830	38-350	1
COOK, FRAN	6238	38-350	1
CRANFORD, JULIAN	6748	16-259	1
CUMMINGS, RICK	6237	38-350	1
DAVIS, DAVE	4825	50-126	1
DE MARCO, BRENDA	4612	38-205	2
DOELING, WALLY	4613	50-354	1
DORMER, DICK	1852	92-331	1
D'SILVA, TONY	4912	16-259	1
EGGLESTON, GORDON	5697	38-205	2
ELEY, MARTY	5182	38-350	1
FEICKERT, ANNA	4822	16-259	1
FINNIGAN, CHARLES	6748	16-259	2
FITZGERALD, FITZ	6748	16-259	2
FRIEND, GREG	LEAVE OF ABSENCE		
GANGER, JANICE	1987	92-321	1
GARDNER, ROY	1987	92-321	1
GARLOCK, LOUANN	5697	38-205	1
GAULT, CHUCK	6446	38-350	1
GEIS, KAY	4930	50-126	1
GORS, KAREN	5697	38-205	2
HALVERSON, GARY	6491	50-115	1
HANSEN, ERIC	5666	50-116	1
HEMSTREET, DUDLEY	6491	50-115	2
HENDRICKS, SUSAN	6748	16-259	3
HINSBEECK, HILDE	6237	38-350	1
HOLLY, JERRY	7830	38-350	1
HOY, JENNY	5059	50-116	1
HOY, MICHAEL	6748	16-259	1
JACKY, JERRY	7830	38-350	1
JOHNSON, RICK	5781	50-126	1
JONES, GLENNA	5783	50-126	1
KAUFMAN, DAWN	5781	50-126	1
KELLER, DONNA	6748	16-259	1
KELLY, DARRELL	5697	38-205	1

NAME	EXTN.	DEL/STA	SHIFT
KENNEDY, JEAN	5666	50-116	1
KING, MERVIN	6748	16-259	1
KLAUS, MARY	5781	50-126	2
KNORE, LINDA	5697	38-205	1
KRAKER, RICHARD*	7817	38-350	1
KRIEGER, BUTCH	4612	38-205	1
LAFFERTY, BEV	1732	93-331	1
LAM, DEBBIE	1987	92-321	2
LONG, DEBBY [S]	6237	38-350	1
LOUNSBURY, BETSY	4822	16-259	1
LUBENOW, HANS	7972	16-259	1
LYNCH, JERRY	4825	50-115	1
LYSKI, CHERYL	6748	16-259	3
MARTIN, RAY	7904	38-350	1
MARTINEZ, IZZY	LEAVE OF ABSENCE		
MARTINEZ, RAMIRO	4612	38-205	2
MARSHALL, CYN	4612	38-205	3
MC DONNELL, TOM	6748	16-259	3
MC KINLEY, MARILYN	5783	50-126	2
MC REYNOLDS, DOROTHY	7972	16-259	1
MEJIA, CARLOS	5468	16-475	1
METCALFE, SONJA	5697	38-205	2
MEYER, JANE	4612	38-205	1
MILLER, JEFF	5697	38-205	3
MILES, JEANNE	LEAVE OF ABSENCE		
MILEWSKI, KAREN	7988	50-354	1
MOLINA, ABEL	5697	38-205	1
NEISS, TERRI	5059	50-116	1
NGUYEN, DANH	5781	50-126	2
NOU, VISIDH	7904	38-350	1

NAME	EXTN.	DEL/STA	SHIFT
OLDS, STEPHEN	5697	38-205	1
ORNELAS, TINO	1851	92-331	1
OROZCO, JUANITA	5697	38-205	1
PAINTER, FAYE	5697	38-205	1
PALERMINI, JOHN	5697	38-205	2
PALMER, GENE	5666	50-116	1
PARQUET, DAN	6446	38-350	1
PAUL, GARY [S]	7972	16-259	2
PEIRCE, JAY	4822	16-259	1
PETRIE, TRACY [S]	5697	38-205	1
PHELPS, MIKE	6748	16-259	1
PHELPS, RON	1826	92-331	1
PICKETT, MIKE	1987	92-321	2
PUTNEY, ART	1988	92-321	1
REED, DOUG	7817	38-350	1
RODRIGUEZ, BETTY JEAN	7830	38-350	1
SANDHU, ANJU*	7817	38-350	1
SCHMIDLKOFER, MURIEL	5697	38-205	1
SCHULTZ, SERENA	7904	38-350	1
SCHWABLE, GLENN	6045	50-126	1
SCOTT, DOROTHY	LEAVE OF ABSENCE		
SMITH, TERRY	5468	16-475	1
SMUOEK, NORITHY	6491	50-115	2
STAMITOLES, LORI	6748	16-259	2
STEVENS, CAROLINE	4612	38-205	1
STEVENS, JANNA	5697	38-205	2
STUART, JANET	6491	50-115	3
TALVISTE, MIKE	1987	92-321	1
TANNER, DEE	6237	38-350	3

NAME	EXTN.	DEL/STA	SHIFT
THOMAS, RANDY	1987	92-321	3
TRAMP, JILL	5783	50-126	1
U'REN, DAVE	6237	38-350	2
VANDERZANDEN, JULIE	5697	38-205	2
VAN GRUNSVEN, BECKY	5182	38-350	1
VERD, BECKY	5697	38-205	3
VITAS, SUE	5666	50-116	2
VOIGT, MAUDIE	5697	38-205	3
WARREN, CALVIN	6748	16-259	2
WHETZEL, JUDY	5059	50-126	1
WILLIAMS, BARB	5697	38-205	3
WILLIAMS, MIKE	4612	38-205	3
WILSON, GRACE	7988	50-354	1
WOLEVER, ED	1987	92-321	3
WRIGHT, MIKE	6491	50-115	3

*0514-96 - ON LOAN - WILSONVILLE

[S] = SUMMER STUDENT

6/23/80 KGM