SCHEDULING

HOW TO AVOID DELAY, ACCELERATION, IMPACT AND INEFFICIENCY

For
Northwest Construction Consumer Council

Construction Conference & Exposition
Washington State Convention & Trade Center
Seattle, Washington

October 24, 2000 - 10:00 to 3:00

Presented By:

Steve Pinnell, PE - President, Pinnell♦Busch, Inc., Portland, OR
Tony Bolstad - Project Services Manager, TIC, The Industrial Company NW Region, Tualatin, OR

Copyright © 2000 Pinnell♦Busch, Inc.

OUTLINE OF PRESENTATION

HOW TO AVOID DELAY, ACCELERATION, IMPACT AND INEFFICIENCY

Morning - Scheduling

Overview
Procedures
Conflicting Objectives
Differing Definitions
WBS / Cost Coding
Level of Detail
Logic
Resources
Critical Path & Float
Constraints & Targets

Afternoon - Scheduling Claims

Change Order Requests & Claims
Time Impact Analysis vs. Would-Have-Been Schedules
As-Planned & As-Built Schedules
Detailed As-Builts & Other Tools
Would-Have-Been Schedule
Owner Defenses & Counterclaims
Damages
Inefficiency
Negotiation

Copyright © 2000 Pinnell♦Busch, Inc.

INDUSTRY TRENDS

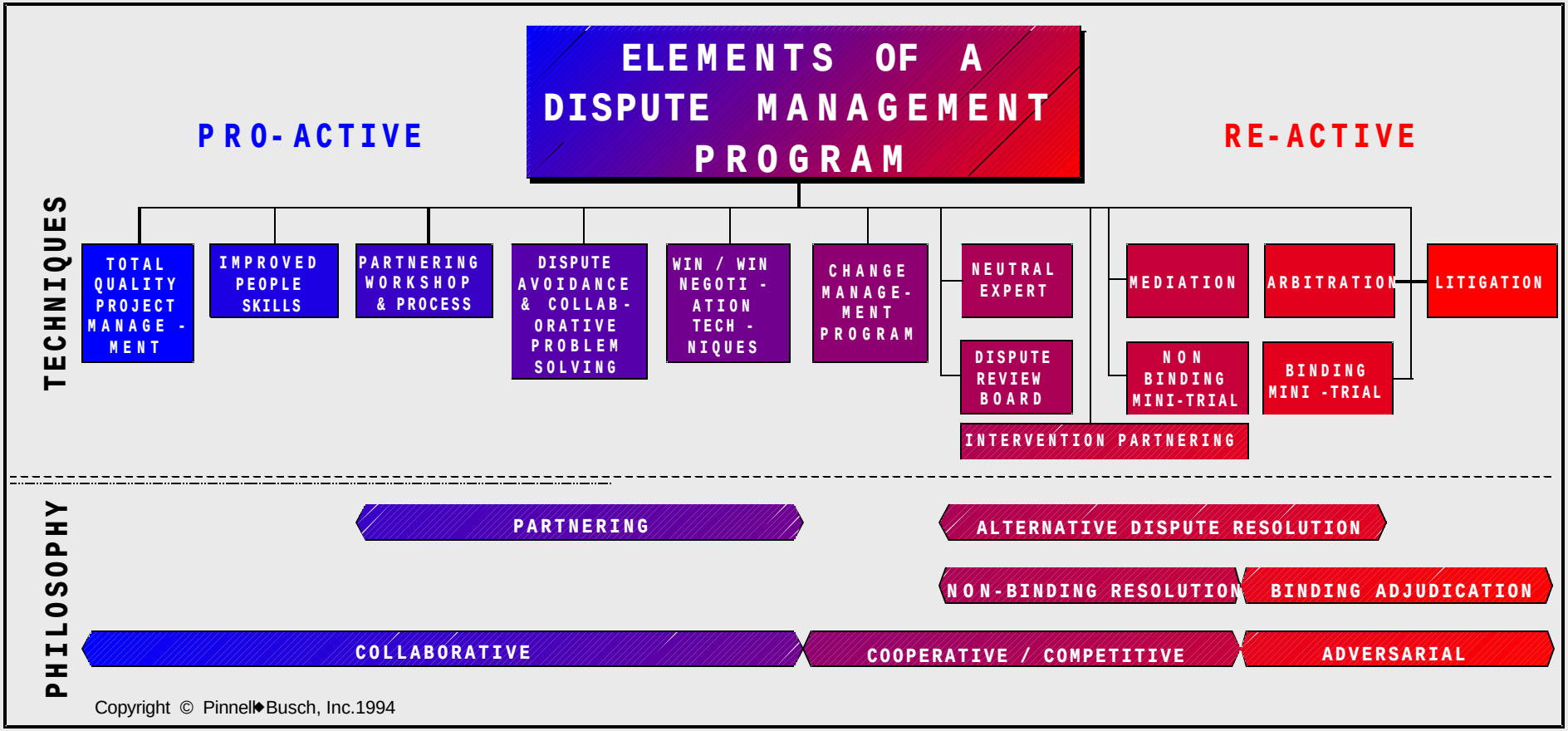
CONSTRUCTION DISPUTE TRENDS:

- More Competition, Reduced Margins & Tighter Schedules
- Contractor Claims-Consciousness & Owner Risk-Avoidance
- Weakened Relations between Contractors and Subcontractors
- New Contract Forms – Design/Build, CM/GC, & Build/Operate
- Changed Design Quality and Designer Responsibility
- Dispute Avoidance and Resolution Trends – the ‘90s
- Partnering
- Dispute Management Programs

SCHEDULING TRENDS:

- Owner-Required CPM Specs
- Relatively Easy-To-Use Software on PC’s
- Better Understanding of CPM
- Tighter Schedules
- Recognition of Schedule Importance & the Cost of Delays

Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.

SUGGESTED SCHEDULING SPECIFICATIONS

- **CPM Schedule** (not bar chart)

- **Tabular Report** with activity number, description, duration, early/late start and finish, logic (priors or successors), lag/leads, constraints, and float
- **Timescale Logic Diagram or Connected Bar Chart**

- **Identify Subcontractor/Crew, Work Area, and Pay Item**
- **Specified Activity Durations and Number of Activities** (maximum duration of 1 month, separate activities for each subcontractor, maximum detail with one activity per crew)
- **Separate Activities for Procurement**
- **Sorts by Activity Number and Float/Early Start**

- **Preliminary Schedule at Pre-Construction Conference** - with details of first 60-days and summary to completion
- **Complete Schedule within 60 days, Approval within 90**
- **Monthly Updates and Narrative with Pay Requests** - Updates w/actual start/finish dates, percent complete and days remaining.
- **Revised Schedule When Delayed or Requested by Owner**

- **Reduced Payment if Failure to Comply with Specs**

Copyright © 2000 Pinnell♦Busch, Inc.

SCHEDULE REVIEW AND APPROVAL PROCESS

1. **Initial Review Upon Receipt Prior to Meeting**

2. **Joint Meeting with Contractor's Scheduler** (and Superintendent)
   - **Presentation by Contractor, Ask Questions, Take Notes**
   - **Review Critical Path in Sequence --** Logic, Crew, Qty …
   - **Check Work Quantities, Production Rates, & Durations**
   - **Check Critical Crew Chases** (crane, equipment fleet, …)
   - **When Done, Brainstorm for Improvements**

3. **Approve at the Meeting** or as soon as possible afterwards
4. **If Reject** - state exactly why and require re-submittal by a specific date. Offer to discuss – to ensure you get what you need.

Copyright © 2000 Pinnell◆Busch, Inc.

REASONABLE LOGIC AND ACTIVITY DURATION

- Missing logic ties
- Excess/duplicate logic ties
- Weather compatibility
- Crew chases that will control progress
- Excessive resource peaks and fluctuations
- Reasonable logic for efficiency
- Avoid crew stacking in limited work areas
- Reasonable durations (based on crew size/capacity)
- The effect of working under traffic
- Extended durations for startup or weather impact
- Contract-specified durations
- Check long-lead procurement times
- Overly tight schedules (multiple critical paths)
- Potential safety problems
- Conditions of railroad agreements
- Utility relocations by others
- Soil conditions, terrain, groundwater, etc.
- Contractor's capacity, approach, crew and work load

Copyright © 2000 Pinnell♦Busch, Inc.

ADEQUATE LEVEL OF DETAIL

- Normal maximum activity duration of 1 month
- Number of activities for size and complexity of project
- Separate activities for each subcontractor
- Maximum level of detail: one activity per crew

Copyright © 2000 Pinnell♦Busch, Inc.

OTHER ISSUES

- Anticipate potential delays and problems (complete weather-sensitive work before winter weather)
- Risk analysis of critical delays (push critical path activities into environmental no-work windows)
- Obtain expected crew sizes for critical activities and for each subcontractor
- Check for excess demands on owner's resources (inspection, surveying, etc.)
- Check on available access, public notice requirements, permit requirements

Copyright © 2000 Pinnell♦Busch, Inc.

MONITORING PROGRESS

- **Maintain Good Records** – record start-and-finish dates, delays and the reason why, crew sizes, etc.
- **Enforce Contract** – Schedule Updating/Revision Requirements
- **Meet** to Discuss Delays, Impact, or Claims
- **Promptly Respond** to Questions or Notices
- **Continue to Partner**

Copyright © 2000 Pinnell♦Busch, Inc.

MONTHLY UPDATES

The schedule reviewer should note and record the following information:

- **Actual Start and Finish Dates**
- **Periods of Intermittent Progress** with restricted or no work (and the reason)
- **Days Remaining or Percent Complete** of partially complete activities
- **Minor Revisions** to durations and logic
- **Correction of Logic** for out-of-sequence work
- **Delays** to the scheduled start of non-critical activities

Copyright © 2000 Pinnell♦Busch, Inc.

INFORMATION TO BE RECORDED pg. 1

- Work started, completed, interrupted, in progress; its location and quantities
- Concrete pours - where, how much
- Tests conducted and their results, if known
- Crew sizes, equipment and work by general contractor - by trade
- Crew size, equipment and work by subcontractors
- Material delivery, on-site, being used and needed
- Contractor questions and responses given
- Directives to Contractor and action taken
- Summary of discussions with Contractor
- Delay or acceleration, the cause and impact
- Problems occurring, pending or developing; their impact and resolution
- Acceleration: directed, constructive, or contractor-initiated
- Changes in scheduled dates
- Changed conditions discovered or impacting work
- Accidents and their impact on work
- Restricted access and any impact

Copyright © 2000 Pinnell♦Busch, Inc.

INFORMATION TO BE RECORDED pg. 2

- Damage to previously installed work
- Defective work being done, discovered, or reported
- Repairs to defective work, the effort expended and any impact on other work
- Extra work or protested work being done and any impact on other work
- Labor disputes, shortages, excess
- Problems with subcontractors
- Poor condition and control of subcontractors
- Changes in productivity, rate of progress, etc.
- Insufficient equipment capacity, poor operation, or inefficient layout
- Equipment delivery, removal, in use, on standby (not needed or need repair)
- Visitors to site
- Insufficient or inadequate labor or equipment
- Weather and its impact
- Other site conditions and impacts - mud stream flow, traffic conditions
- Change order work, RFIs, etc. and their impact

Copyright © 2000 Pinnell♦Busch, Inc.

SCHEDULING RECOMMENDATIONS FOR CONTRACTORS

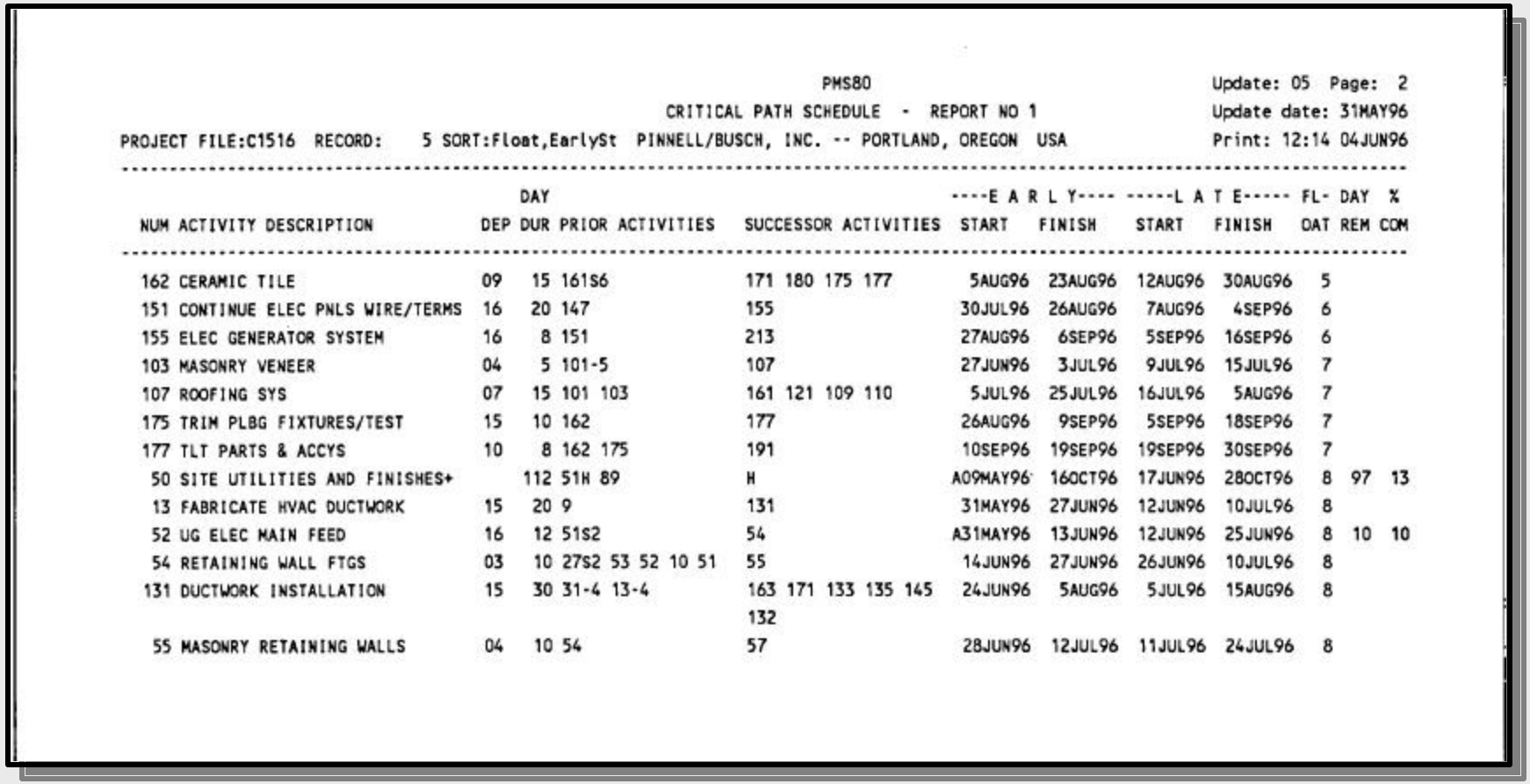
1. **Train Key Personnel** – in scheduling, record keeping and claim avoidance
2. **Train an In-house Scheduling Guru**

3. **Prepare Preliminary CPM Schedules for All Estimates**
4. **Submit and Discuss Schedule at Pre-Construction Meeting**
5. **Prepare Monthly Schedule Updates and Narratives**
6. **Tie Short-Interval Schedules to Project Schedule** - show Plan vs. Actual

7. **Prepare Time Impact Analyses for Changes**
8. **Develop and Distribute a "Jobsite Overhead Cost Sheet"**
9. **Selectively Accelerate Low "Cost-Slope" Activities** – to lower total project costs

10. **Maintain Better Records** – superintendent's daily reports, RFIs, telcons, etc.

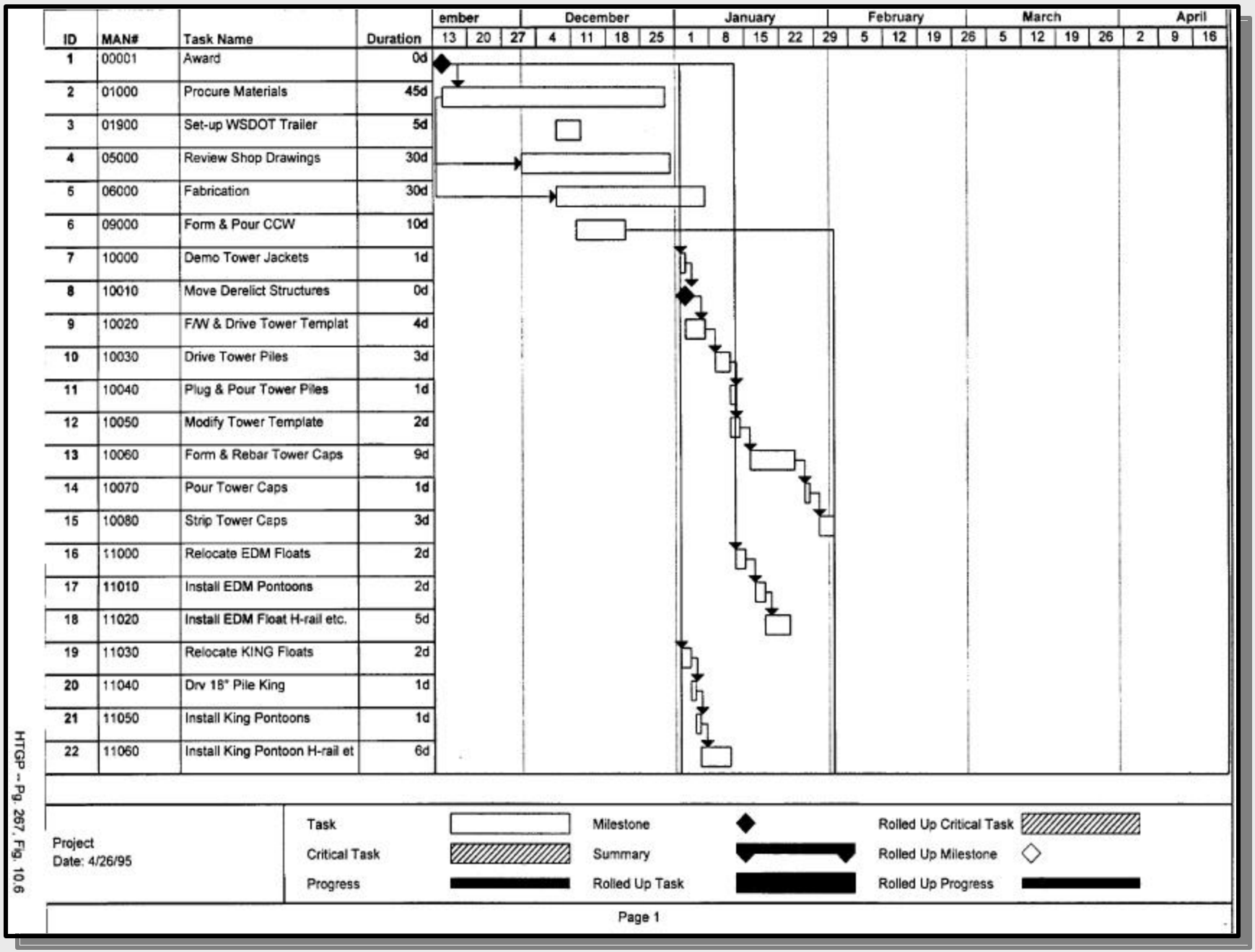
Copyright © 2000 Pinnell♦Busch, Inc.



PMS80 Update: 05 Page: 2
CRITICAL PATH SCHEDULE - REPORT NO 1 Update date: 31MAY96
PROJECT FILE:C1516 RECORD: 5 SORT:Float,EarlySt PINNELL/BUSCH, INC. -- PORTLAND, OREGON USA Print: 12:14 04JUN96

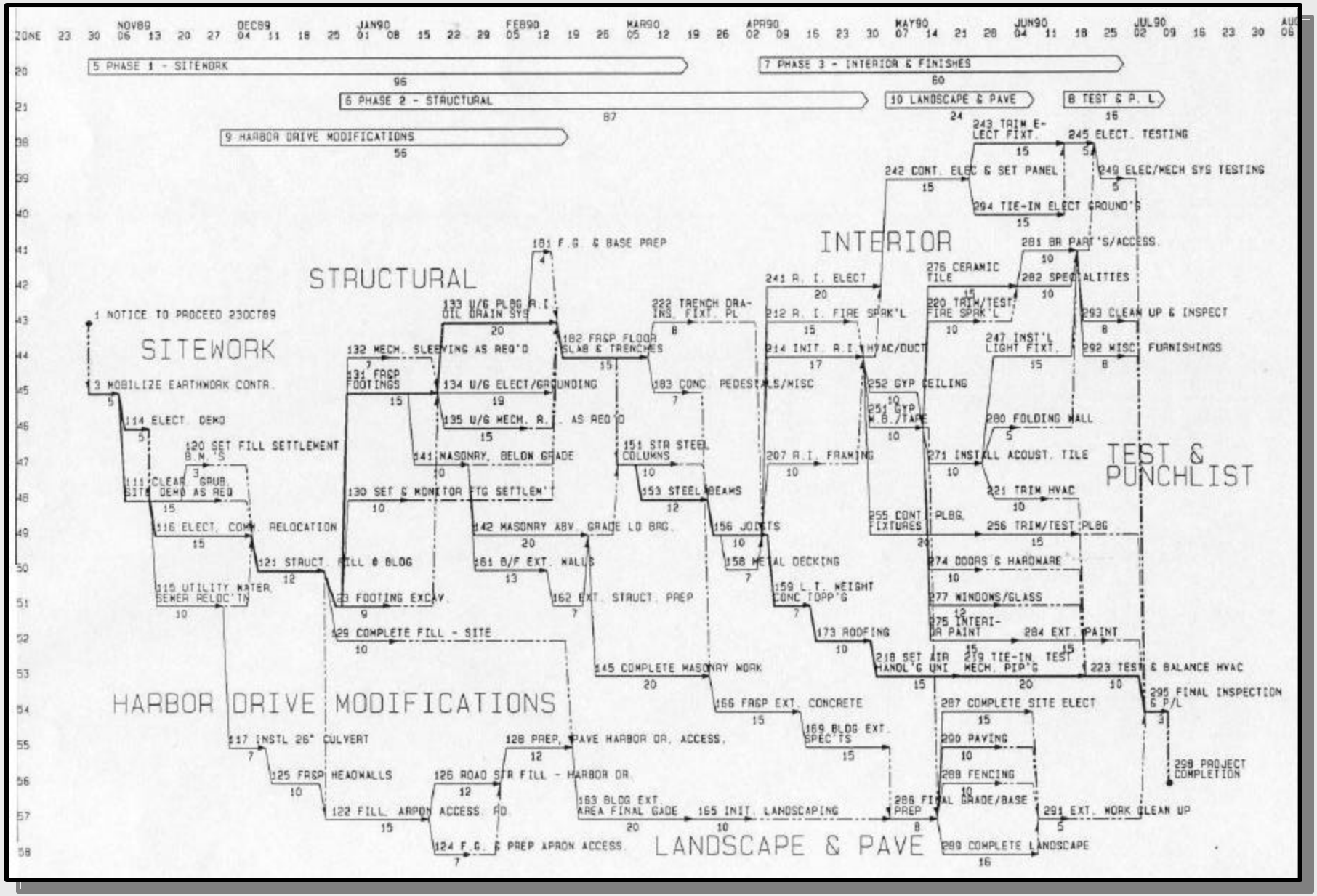
NUM	ACTIVITY DESCRIPTION	DAY DEP	DUR	PRIOR ACTIVITIES	SUCCESSOR ACTIVITIES	EARLY START	EARLY FINISH	LATE START	LATE FINISH	FL- DAT	DAY REM	% COM
162	CERAMIC TILE	09	15	161S6	171 180 175 177	5AUG96	23AUG96	12AUG96	30AUG96	5		
151	CONTINUE ELEC PNLS WIRE/TERMS	16	20	147	155	30JUL96	26AUG96	7AUG96	4SEP96	6		
155	ELEC GENERATOR SYSTEM	16	8	151	213	27AUG96	6SEP96	5SEP96	16SEP96	6		
103	MASONRY VENEER	04	5	101-5	107	27JUN96	3JUL96	9JUL96	15JUL96	7		
107	ROOFING SYS	07	15	101 103	161 121 109 110	5JUL96	25JUL96	16JUL96	5AUG96	7		
175	TRIM PLBG FIXTURES/TEST	15	10	162	177	26AUG96	9SEP96	5SEP96	18SEP96	7		
177	TLT PARTS & ACCYS	10	8	162 175	191	10SEP96	19SEP96	19SEP96	30SEP96	7		
50	SITE UTILITIES AND FINISHES+		112	51H 89	H	A09MAY96	16OCT96	17JUN96	28OCT96	8	97	13
13	FABRICATE HVAC DUCTWORK	15	20	9	131	31MAY96	27JUN96	12JUN96	10JUL96	8		
52	UG ELEC MAIN FEED	16	12	51S2	54	A31MAY96	13JUN96	12JUN96	25JUN96	8	10	10
54	RETAINING WALL FTGS	03	10	27S2 53 52 10 51	55	14JUN96	27JUN96	26JUN96	10JUL96	8		
131	DUCTWORK INSTALLATION	15	30	31-4 13-4	163 171 133 135 145 132	24JUN96	5AUG96	5JUL96	15AUG96	8		
55	MASONRY RETAINING WALLS	04	10	54	57	28JUN96	12JUL96	11JUL96	24JUL96	8		

Copyright © 2000 Pinnell♦Busch, Inc.

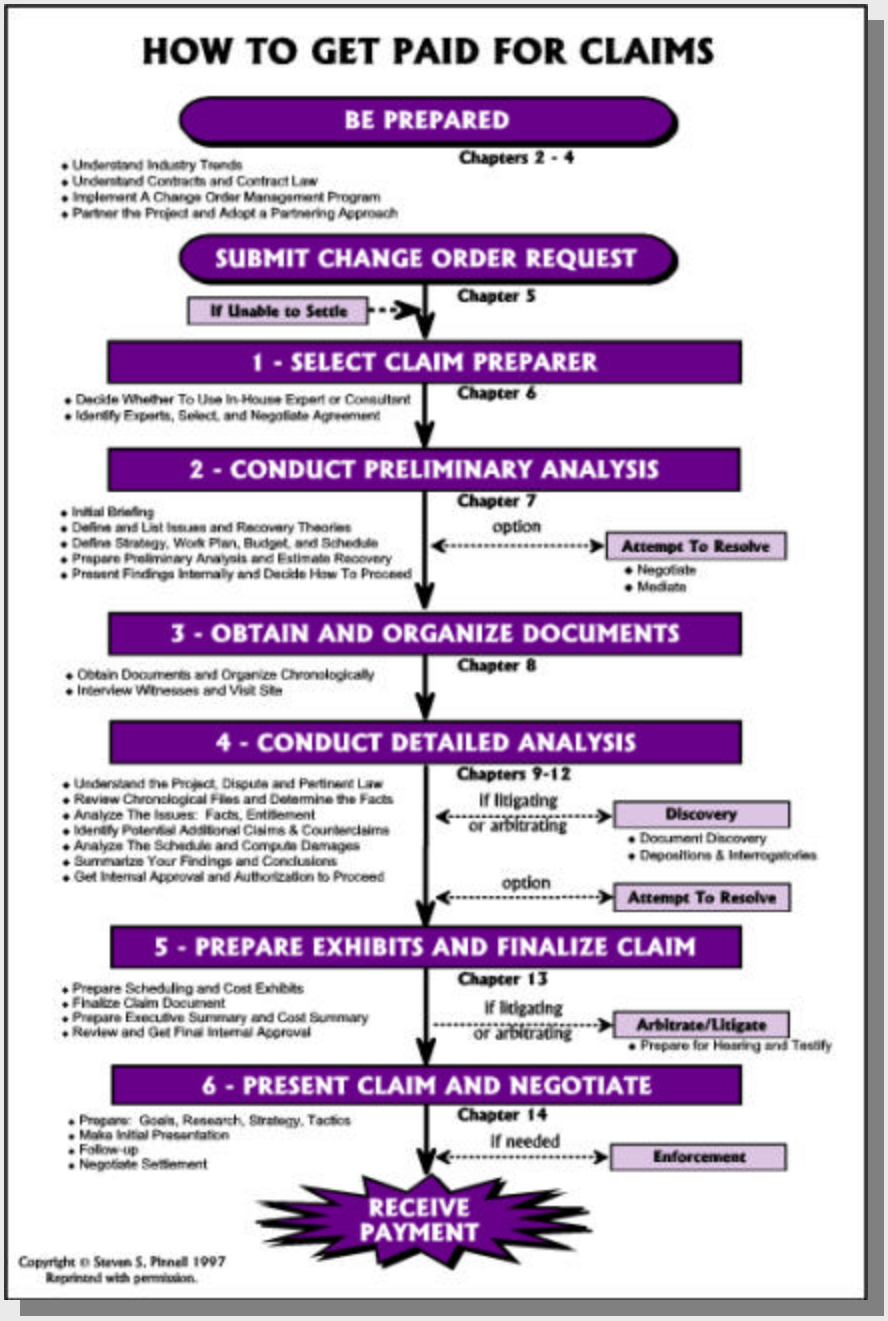


HTGP -- Pg. 267, Fig. 10.6

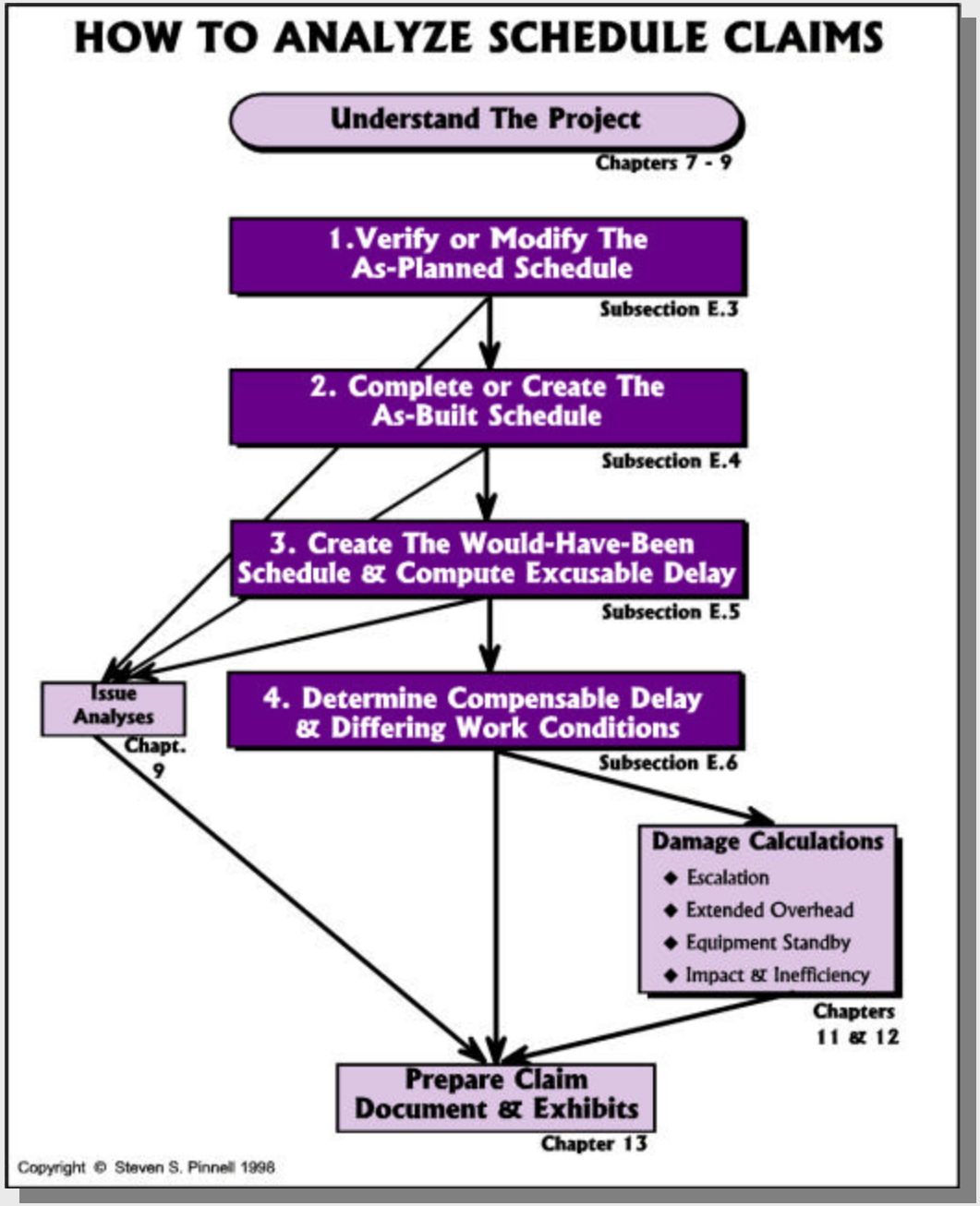
Copyright © 2000 Pinnell♦Busch, Inc.



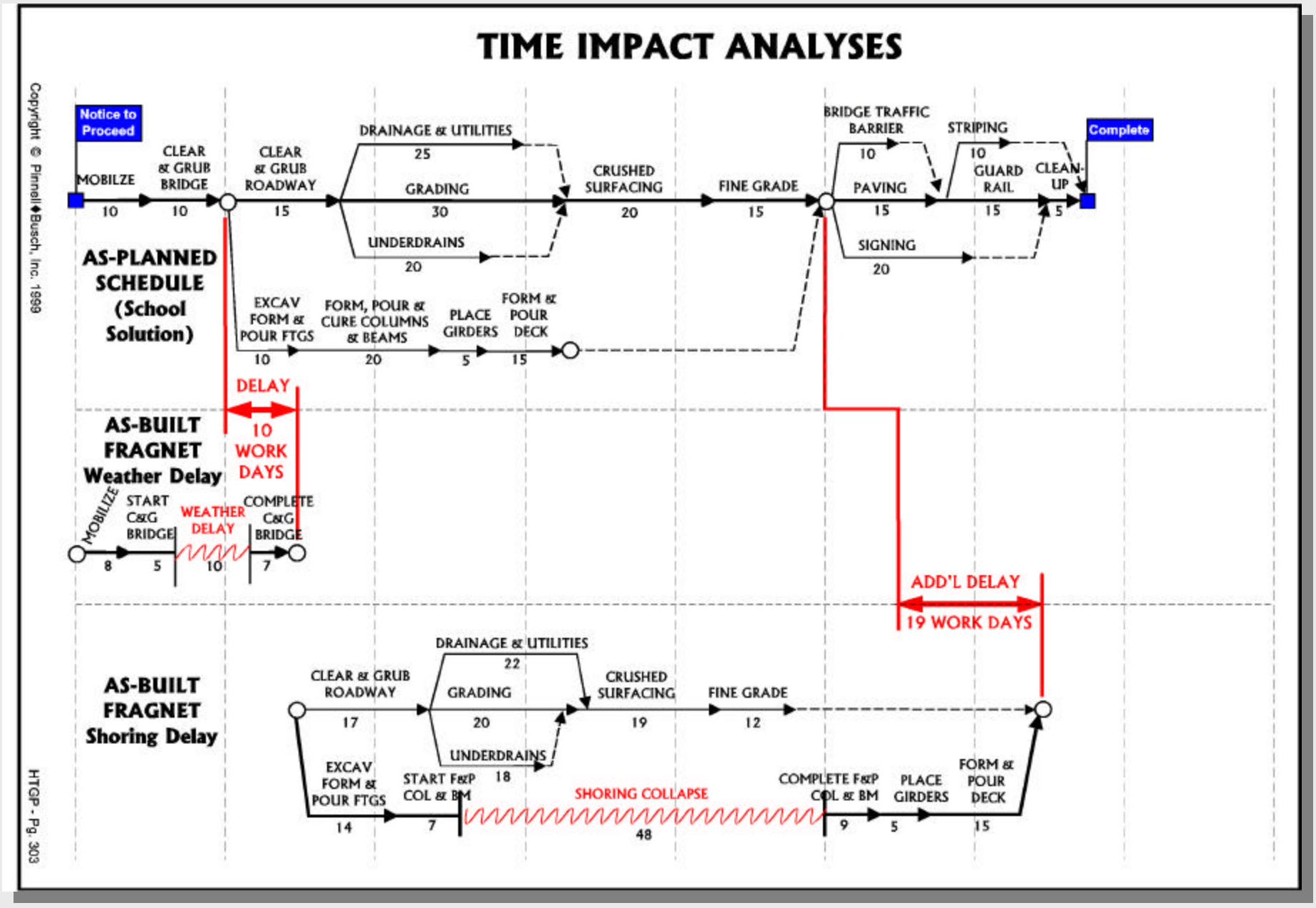
Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.


TIME IMPACT ANALYSES
Copyright © Pinnell♦Busch, Inc. 1999
Notice to Proceed
MOBILZE
10
CLEAR & GRUB BRIDGE
10
CLEAR & GRUB ROADWAY
15
DRAINAGE & UTILITIES
25
GRADING
30
UNDERDRAINS
20
CRUSHED SURFACING
20
FINE GRADE
15
BRIDGE TRAFFIC BARRIER
10
PAVING
15
STRIPING
10
GUARD RAIL
15
CLEAN-UP
5
Complete
SIGNING
20
AS-PLANNED SCHEDULE (School Solution)
EXCAV FORM & POUR FTGS
10
FORM, POUR & CURE COLUMNS & BEAMS
20
PLACE GIRDERS
5
FORM & POUR DECK
15
DELAY
10 WORK DAYS
AS-BUILT FRAGNET Weather Delay
MOBILIZE
8
START C&G BRIDGE
5
WEATHER DELAY
10
COMPLETE C&G BRIDGE
7
ADD'L DELAY
19 WORK DAYS
AS-BUILT FRAGNET Shoring Delay
CLEAR & GRUB ROADWAY
17
DRAINAGE & UTILITIES
22
GRADING
20
UNDERDRAINS
18
CRUSHED SURFACING
19
FINE GRADE
12
EXCAV FORM & POUR FTGS
14
START F&P COL & BM
7
SHORING COLLAPSE
48
COMPLETE F&P COL & BM
9
PLACE GIRDERS
5
FORM & POUR DECK
15
HTGP - Pg. 303

HOW TO VERIFY (or create) AN AS-PLANNED SCHEDULE

1. If No As-Planned Schedule Exists, Create One

1. Base it on reasonable expectations at the start of work and actual progress to date.
2. Document all assumptions, references, and computations.

2. If A Bar Chart, Convert It Into A CPM Network

1. Identify and draw relationship lines on the Bar Chart.
2. Add detail as required.
3. Computerize.

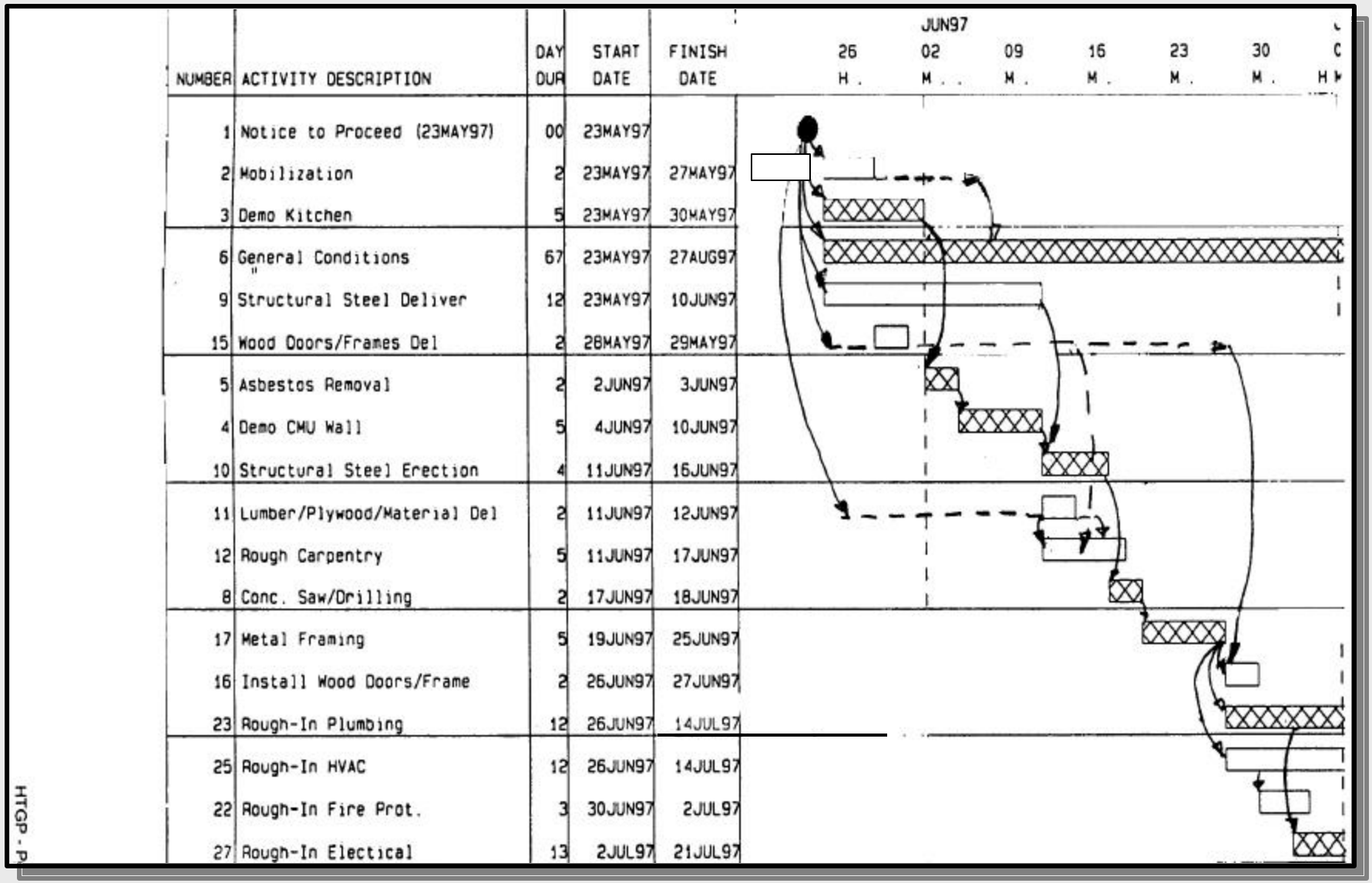
3. Plot The As-Planned Schedule As A Timescaled Network

For easier review and better understanding, plot the As-Planned Schedule as a Timescaled Network Diagram showing the activities scaled to a calendar and the relationships shown between activities.

4. Verify Adequacy And Accuracy, And Modify If Required

1. Examine the job logic, activity durations, available resources, etc.
2. Add missing activities and relationships, show overlapping activities or intermittent progress, and correct patent (obvious) errors.
3. If necessary, modify the As-Planned Schedule for comparison with the As-Built.

Copyright © 2000 Pinnell♦Busch, Inc.



NUMBER	ACTIVITY DESCRIPTION	DAY DUR	START DATE	FINISH DATE
1	Notice to Proceed (23MAY97)	00	23MAY97	
2	Mobilization	2	23MAY97	27MAY97
3	Demo Kitchen	5	23MAY97	30MAY97
6	General Conditions	67	23MAY97	27AUG97
9	Structural Steel Deliver	12	23MAY97	10JUN97
15	Wood Doors/Frames Del	2	28MAY97	29MAY97
5	Asbestos Removal	2	2JUN97	3JUN97
4	Demo CMU Wall	5	4JUN97	10JUN97
10	Structural Steel Erection	4	11JUN97	16JUN97
11	Lumber/Plywood/Material Del	2	11JUN97	12JUN97
12	Rough Carpentry	5	11JUN97	17JUN97
8	Conc. Saw/Drilling	2	17JUN97	18JUN97
17	Metal Framing	5	19JUN97	25JUN97
16	Install Wood Doors/Frame	2	26JUN97	27JUN97
23	Rough-In Plumbing	12	26JUN97	14JUL97
25	Rough-In HVAC	12	26JUN97	14JUL97
22	Rough-In Fire Prot.	3	30JUN97	2JUL97
27	Rough-In Electical	13	2JUL97	21JUL97

Copyright © 2000 Pinnell◆Busch, Inc.

HOW TO VERIFY (or create) AN AS-BUILT SCHEDULE

1. If No As-Built Activity Exists, Create One

1. Base it on actual progress as noted in the job records.
2. If necessary, create a Detailed As-Built Schedule and condense it to the same level of detail as the As-Planned.

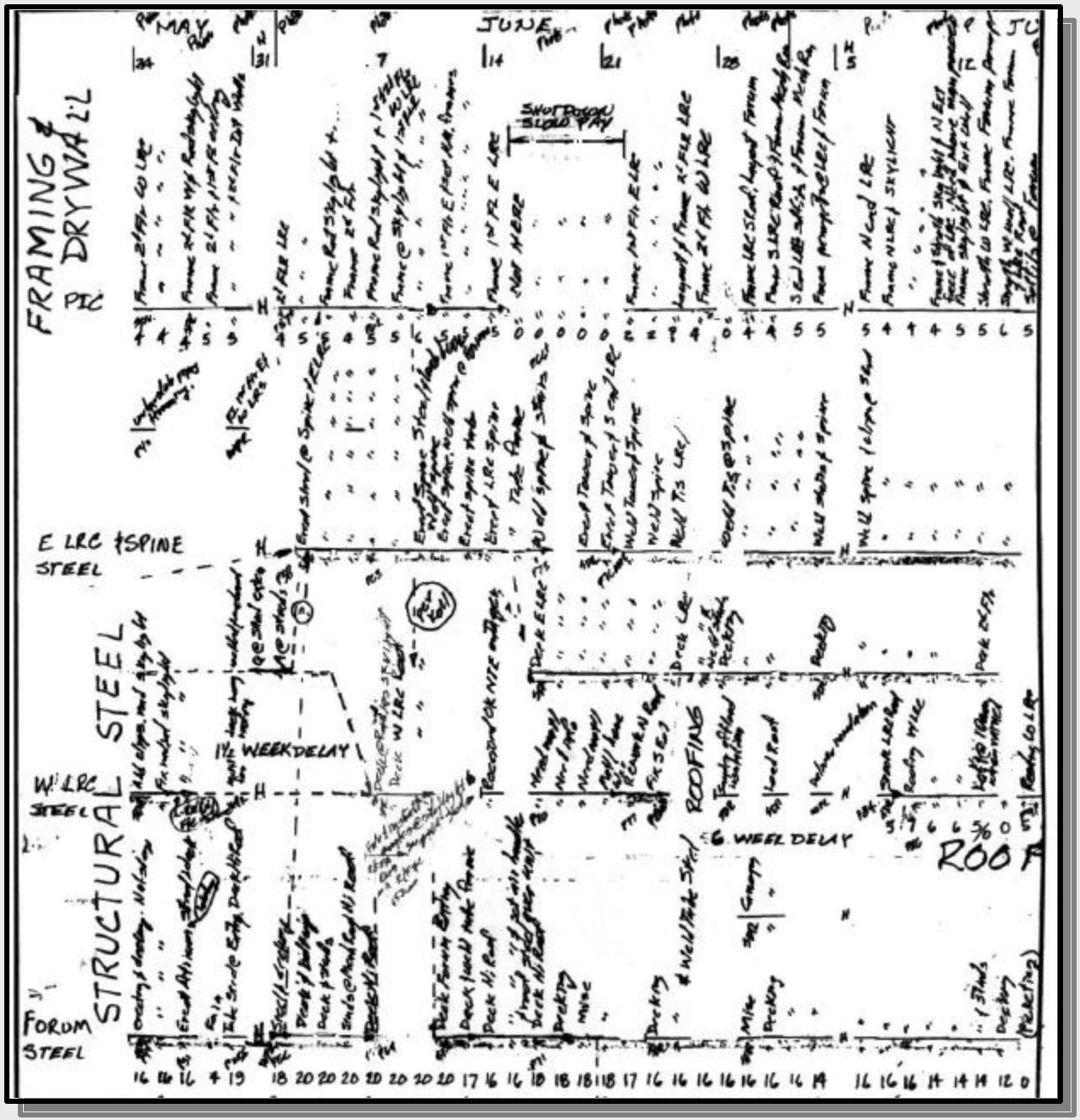
2. Verify The Accuracy Of The As-Built Schedule Updates

1. Examine the records to determine if the schedule was updated regularly.
2. If Short-Interval Schedules exist, compare them with the As-Built Schedule.
3. Check the accuracy of the start and finish dates and job logic.
4. If significant shortcomings exist, check all critical and near-critical activities.

3. Modify The As-Built Schedule, If Necessary

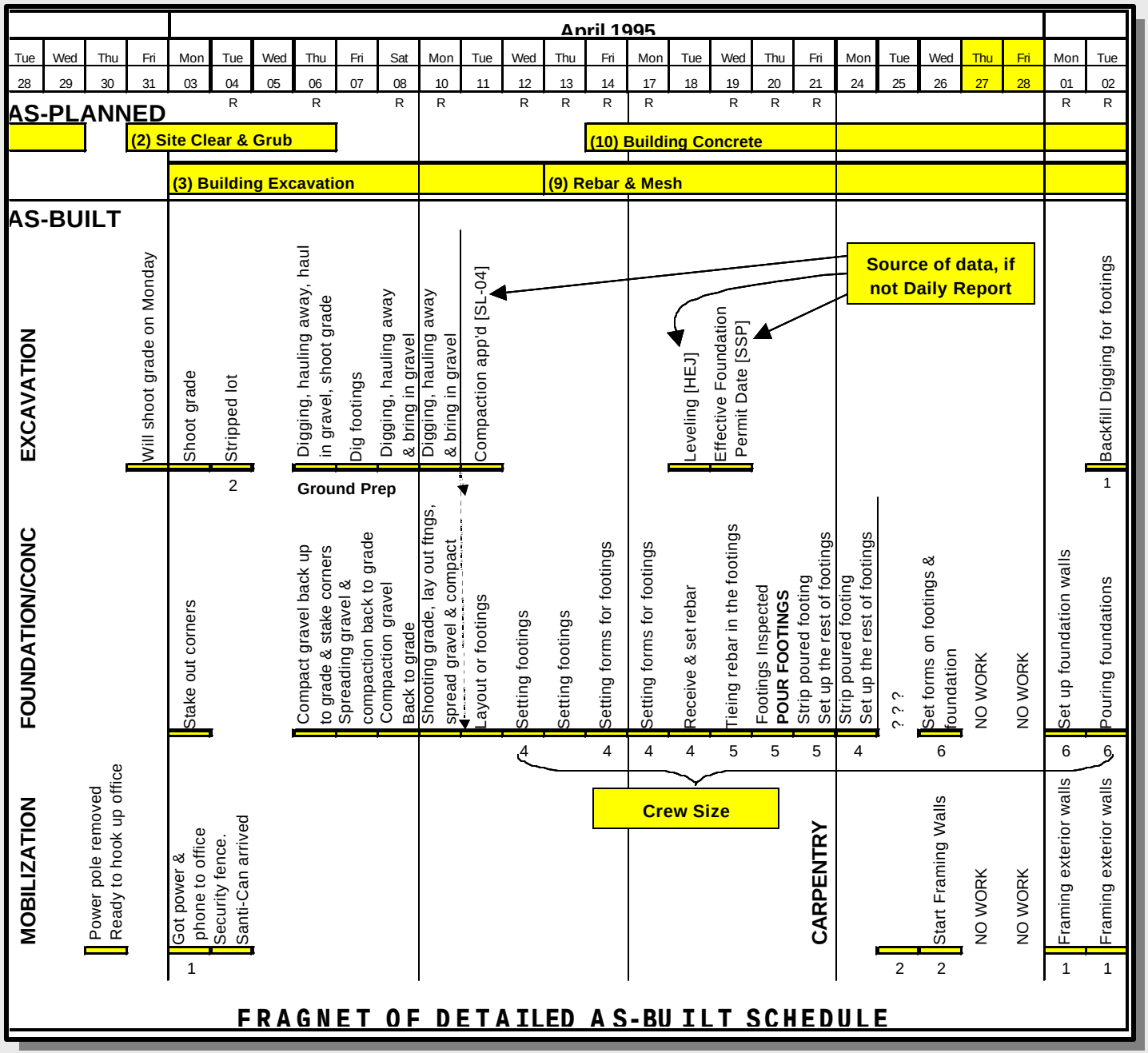
1. Correct for errors and logic changes, add missing activities and detail (if required.)
2. Use the Short Interval Schedules, the daily field reports, and other records.
3. If necessary, create a Detailed As-Built Schedule and then condense it to be compatible and with the same level of detail as the As-Planned Schedule.

Copyright © 2000 Pinnell◆Busch, Inc.



HTGP – Pg. 313, Fig. 10.27

Copyright © 2000 Pinnell♦Busch, Inc.



FRAGNET OF DETAILED AS-BUILT SCHEDULE

Copyright © 2000 Pinnell◆Busch, Inc.

DETAILED AS-BUILTS
Advantages And Disadvantages

For Analysis

- Explains apparent contractor errors
- Identifies additional issues
- Can generate productivity rates and damages
- Offers convenient display and access to other data
- Provides information for issue analyses and reports
- Provides all the above simultaneously

For Presentation

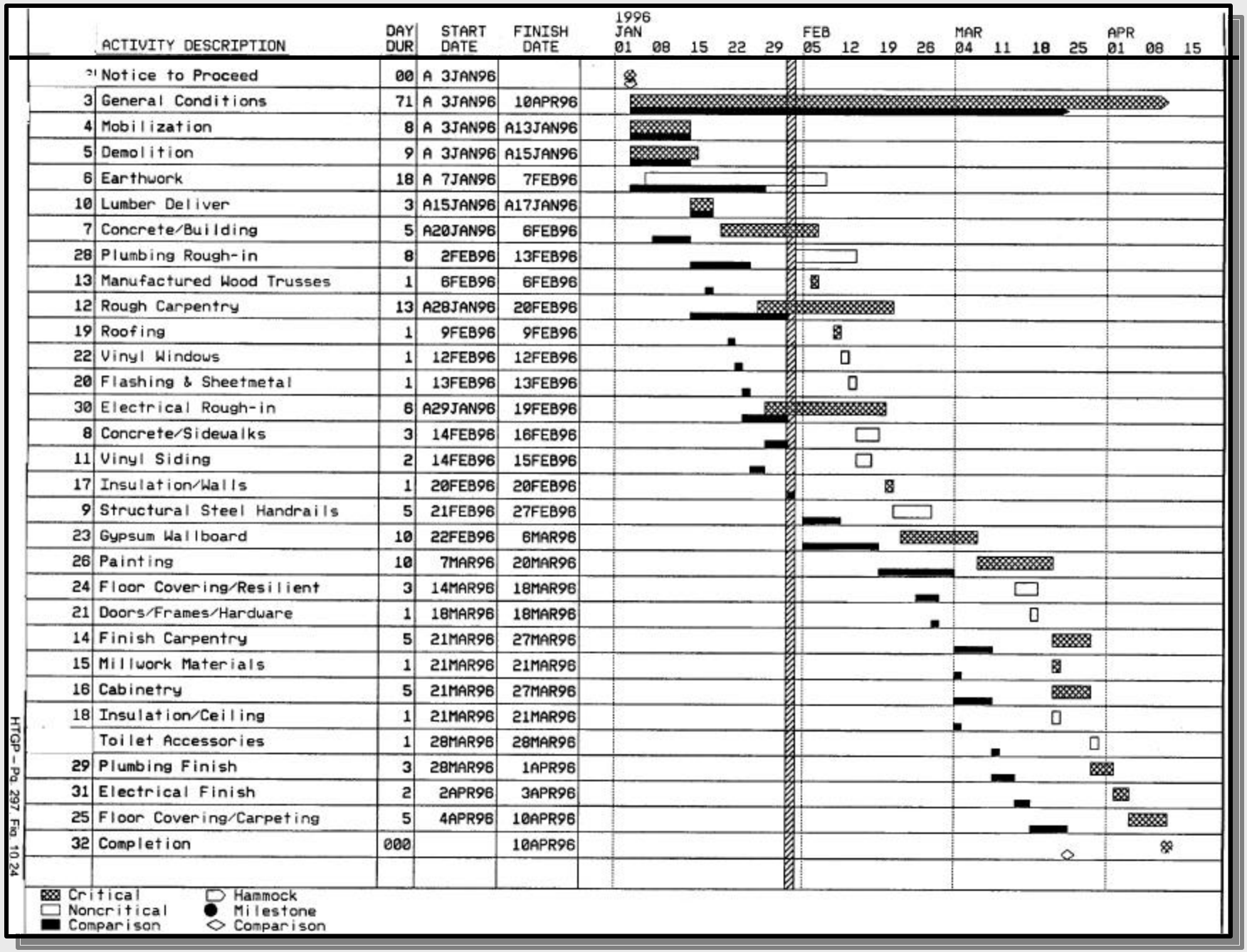
- Easier to understand
- Refutes alleged concurrent delay
- Allows quick response to unanticipated questions
- Establishes credibility
- Provides a foundation for conclusions
- Intimidates opposing witnesses

Copyright © 2000 Pinnell♦Busch, Inc.

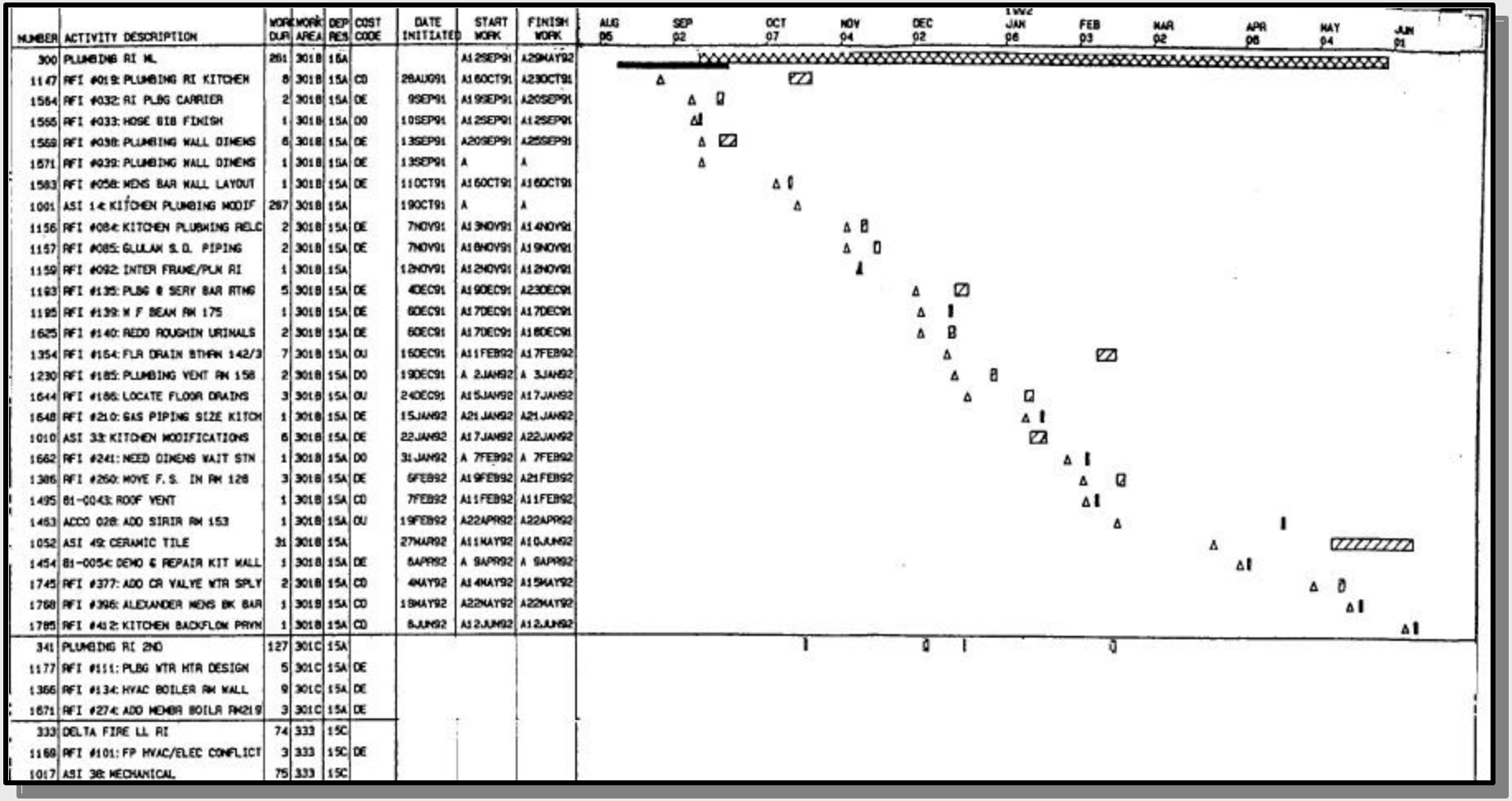
HOW TO PREPARE A "WOULD-HAVE-BEEN, BUT FOR. . ." SCHEDULE

1. **Plot As-Planned vs. As-Built Comparison Bar Chart** – evaluate differences
2. **Review Time Impact Analyses** – of individual delays (if existing)
3. **Examine the Detailed As-Built Schedule** – if one was created
4. **Review Issue Analyses and Chronological Summary Notes**
5. **Create an ELIPSE Schedule** – integrating RFIs, extra work, the schedule
6. **Look at Labor & Equipment Use**
7. **Optionally, Prepare What-If Analyses and Computer Simulations**
8. **Create the Would-Have-Been Schedule:**
   - One activity at a time, from the beginning
   - Based on the contractor's intent as evidenced by the as-planned schedule and subsequent documents (correspondence, schedule updates, etc.)
   - Adjusting the job logic, when appropriate, to what the contractor probably would have done under the circumstances
   - Using actual durations for un-impacted activities, after adjusting for the working conditions when the work would have been done.
   - Using computed durations for impacted activities, based on an analysis of planned duration, actual duration, actual vs. would-have-been working conditions, crew size and productivity rates, etc.
9. **Include Excusable but Non-Compensable Delays** - e.g. weather
10. **Record Assumptions and Calculations**

Copyright © 2000 Pinnell◆Busch, Inc.

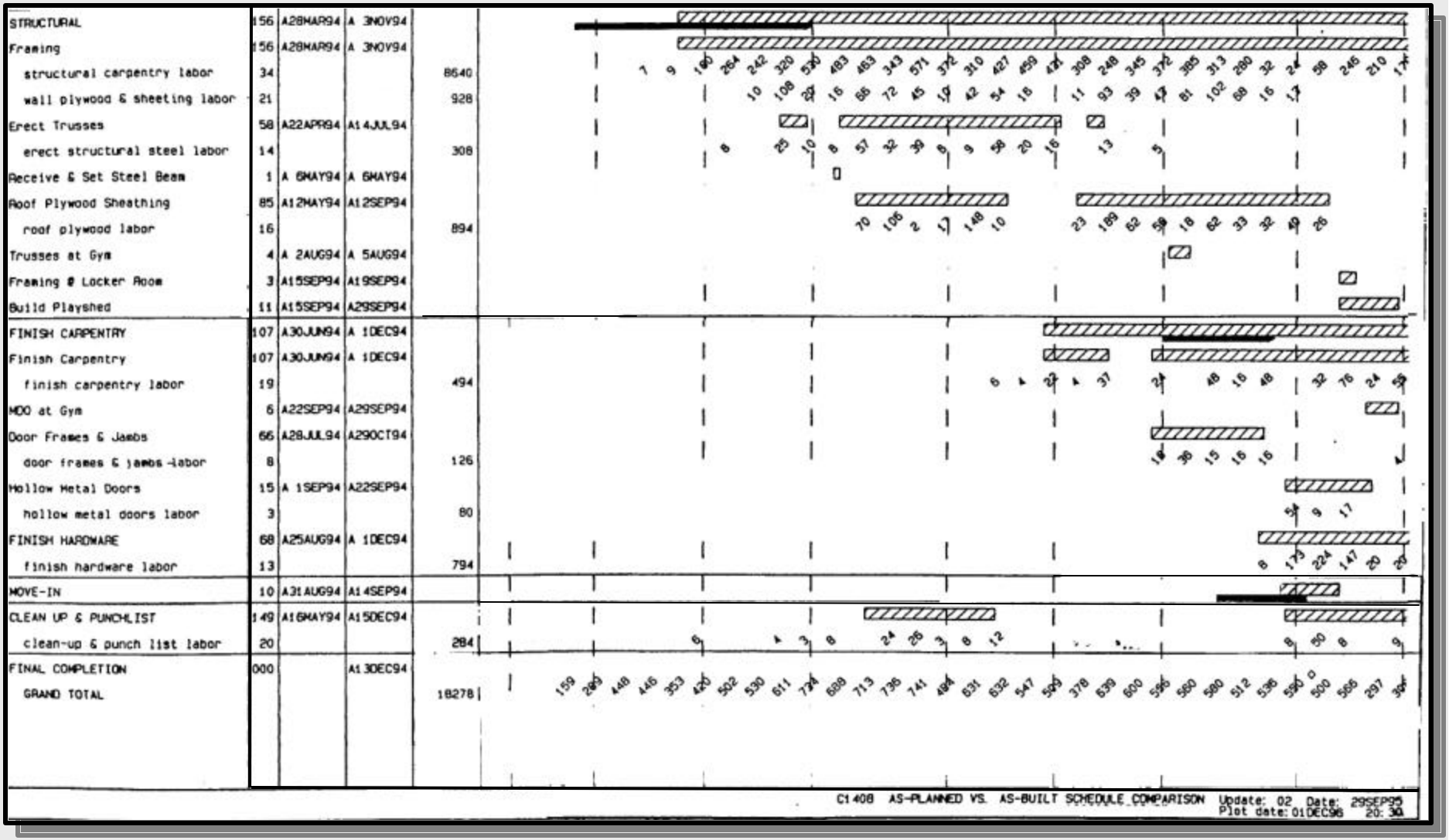


Copyright © 2000 Pinnell♦Busch, Inc.

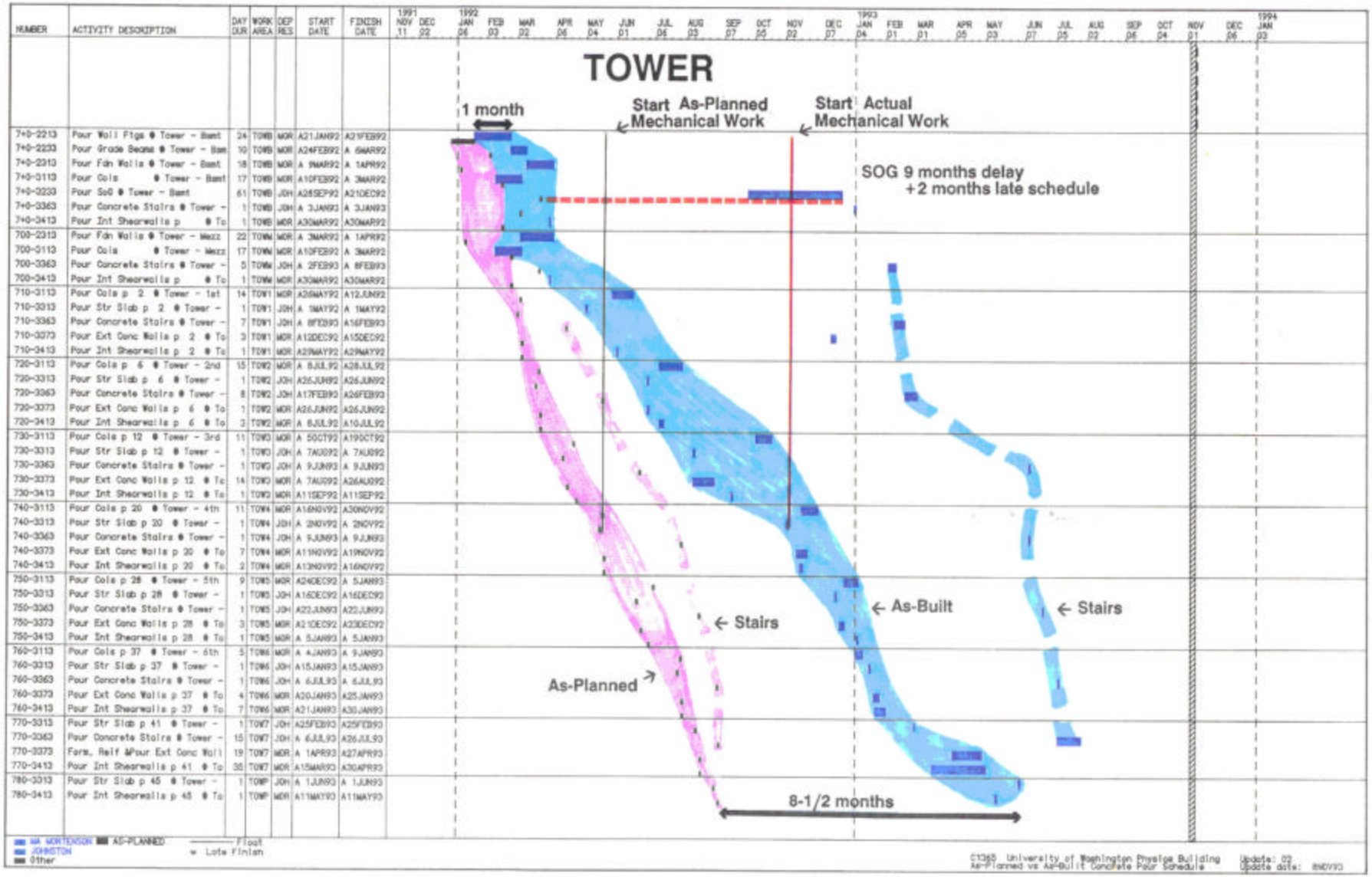


NUMBER	ACTIVITY DESCRIPTION	WORK DUR	WORK AREA	DEP RES	COST CODE	DATE INITIATED	START WORK	FINISH WORK
300	PLUMBING RI ML	261	301B	15A			A12SEP91	A29MAY92
1147	RFI #019: PLUMBING RI KITCHEN	8	301B	15A	CD	26AUG91	A16OCT91	A23OCT91
1564	RFI #032: RI PLBG CARRIER	2	301B	15A	DE	9SEP91	A19SEP91	A20SEP91
1565	RFI #033: HOSE BIB FINISH	1	301B	15A	DO	10SEP91	A12SEP91	A12SEP91
1569	RFI #038: PLUMBING WALL DIMENS	6	301B	15A	DE	13SEP91	A20SEP91	A25SEP91
1571	RFI #039: PLUMBING WALL DIMENS	1	301B	15A	DE	13SEP91	A	A
1583	RFI #058: MENS BAR WALL LAYOUT	1	301B	15A	DE	11OCT91	A16OCT91	A16OCT91
1001	ASI 14: KITCHEN PLUMBING MODIF	287	301B	15A		19OCT91	A	A
1156	RFI #084: KITCHEN PLUMBING RELC	2	301B	15A	DE	7NOV91	A13NOV91	A14NOV91
1157	RFI #085: GLULAM S.O. PIPING	2	301B	15A	DE	7NOV91	A18NOV91	A19NOV91
1159	RFI #092: INTER FRAME/PLN RI	1	301B	15A		12NOV91	A12NOV91	A12NOV91
1193	RFI #135: PLBG @ SERV BAR RTNG	5	301B	15A	DE	4DEC91	A19DEC91	A23DEC91
1195	RFI #139: W F BEAM RM 175	1	301B	15A	DE	6DEC91	A17DEC91	A17DEC91
1625	RFI #140: REDO ROUGHIN URINALS	2	301B	15A	DE	6DEC91	A17DEC91	A18DEC91
1354	RFI #164: FLR DRAIN BTWN 142/3	7	301B	15A	OU	16DEC91	A11FEB92	A17FEB92
1230	RFI #185: PLUMBING VENT RM 158	2	301B	15A	DO	19DEC91	A 2JAN92	A 3JAN92
1644	RFI #186: LOCATE FLOOR DRAINS	3	301B	15A	OU	24DEC91	A15JAN92	A17JAN92
1648	RFI #210: GAS PIPING SIZE KITCH	1	301B	15A	DE	15JAN92	A21JAN92	A21JAN92
1010	ASI 33: KITCHEN MODIFICATIONS	6	301B	15A	DE	22JAN92	A17JAN92	A22JAN92
1662	RFI #241: NEED DIMENS WAIT STN	1	301B	15A	DO	31JAN92	A 7FEB92	A 7FEB92
1386	RFI #260: MOVE F.S. IN RM 128	3	301B	15A	DE	6FEB92	A19FEB92	A21FEB92
1495	81-0043: ROOF VENT	1	301B	15A	CD	7FEB92	A11FEB92	A11FEB92
1483	ACCO 028: ADD SIRIR RM 153	1	301B	15A	OU	19FEB92	A22APR92	A22APR92
1052	ASI 49: CERAMIC TILE	31	301B	15A		27MAR92	A11MAY92	A10JUN92
1454	81-0054: DEMO & REPAIR KIT WALL	1	301B	15A	DE	6APR92	A 9APR92	A 9APR92
1745	RFI #377: ADD CR VALVE WTR SPLY	2	301B	15A	CD	4MAY92	A14MAY92	A15MAY92
1768	RFI #396: ALEXANDER MENS BK BAR	1	301B	15A	CD	18MAY92	A22MAY92	A22MAY92
1785	RFI #412: KITCHEN BACKFLOW PRVN	1	301B	15A	CD	8JUN92	A12JUN92	A12JUN92
341	PLUMBING RI 2ND	127	301C	15A				
1177	RFI #111: PLBG WTR HTR DESIGN	5	301C	15A	DE			
1366	RFI #134: HVAC BOILER RM WALL	9	301C	15A	DE			
1671	RFI #274: ADD MEMBR BOILR RM219	3	301C	15A	DE			
333	DELTA FIRE LL RI	74	333	15C				
1169	RFI #101: FP HVAC/ELEC CONFLICT	3	333	15C	DE			
1017	ASI 38: MECHANICAL	75	333	15C				

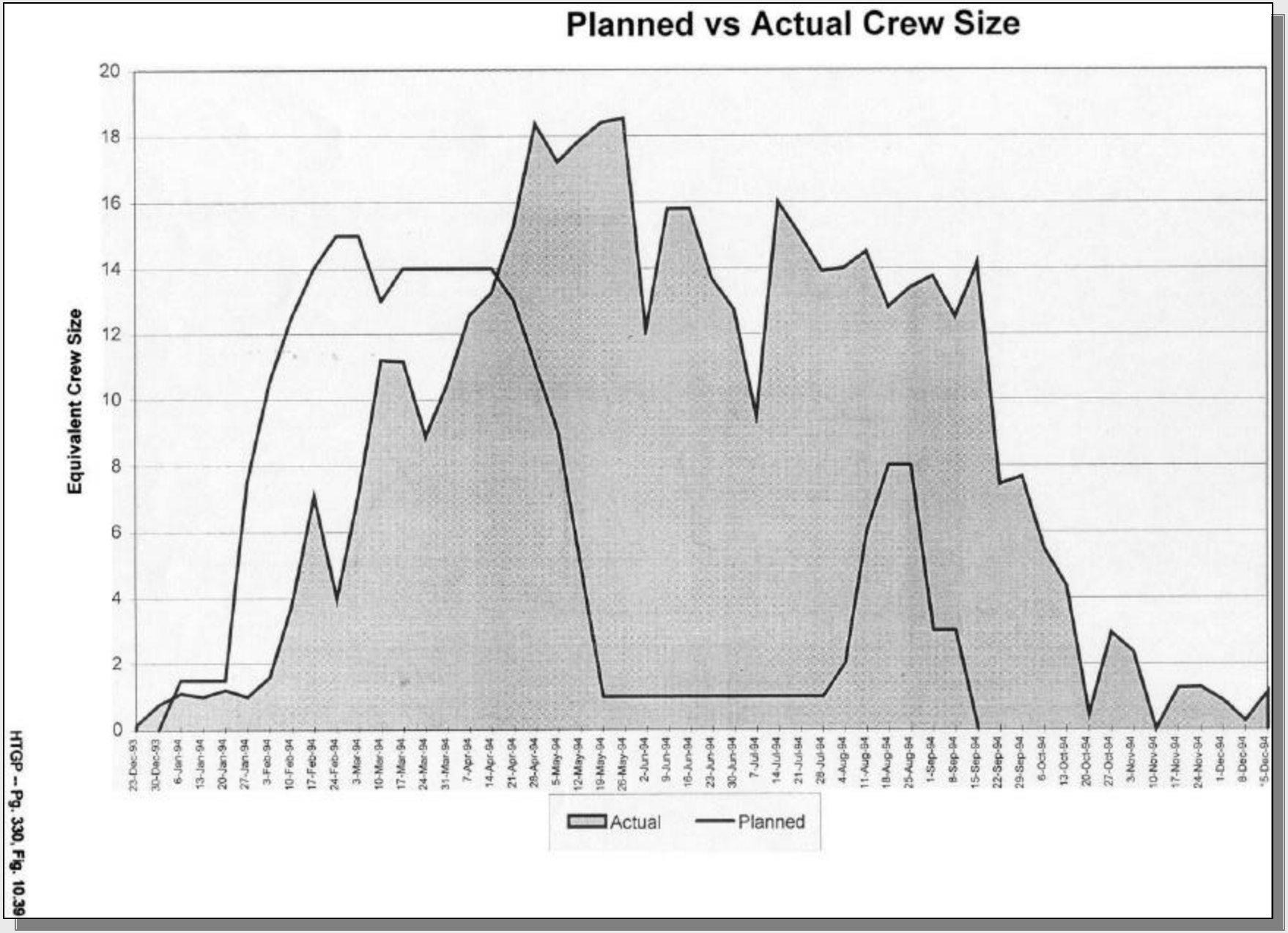
Copyright © 2000 Pinnell◆Busch, Inc.



Copyright © 2000 Pinnell◆Busch, Inc.



Copyright © 2000 Pinnell◆Busch, Inc.



HTGP -- Pg. 330, Fig. 10.39

Copyright © 2000 Pinnell♦Busch, Inc.

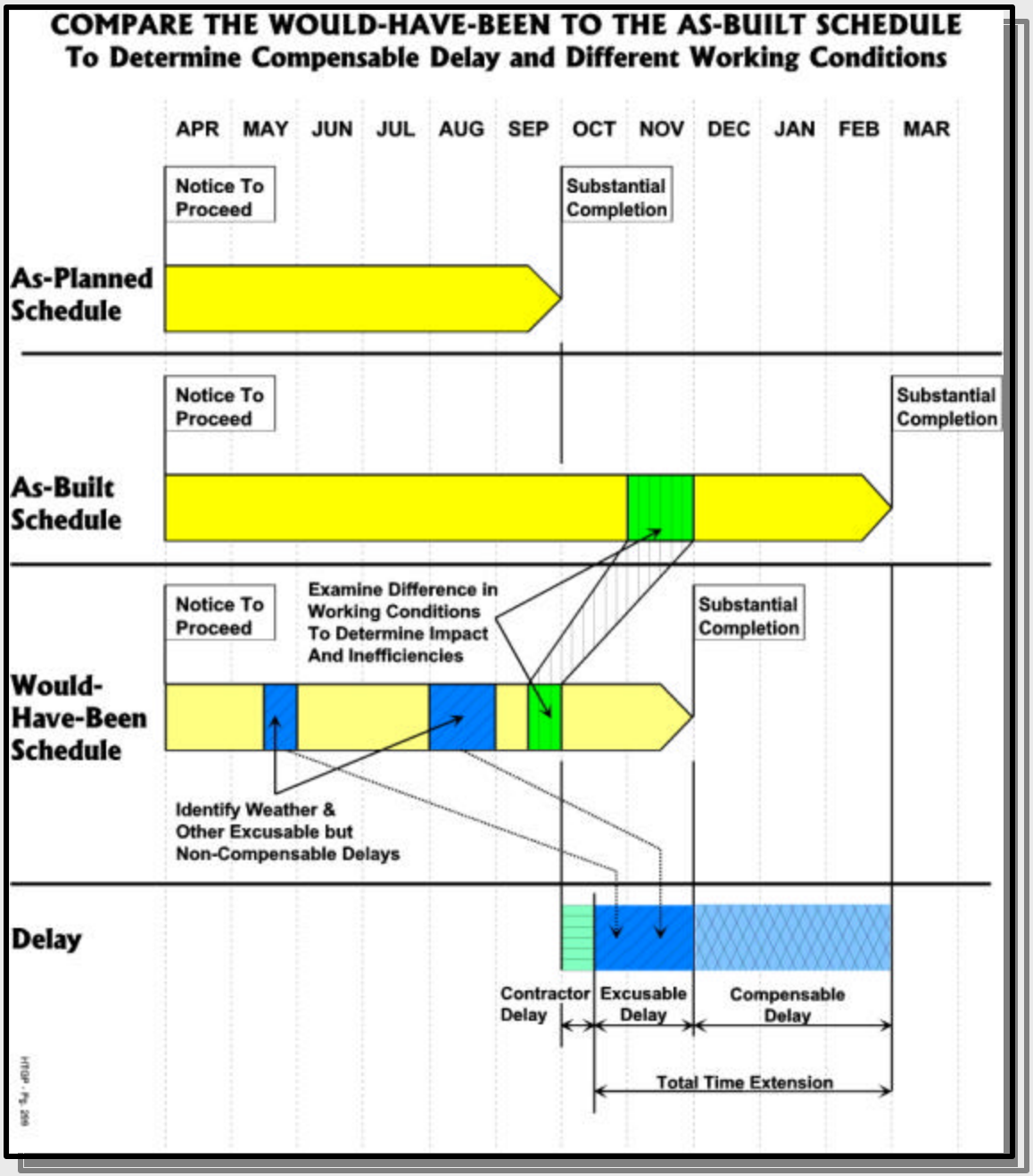
C1130 PMS80 Update: 15 Page: 2
Would have been, but for SCHEDULE COMPARISON - REPORT NO 11 Update date: 28AUG90
PROJECT FILE:C1130 RECORD: 15 SORT:Activity Numb PINNELL/BUSCH, INC. - PORTLAND, OR Print date: 24SEP91

NUMBER	ACTIVITY DESCRIPTION	WORK AREA	<AS-PLANNED SCHEDULE> DUR	EARLY ST	EARLY FN	< WOULD-HAVE-BEEN SCHEDULE> DUR	EARLY ST	EARLY FN	REMARKS (Rainfall)	< CHANGES> DUR	ES	EF
1018	PLUMBING UNDERGROUND	A	3	14SEP90	18SEP90	3	7SEP90	11SEP90	1d .03 .	0	-5	-5
1024	BACKFILL	A	3	80CT90	100CT90	4	25SEP90	28SEP90	2d .09	1	-9	-8

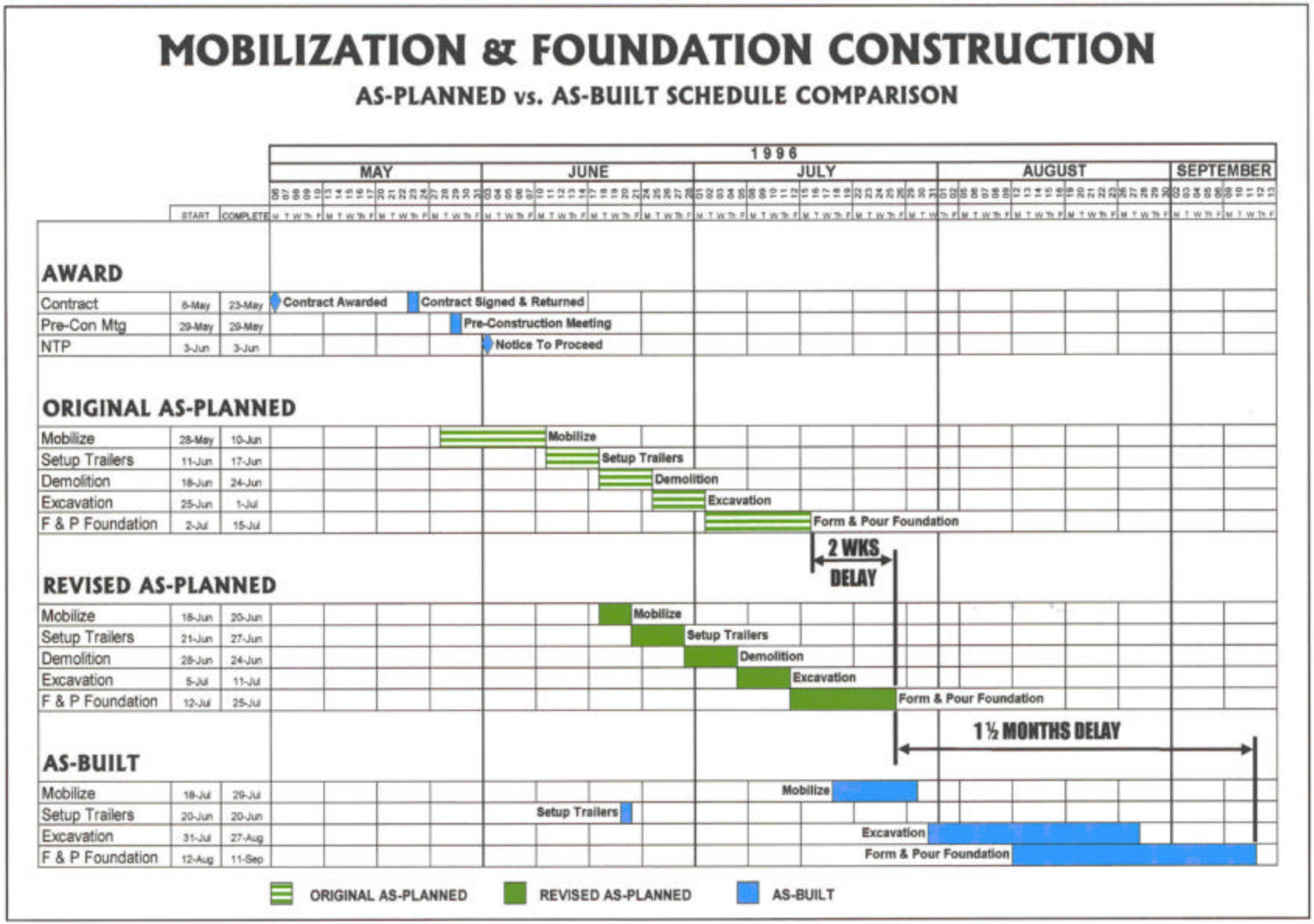
This activity was increased from 3 to 4 days, in spite of being scheduled in September when no rain fell. This was to adjust for the larger excavated area caused by the three sanitary sewer line taps (a change to the contract). This was probably overly conservative. The actual work took 8 days from 240ct to 2Nov, but 6 of those days experienced rain with a total of 1.59" in addition to the substantial rains before work started.

1026	CMU - 1ST FLOOR	A	3	110CT90	150CT90	3	10CT90	30CT90	3d1.43	0	-8	-8

Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.

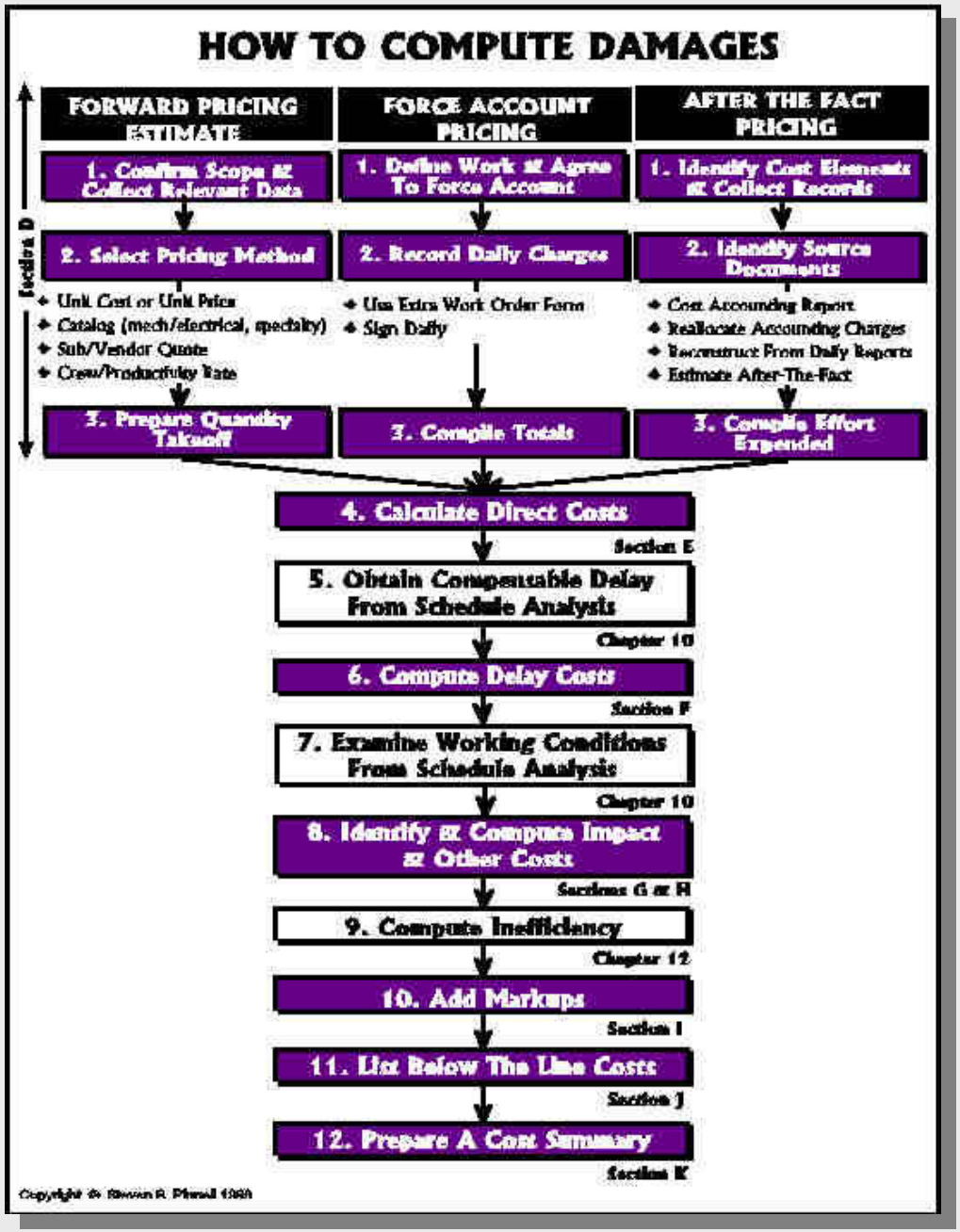
OWNER DEFENSES AND COUNTERCLAIMS

- **Lack of Entitlement** – disputed contract interpretation or other failure to prove the contract or contract law entitles the contractor to extra payment or time extension
- **Concurrent Delay** – due to weather delays, contractor error in prosecuting other activities, etc.

- **Failure to Re-Sequence** – overlap relationships, expand level of detail, break non-essential logic links, re-sequence activities, add labor or equipment to eliminate resource constraints, etc.
- **Faulty Scheduling** – poor or impractical as-planned schedule, overly optimistic as-planned activity durations, inaccurate or insufficiently detailed as-built schedule, incorrect or inadequately supported would-have-been schedule logic and durations
- **Erroneous Analysis** – lack of causation, improper allocation of delay, unsupported computation of damages

- **Liquidated or Consequential Damages** – for non-excusable delays and consequential delays to repair defective work
- **Defective Work** – out-of-spec work product

Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.

TYPES OF DAMAGES

Direct Cost of Extra Work -- From a change resulting in a project that is different and more costly.

- Labor
- Materials
- Equipment
- Subcontract
- Small Tools & Expendables
- Mark-up

Impact from Change In Conditions -- under which the work is done, which can be:

- Inefficiency -- of labor, equipment and subcontract costs in performing original bid work.
- Additional Tasks -- not leading to a scope change in the project, such as access road.
- Additional Materials -- such as extra base rock to allow working on wet subgrades.

Delay -- causing the project to take longer or be done later, resulting in:

- Extended Overhead -- of jobsite and home office overhead
- Escalation -- in the unit costs of labor, materials, equipment use, or subcontract costs.
- Equipment Standby -- while waiting for a problem to be resolved.
- Demobilization and Remobilization -- due to delay and the need to return later.
- Extended Warranty -- and other cost due to delay
- Change In Conditions with Impact (inefficiency, additional tasks and/or materials use).
- Lost Profits -- for projects that could not be bid, due to delay. No markup added.

Acceleration -- from having to complete earlier or with less time than anticipated, resulting in:

- Change In Conditions with Impact

Other

- Additional Overhead -- jobsite or home office for many claims or a specific claim.
- Change Order Preparation and Negotiation Costs -- separate from claim costs.
- Future Costs -- such as higher insurance or workers' compensation premiums.

Markup -- for indirect costs added to direct costs

- Jobsite Overhead -- expressed as a percentage or direct costs.
- Home Office Overhead -- expressed as a percentage of jobsite costs.
- Profit -- expressed as a percentage of total job costs.
- Bond, Insurance Premium and Taxes -- computed as a percent of job cost plus profit.

Below The Line Costs -- added at the end, without markup:

- Retainage and Unpaid Contract Balances
- Interest -- for late payment of retainage, the claimed amounts, or progress payments
- Attorney Fees and Claim Preparation Cost
- Credit for Nonconforming and Unsatisfactory Work

Copyright © 2000 Pinnell◆Busch, Inc.

UNIT PRICE ESTIMATE

Concrete	**100 cy @ $150/cy =**	**$15,000.00**

HTGP – Pg. 363

Copyright © 2000 Pinnell♦Busch, Inc.

Crew and Productivity Rate Estimate
For Additional Footings

	No.	Hours	Hourly Base Rate	Subtotal Amount	
1. Labor Daily Rate					
Carpenter foreman	1	8	$ 18.13	$ 145.00	
Carpenter journeymen	2	8	16.99	271.84	
Carpenter apprentice 3	1	8	16.70	133.60	
Laborers	4	8	9.45	302.40	
Operating engr. (crane)	1	8	16.25	130.00	
	9 workers			$ 982.84	
2. Labor Burden (see Exhibit A)					
FICA 6.20%					
Medicare	1.45				
Federal unemployment	0.80				
Workers' compensation	7.40				
State unemployment	1.35				
Insurance	0.25				
Health & welfare & pension	1.50				
Labor Burden	18.95	/100 x $982.84		$186.25	
3. Subtotal Labor Daily Rate				$1,169.09	per day
4. Equipment Daily Rate					
Hyundai Crane, Bucyrus-RT58D	1 day @$425.00*			$425.00	per day
Rough Terrain Lift Truck – Bob's Rentals				$300.00	per day
Rental Rate Blue Book,	13-3				
5. Small Tools					
@ 5% of labor costs	$1,169.09 x 0.05			$58.45	per day
DAILY COMPOSITE CREW RATE				$1,952.54	
6. Equipment Daily Rate				$783.45	per day
7. Estimated Production Rate					
Form & pour wall estimated @ 50 cy / day (100 cy / 50 cy / per day = 2 days)				x 2 days	
				$3,905.08	
8. Materials (see Exhibit B)					
Form lumber 20 MFBM @ $240/M (invoice attached)				$2,400.00	
Form Hardware, lump sum estim. @ 10% of lumber cost				240.00	
Concrete 100 cy $45.00 (quote attached)				4,500.00	
Consumables @ 3% of labor costs	$1,169.09 x 0.03 = 35.07 / day x 2 days			70.14	
Safety Supplies @ 1% of labor costs	$1,169.09 x 0.01 = 11.96 / day x/2 days			23.92	
				$7,234.06	
9. Subcontract					
P&J Concrete quote to place and finish concrete (attached)				$2,000.00	
R&R Steel quote to furnish and place rebar (attached)				1,275.00	
				$3,275.00	
10. Recap by Cost Category					
Labor (#3 x 2 days)				$2,338.18	
Equipment (#6 x 2 days)				1,566.90	
Materials (#8)				7,234.06	
Subcontract (#9)				3,275.00	
Subtotal Direct Costs				**$14,414.14**	

Copyright © 2000 Pinnell♦Busch, Inc.

DELAY DAMAGES

- **Extended Jobsite Overhead** – estimated or from cost accounting records – time dependent costs only
- **Extended Home Office Overhead** – Eichleay formula is applicable only when the contractor cannot obtain other work
- **Escalation** – normally minimal, except for union wage escalation

- **Standby** of Equipment and Labor
- **Under-Utilization** of Labor and Equipment
- **Subcontractor Demobilization and Re-mobilization**
- **Labor Layoff and Re-Hire**
- **Materials Storage, Extra Handling and Deterioration or Theft**

- **Interest** on Retainage and Pending Change Orders
- **Extended Warranty Liability**
- **Lost Profits** or Loss of Operating Business

- **Ripple Effects** of Consequential Delays, Impacts, and Inefficiency
- **Inefficiency** from Changed Working Conditions - e.g. pushing weather-sensitive work into winter

Copyright © 2000 Pinnell♦Busch, Inc.

EXTENDED JOBSITE OVERHEAD

General Conditions Item Description	Cost per Work Day
♦ Field Superintendent	$ 340
♦ Carpenter foreman	311
♦ Job Trailer	16
♦ Phone/Pager	17
♦ Fax	8
♦ Copier	10
♦ Weather Service	5
♦ Travel	18
♦ Storage Trailer	5
♦ 35 ft 4wd Reach Lift	105
♦ Two 60 ft Boom Lifts (Ivy HiLift)	210
♦ 20 Ton Hydro Crane	720
♦ Forming Material (Mason's Supply)	429
♦ Planking Material (Ivy HiLift)	29
♦ Safety Equipment (harness, lanyards, . . .)	50
♦ Miscellaneous Tools and Equipment	599
Total Daily Cost	**$ 2,872**

The extended jobsite overhead cost is therefore:
33 days delay @ $2,872/day = **$ 94,776**

Copyright © 2000 Pinnell♦Busch, Inc.

MODIFIED EICHLEAY FORMULA

$\frac{\text{Original Contract Amount}}{\text{Total Company Billings During Original Contract Period}}$	×	Total Home Office Overhead During Original Contract	=	Overhead Allocated to Project
Overhead Allocated to Project	÷	Original Contract Duration	=	Daily Home Office Overhead Allocated to Project
Daily Home Office Overhead Allocated to Project	×	Days of Delay	=	Extended Home Office Overhead Amount

Copyright © 2000 Pinnell♦Busch, Inc.

ACCELERATION DAMAGES

- **Overtime or Shift Work Premium and Fatigue** - with resulting inefficiency

- **Mobilization and Demobilization** - additional/larger equipment, more personnel
- **Crowding and Trade Stacking**
- **Excessive Activity Re-sequencing and Overlap** - with increased conflicts
- **Start-Stop Operation and Out-of-Sequence Work**
- **Additional Tasks** - e.g. better or additional access roads
- **Increased Errors and Rework** - from rushing, insufficient time for layout, etc.

- **Additional Overhead** - to manage the additional work force
- **Overloaded Supervision and Administration** - more errors and less oversight

- **Expedited Materials Delivery** - vendor premiums, rushed procurement/shipping
- **Additional or More Expensive Materials** - that assemble or install quicker

Copyright © 2000 Pinnell♦Busch, Inc.

REASONS FOR LOSS OF EFFICIENCY

- Adverse of Abnormal Environmental Conditions
- Acceleration
- Delay
- Disruption, Interference, And Change
- Inadequate Access and Work Space
- Supervision and Management Problems
- Resource Problems
- Poor Morale
- Safety Constraints
- Errors
- Other

Copyright © 2000 Pinnell♦Busch, Inc.

REASONS FOR LOSS OF EFFICIENCY

Adverse or Abnormal Environmental Conditions

- ♦ Rain
- ♦ Cold
- ♦ Wind
- ♦ Combination of Cold, Rain, and Wind together
- ♦ Snow
- ♦ Heat
- ♦ Noise
- ♦ Dust or Odors
- ♦ Humidity (intensifies effect of heat)
- ♦ Poor Lighting or Darkness

Acceleration

- ♦ Overtimes
  - Premium labor rates
  - Fatigue – physical, mental, boredom
- ♦ Multiple Shift Operation
  - Overlap between crews
  - Poor lighting
  - Circadian rhythm disruption on swing shifts
  - Lighting for multi-shift operation
  - Shutdown to service equipment
  - Shift premium pay
- ♦ Rescheduling and Expediting

Delay

- ♦ Idle Labor and Equipment
- ♦ Equipment Standby
- ♦ Stretch Out/Working at Reduced Pace – while waiting for delay to be resolved.

Disruption, Interference, And Change

- ♦ Start-Stop Operation
- ♦ Fluctuating Labor Force
- ♦ Disruption of Work Flow
- ♦ Loss of Learning Curve Effect
- ♦ De-Mobilization and Re-Mobilization
- ♦ Out-Of-Sequence Work
- ♦ Crew Imbalance
- ♦ Frequent Changes
- ♦ Uncertainty
- ♦ Limited Flexibility
- ♦ Over-Inspection
- ♦ Directed Work by Owner

Inadequate Access and Work Space

- ♦ Crowding
- ♦ Trace Stacking – crowding and trade conflicts
- ♦ Limited Access
- ♦ Inadequate Work Areas for laydown, fabrication or circulation

Supervision and Management Problems

- ♦ Dilution of Supervision
- ♦ Excessive Supervision
- ♦ Poorly Skilled Supervisors
- ♦ Increased Supervision
- ♦ Overworked Supervisors
- ♦ Inadequate Instructions to Crews
- ♦ Layout Errors

Resource Problems

- ♦ Shortage of Qualified Workers
- ♦ Undersized or Insufficient Equipment
- ♦ Excessive Personnel
- ♦ Logistics Problems – procurement or delivery of materials

Poor Morale

- ♦ Uncertainty
- ♦ Frustration with Rework
- ♦ Absenteeism
- ♦ Theft
- ♦ High Turnover
- ♦ Deliberate Slowdown

Safety Constraints

- ♦ Required Safety Measures
- ♦ Caution and Slowdown for dangerous conditions
- ♦ Disruption and Slowdown resulting from accident
- ♦ Increased Accidents

Errors

- ♦ Increased Wastage
- ♦ Re-Work
- ♦ Increased Clean Up
- ♦ Increased Close-Out and Punch List Costs

Other

- ♦ Additional Materials Handling Multiplicity of Changes

Copyright © 2000 Pinnell♦Busch, Inc.

METHODS OF COMPUTING INEFFICIENCY

- **Expert Opinion and/or Survey**
- **Total Cost or Cost Plus**
- **Modified Total Cost** – adjust for for bid error, contractor mistakes or misfortune (abnormal weather, accidents, etc.)
- **Measured Mile** – adjust for learning curve effect
- **Industry Studies** – charts and formulas
- **Scientific Methods** – work improvement analysis
- **Rational Analysis** – a combination of the above

Copyright © 2000 Pinnell♦Busch, Inc.

TOTAL COST, MODIFIED TOTAL COST & COST PLUS

♦ TOTAL COST CLAIM:

ACTUAL COST
- BID COST
+ MARKUP
CLAIM AMOUNT

Does not consider bid errors, contractor mistakes, or unfavorable conditions. (Seldom used.)

♦ MODIFIED TOTAL COST CLAIM:

ACTUAL COST
- BID AMOUNT
- BID ERRORS
- MISTAKE
+ MARKUP
CLAIM AMOUNT

Used when information lacking for using other methods.

♦ COST PLUS CLAIM:

ACTUAL COST
+ MARKUP
CLAIM AMOUNT

Used when the work performed is materially different from what was bid, so as to constitute a cardinal change and recovery as quantum meruit.

Copyright © 2000 Pinnell♦Busch, Inc.

COMMON BID ERRORS

- **Quantity Takeoff Errors**
- **Underestimating Difficulty** of the work
- **Underestimating Time** to do the work
- **Wrong Assumptions** on manner and methods of doing work
- **Underestimating Unit Costs** of labor, equipment, or materials
- **Forgetting** a work item
- **Substitutions** -- that assume an "as equal" material quote will be acceptable to the designer

Copyright © 2000 Pinnell♦Busch, Inc.

MEASURED MILE

1. **Identify Representative Periods of Impacted and Un-impacted Work.**

2. **Determine the Productivity During Each Period** – in hours or cost per unit of work accomplished using:
   - **Weekly Labor Reports** – from the cost accounting system
   - **Monthly Progress Payments Monthly** – adjust for over/under-billing
   - **Other Job Records** – e.g. crew size and work accomplished on daily reports
   - **Videos, Sequential Still Photographs, or Timelapse Photography**
   - **Historical Records from Similar Projects**
   - **Revised Estimates** – based on a composite crew and productivity analysis
   - **Detailed Work Improvement Analysis**

3. **Adjust the Un-impacted Work for Learning Curve Effects**

4. **Compute the Difference in Productivity**

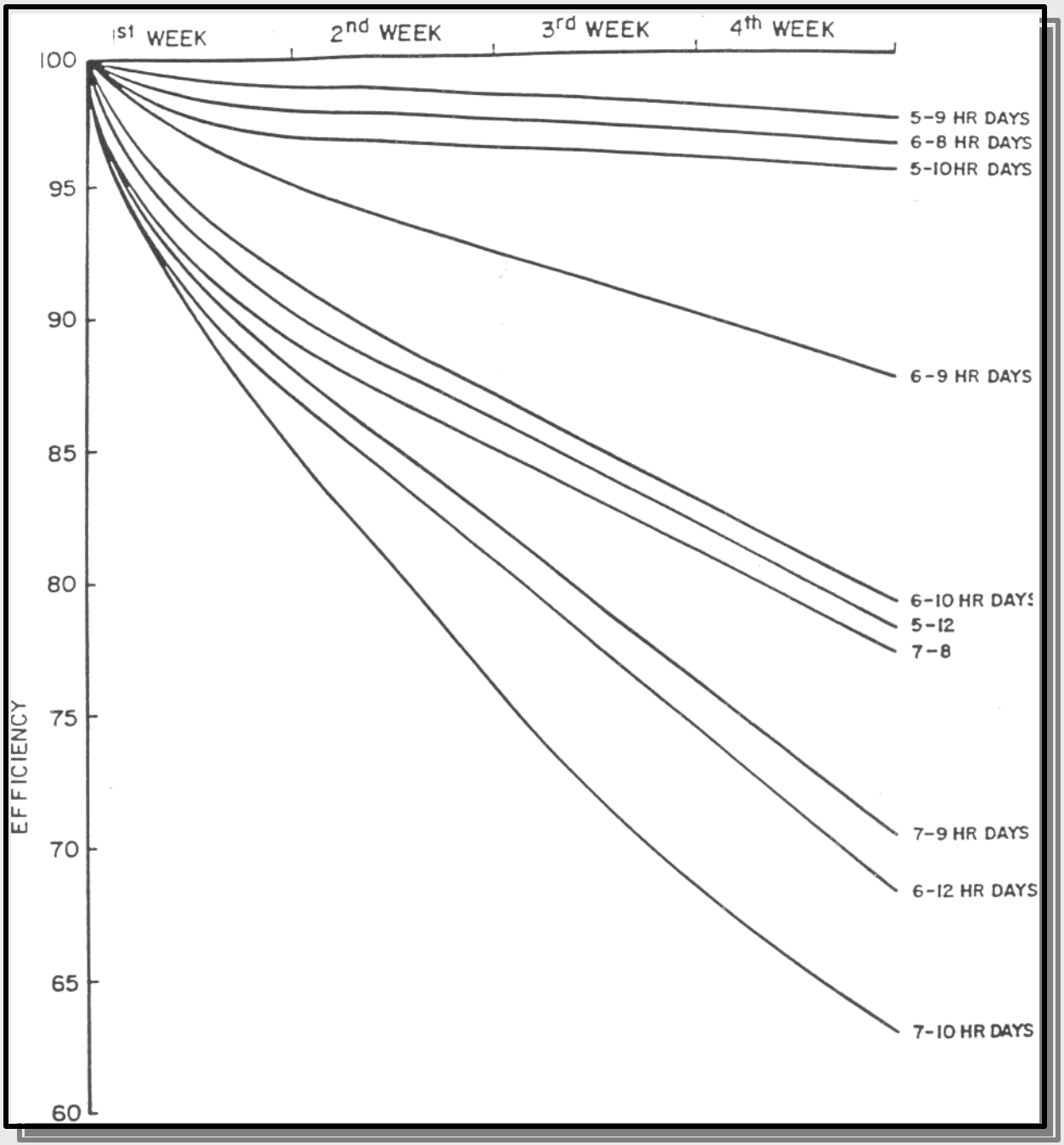
5. **Compute the Total Loss of Productivity**

Copyright © 2000 Pinnell♦Busch, Inc.

INDUSTRY STUDIES

- **Overtime and Fatigue** - Bureau of Labor, NECA, Corps of Engineers
- **Crowding and Trade Stacking** - Corps of Engineers
- **Overstaffing (Oversided Crews)** - Corps of Engineers
- **Task Reassignment** - Corps of Engineers
- **Multiple Changes** - the Leonard Study
- **Environmental Conditions** - Temperature, Wind, Humidity
- **Rain and Show** - no data available
- **Combination of Effects** - generally not additive

Copyright © 2000 Pinnell♦Busch, Inc.

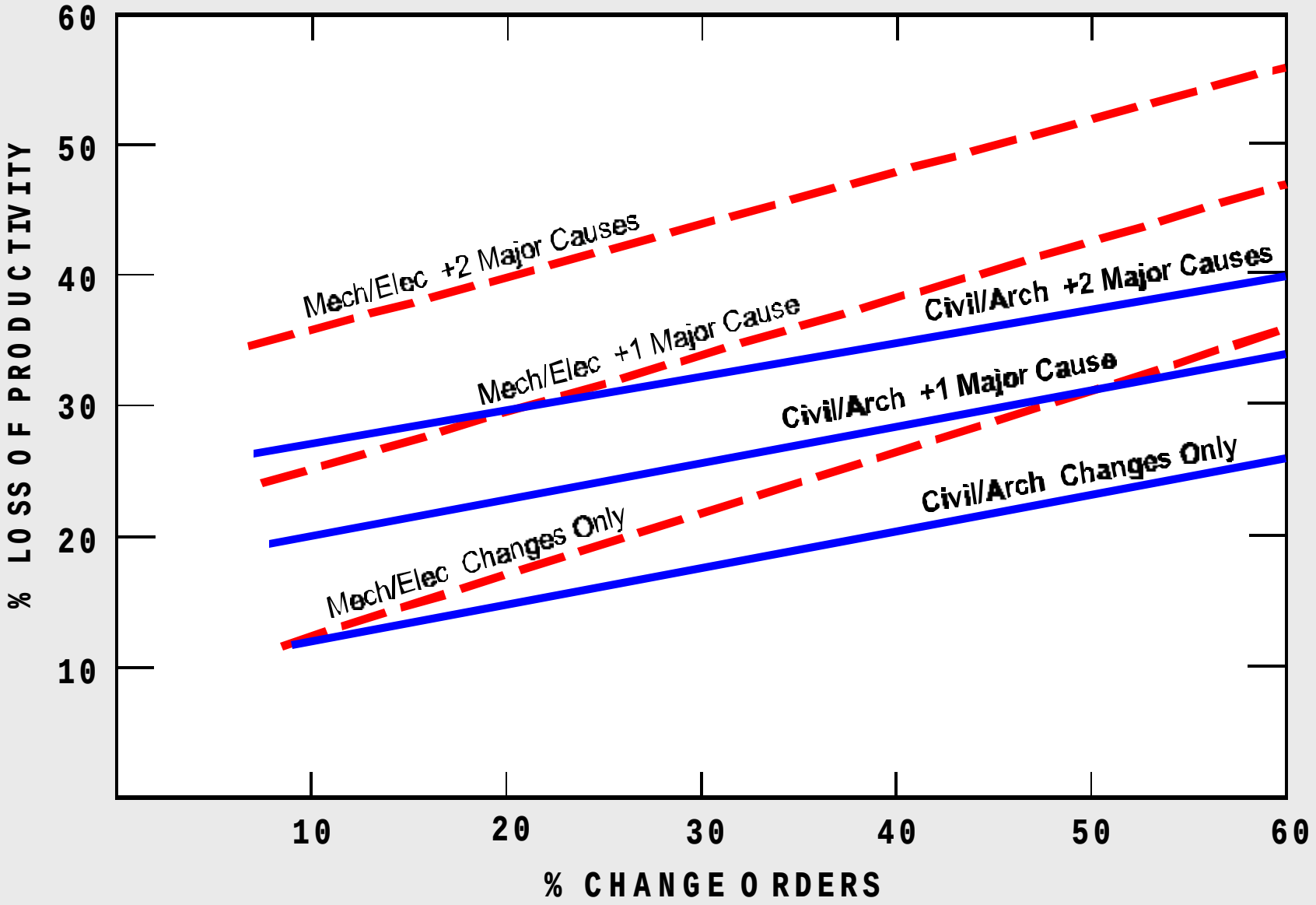


Copyright © 2000 Pinnell♦Busch, Inc.

LABOR INEFFICIENCY - DIFFERENCE IN VALUE

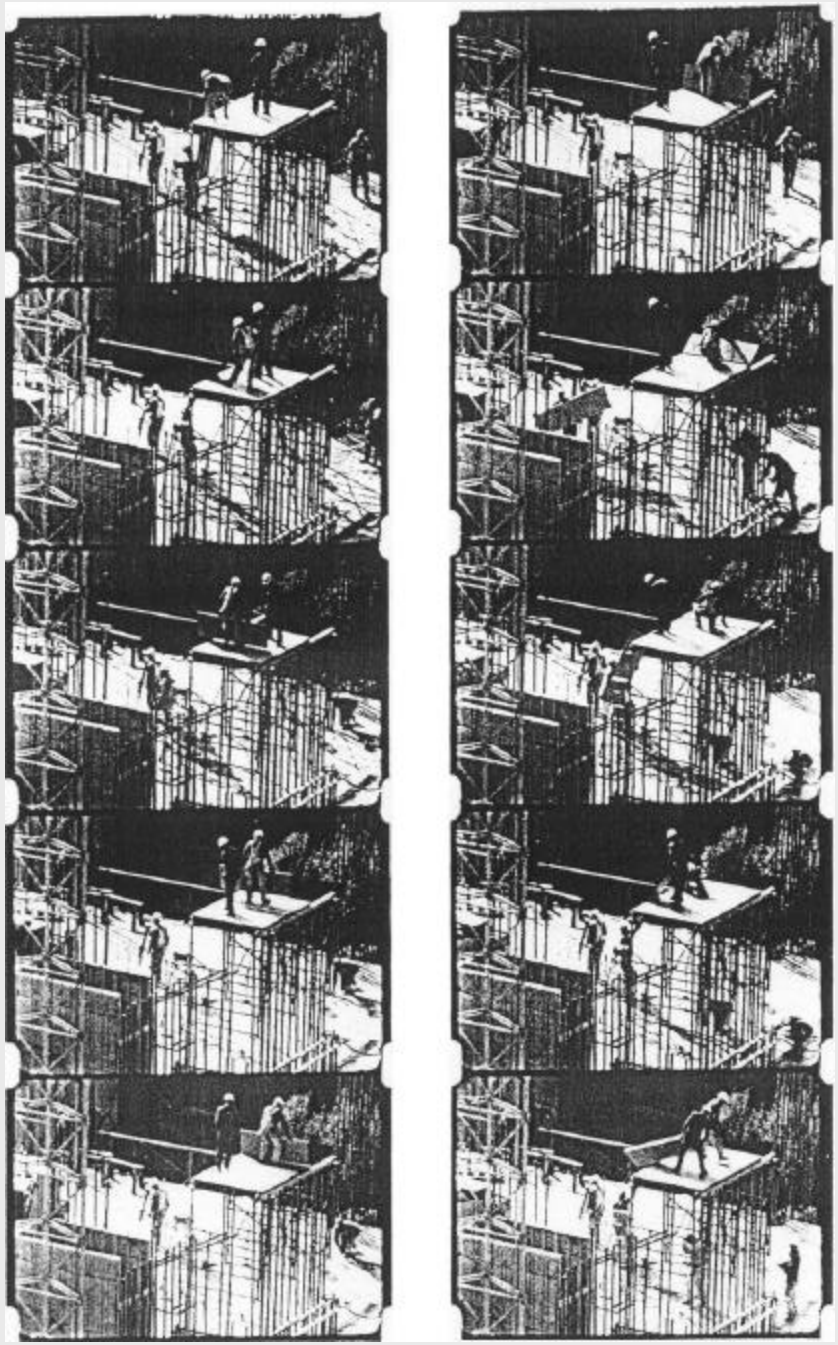
Study	Efficiency 50 hr/wk, %	60 hr/wk, %	70 hr/wk, %
U.S. Bureau of Labor Standards	92	84	78
Foster Wheeler	87	73	----
NECA Survey	88	85	78
C.F. Braun	87	73	58
Proctor & Gamble – 12 weeks	84	64	----
Proctor & Gamble – 4 weeks	90	84	----
U.S. Army MIEG – 4 weeks	96	79	63
Average Value	89%	77%	69%

Copyright © 2000 Pinnell♦Busch, Inc.

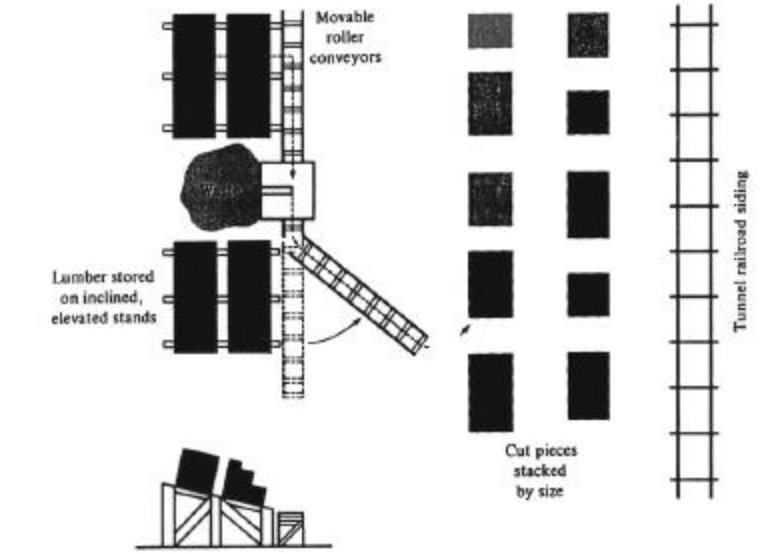


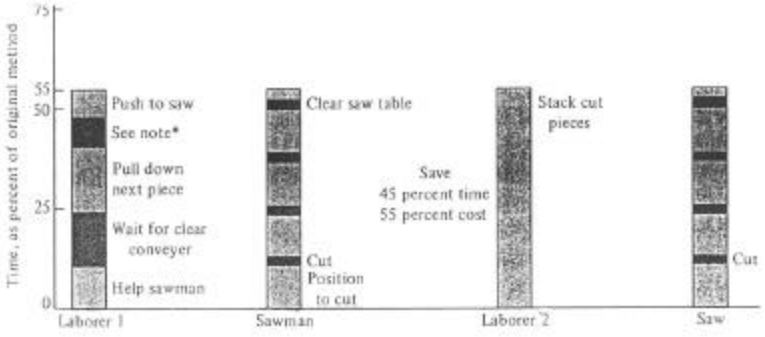
HTGP - Pg. 412, Fig. 12.6

Copyright © 2000 Pinnell◆Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.



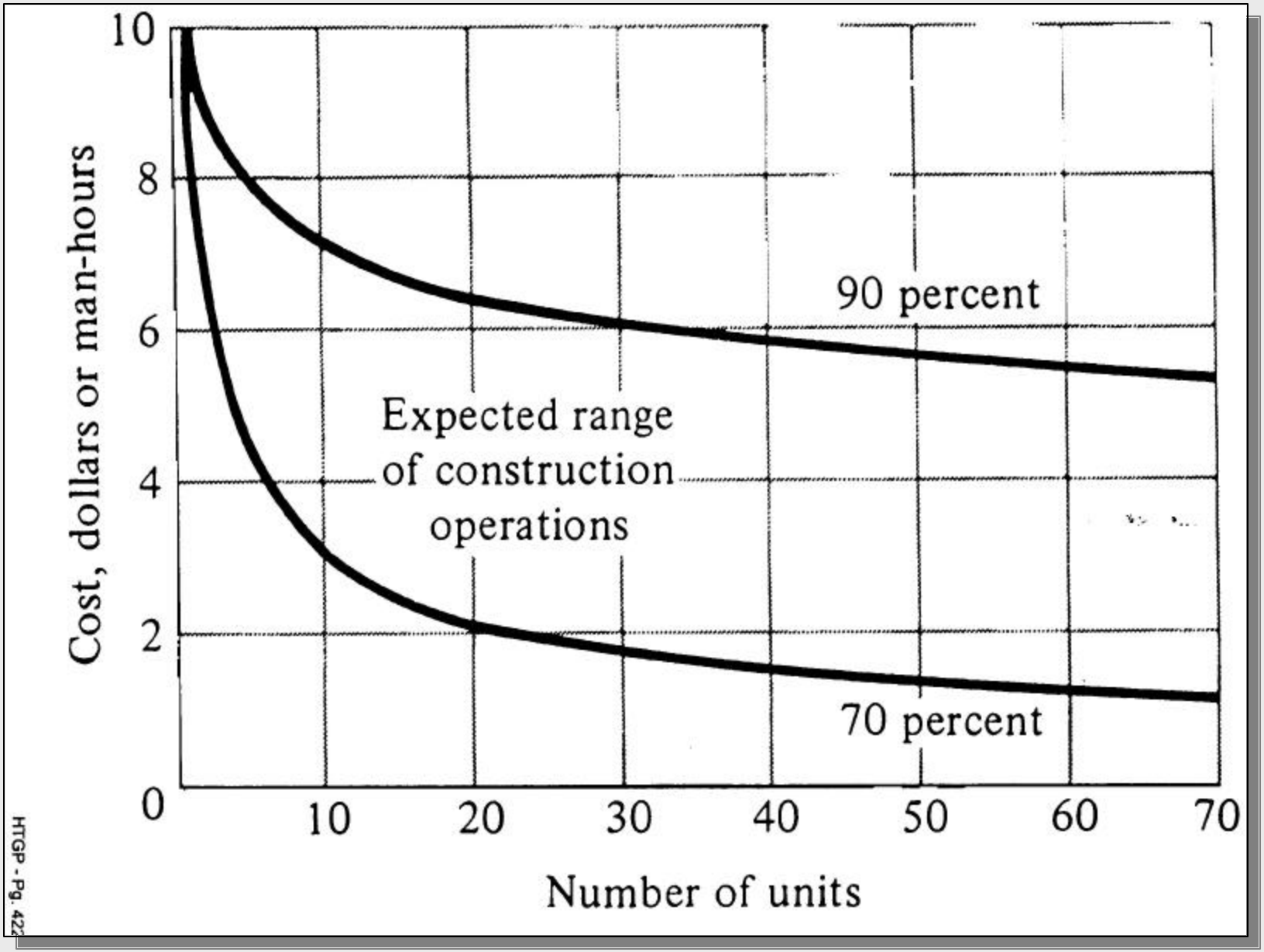


*Note: This time either waiting time or pulling down next piece when extra time is required

d

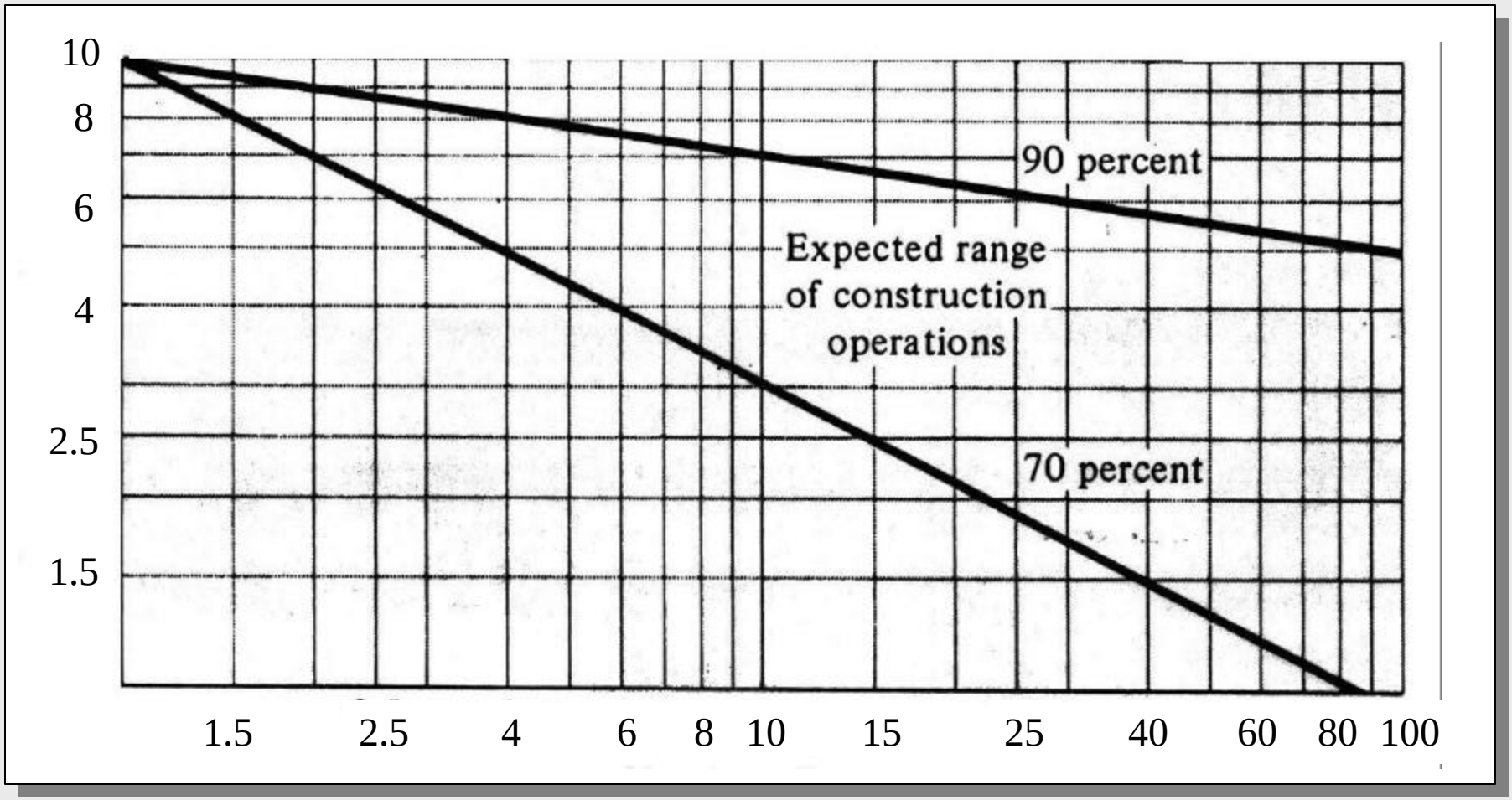
Flow diagram and crew-balance chart for revised method.

Copyright © 2000 Pinnell♦Busch, Inc.



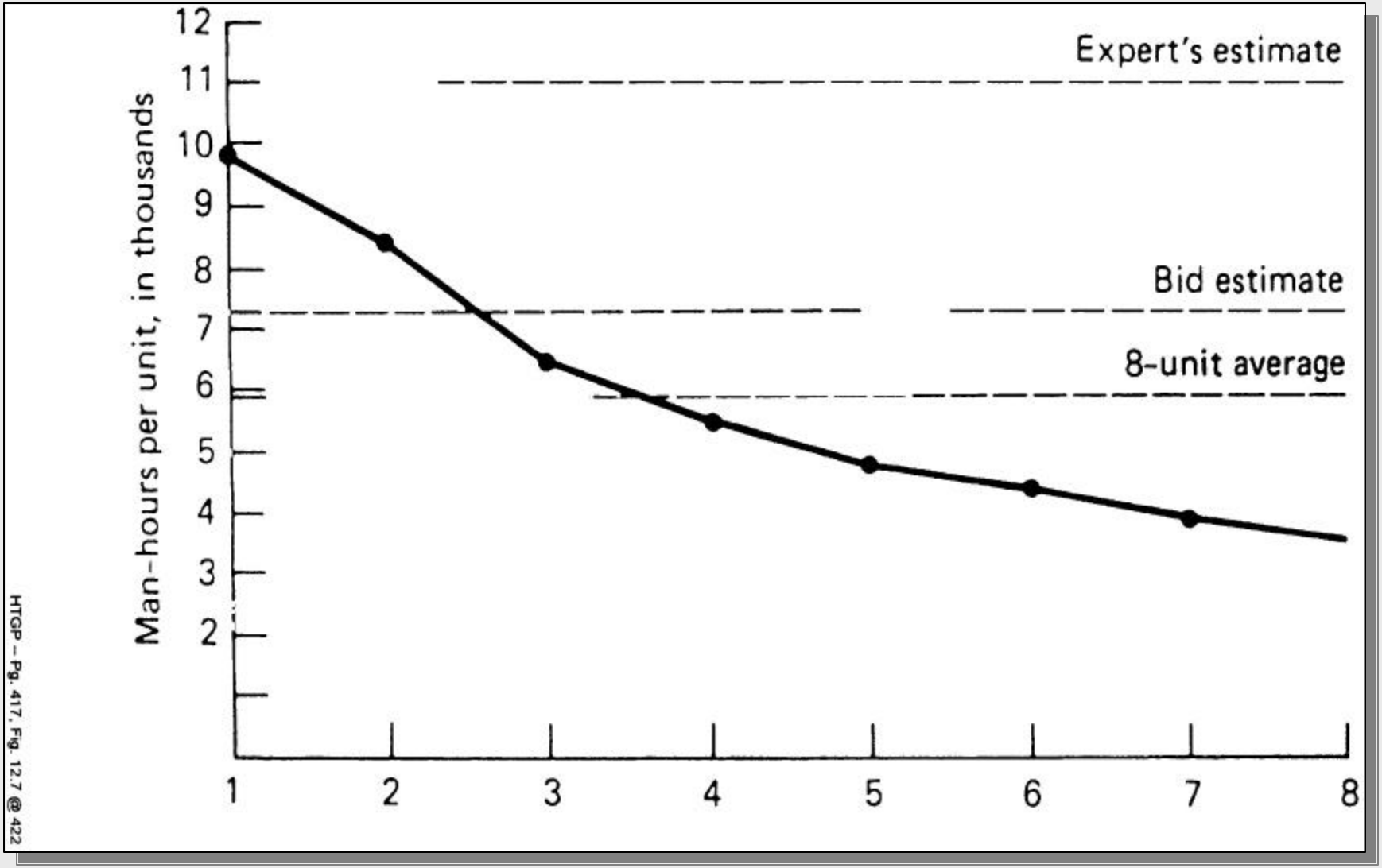
HTGP – Pg. 422, Fig.12.10

Copyright © 2000 Pinnell♦Busch, Inc.



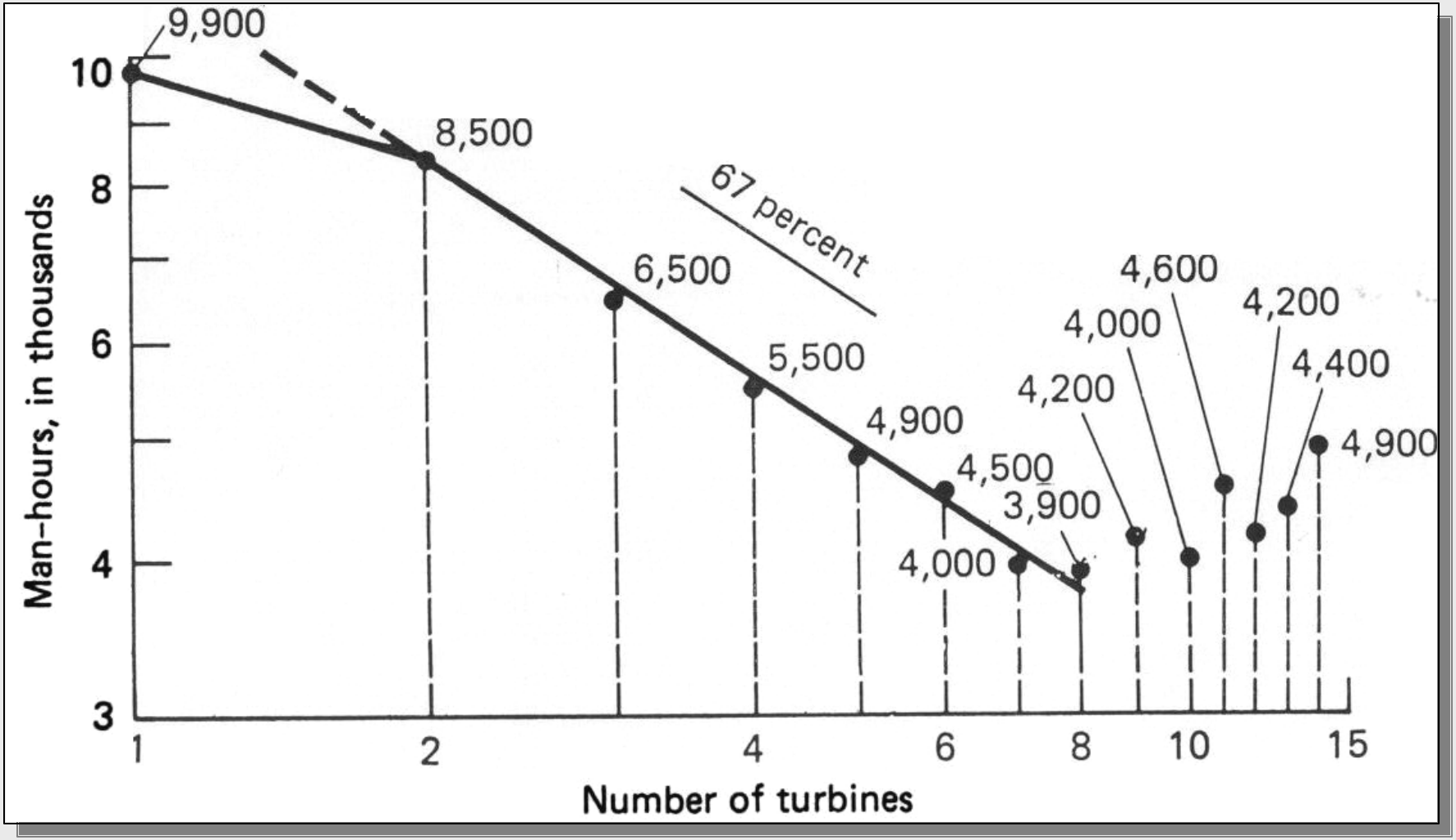
HTGP – Pg. 422, Fig.12.9

Copyright © 2000 Pinnell♦Busch, Inc.



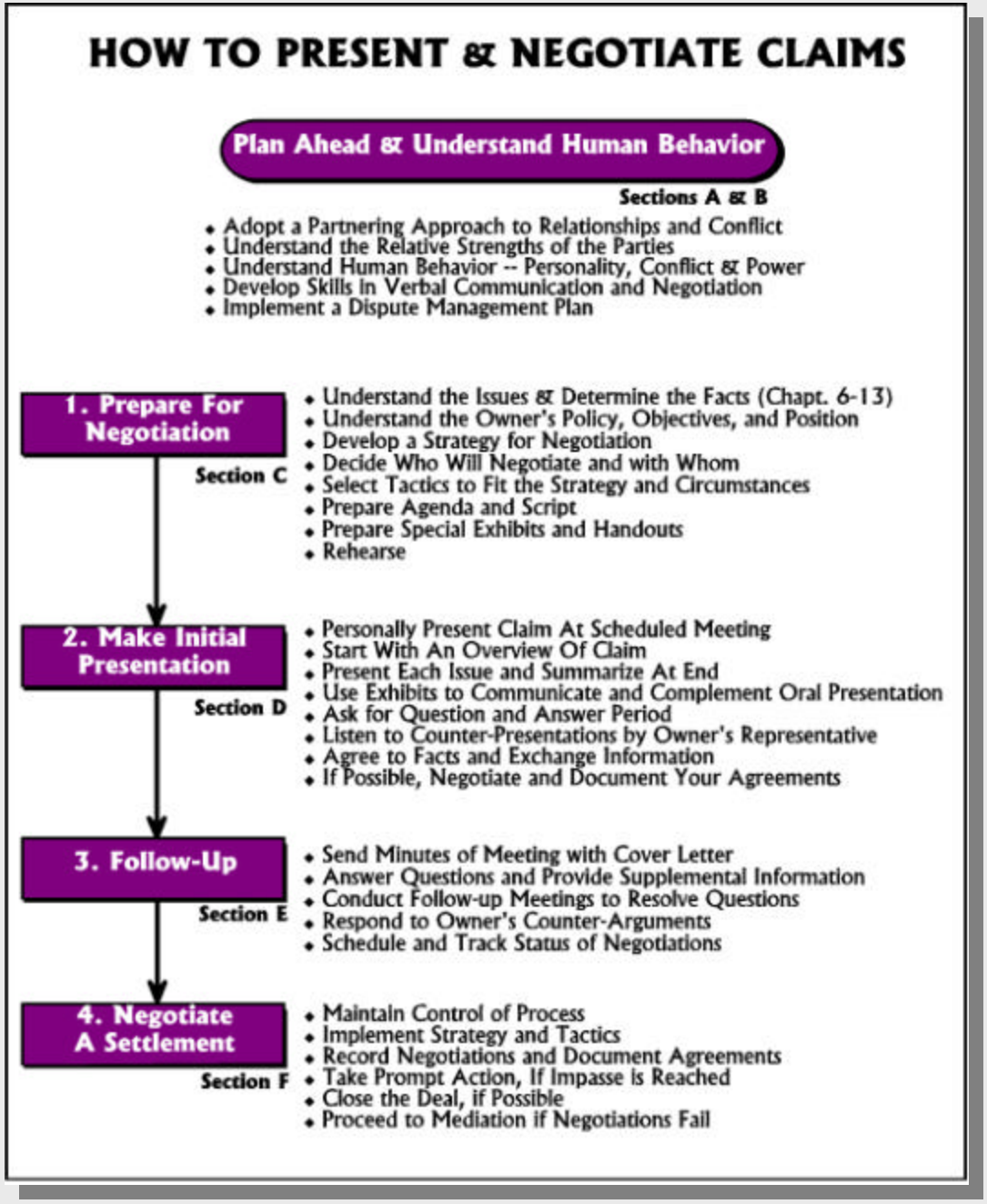
HTGP – Pg. 417, Fig.12.7 @ 422

Copyright © 2000 Pinnell♦Busch, Inc.



HTGP – Pg. 423, Fig.12.11

Copyright © 2000 Pinnell♦Busch, Inc.



Copyright © 2000 Pinnell♦Busch, Inc.