
***Dr. Awad S. Hanna***

Professor, Chair of Construction Engineering and Management Program University of Wisconsin-Madison

# PARTNERS in PROGRESS

2008 CONFERENCE

## *PLANNED SCHEDULE COMPRESSION*

# FACE CHALLENGES CREATE SOLUTIONS

SMACNA

HVAC Industrial Architectural Metal EXPERTISE

SMOHIT

NEMI

# Biography

## Awad S. Hanna, Ph.D., P.E

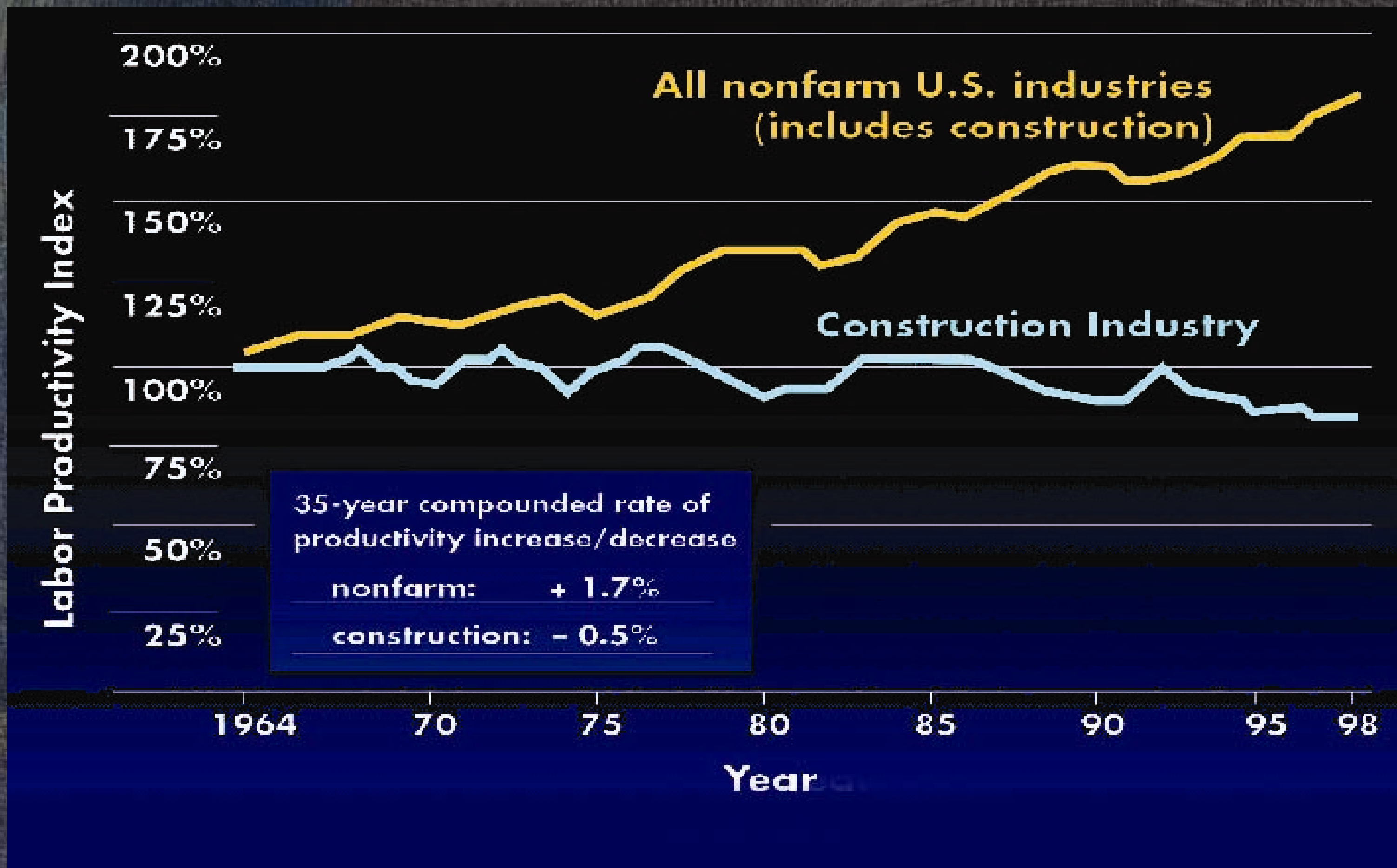
Awad S. Hanna is a professor and chair of the construction engineering and management program at the University of Wisconsin-Madison, department of Civil and Environmental Engineering. Dr. Hanna holds M. S. and Ph.D. degrees from Penn State University and he is a register professional engineer in the U S and Canada. Awad has been an active construction practitioner, educator and researcher for over 30 years. He has taught construction management courses at Penn State University, Memorial University, Canada, and University of Wisconsin-Madison. Dr. Hanna has conducted several research projects for the New Horizon Foundation and the Electrical Contracting Foundation including landmark studies on the cumulative impact of change orders on electrical/mechanical labor productivity, schedule compression and acceleration, impact of stacking of trades on labor productivity, performance evaluation for electrical supervisors, and craftsmen, and productivity factors in electrical construction. Dr. Hanna has conducted research for other national organizations including the National Highway Research Program, and the Mechanical Contracting Foundation, and the Construction Industry Institute. Dr. Hanna has taught more than 300 successful seminars and workshops in more than 35 states on topics such as change orders impacts, project scheduling, estimating, labor productivity, construction delay claims.

Dr. Hanna is also a national consultant representing and assisting many contractors and owners in productivity losses related to change orders, acceleration and compression, delay, and trade stacking.

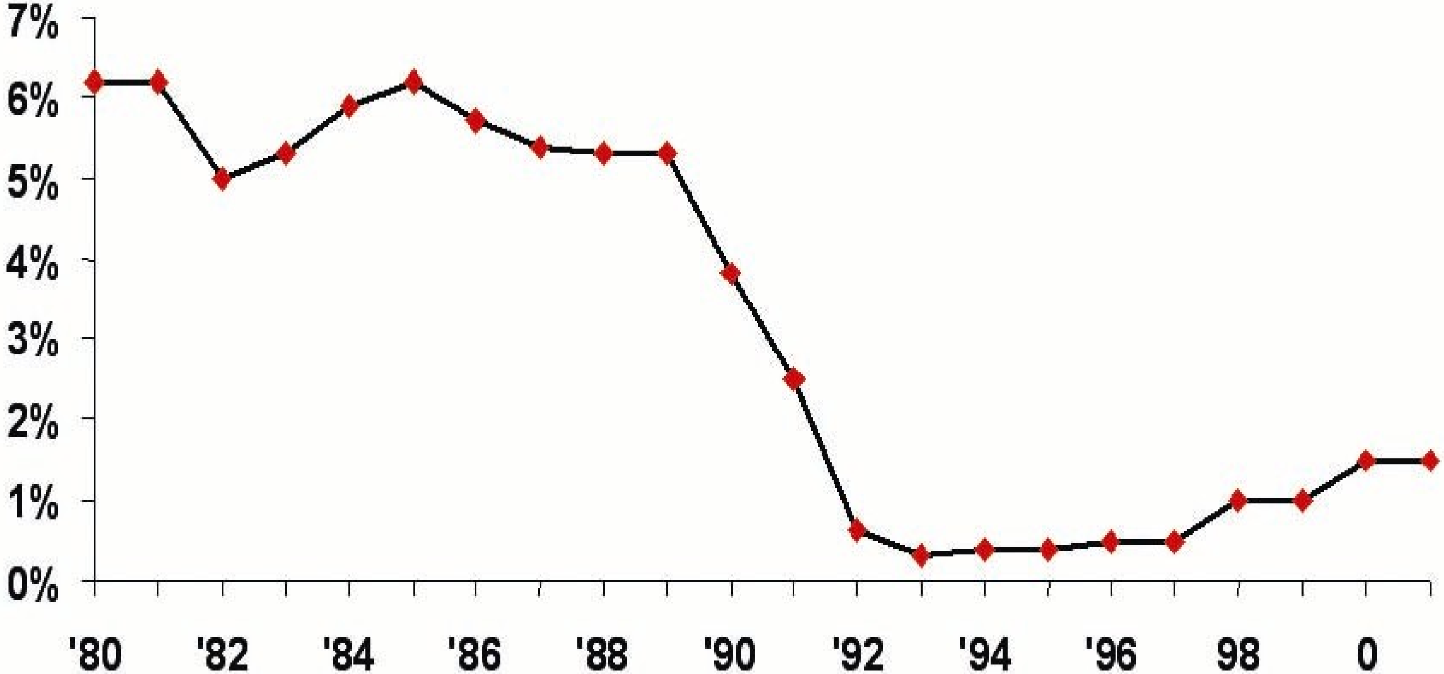
# *Face Challenges*

* *Declining Productivity and Profit*
* *Increased demand on accelerated schedule*

# Productivity Gap



# Profitability is Declining in Construction




** Construction - All Contractors*

Source: Statistics Canada, Quarterly Financial Statistics For Enterprises (61-008)
Ontario Construction Secretariat - Information Base '96

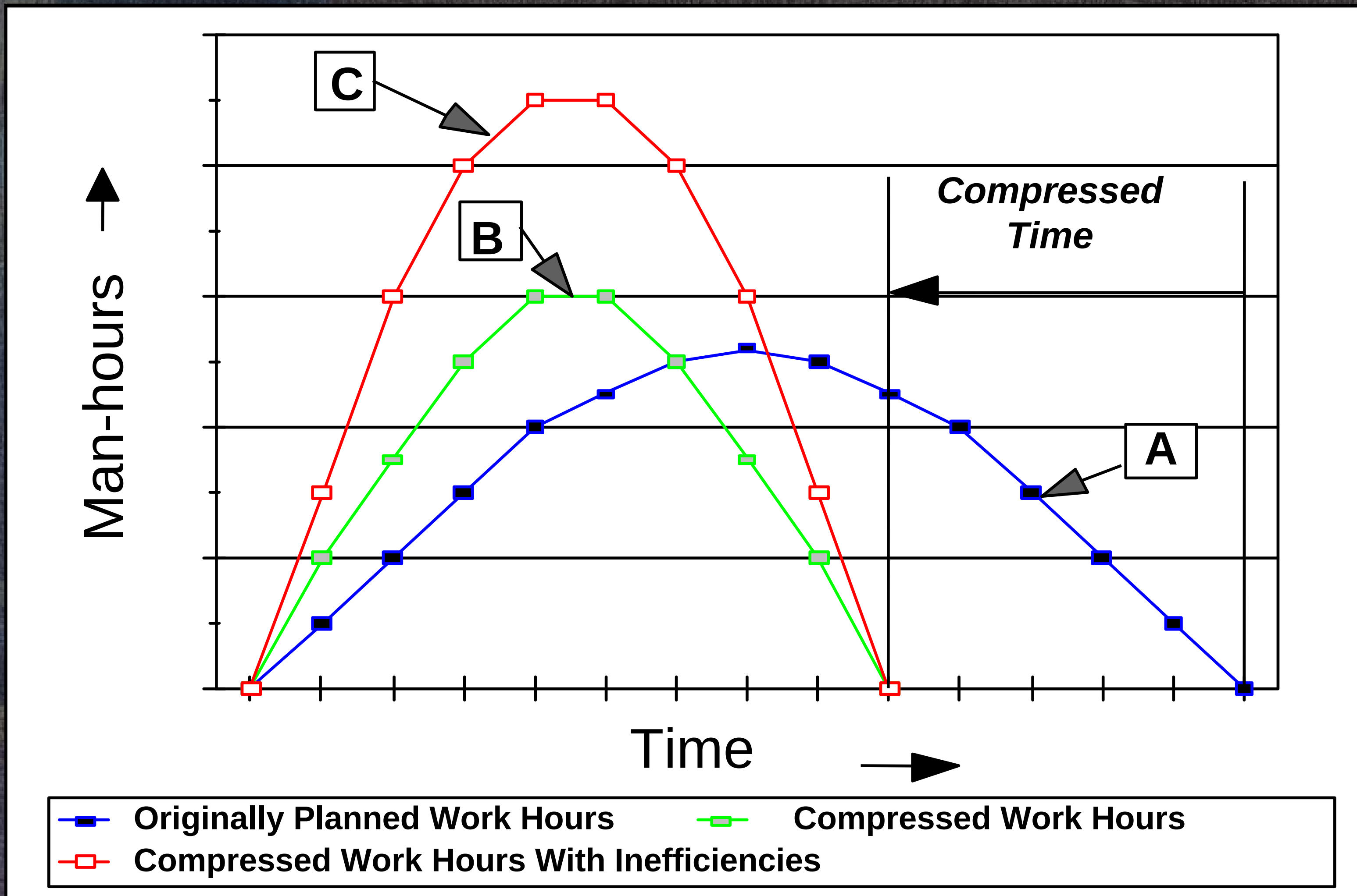
# Normal Project Duration: Comparison Table (Hanna, 2002)

| Project Size (Manhours) | Industry Average | | | | Commercial | | | | Industrial | | | | Institutional | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration | | Peak | | Duration | | Peak | | Duration | | Peak | | Duration | | Peak | |
| | Old | New | Old | New | Old | New | Old | New | Old | New | Old | New | Old | New | Old | New |
| 1000 | * | 14 | * | * | * | 12 | * | | * | 17 | * | * | N/A | 30 | * | * |
| 2000 | * | 18 | * | * | * | 15 | * | | * | 19 | * | * | N/A | 34 | * | * |
| 4000 | 30 | 23 | 6 | 10 | 29 | 20 | 5 | 10 | 21 | 21 | 5 | 11 | 41 | 39 | 10 | 9 |
| 6000 | 38 | 27 | 7 | 13 | 36 | 24 | 6 | 13 | 26 | 22 | * | 15 | 52 | 42 | 11 | 9 |
| 8000 | 45 | 30 | 8 | 15 | 43 | 26 | 7 | 15 | 31 | 24 | * | 18 | 62 | 45 | 12 | 10 |
| 10000 | 52 | 32 | 9 | 18 | 49 | 29 | 8 | 18 | 36 | 24 | 7 | 20 | 70 | 47 | 13 | 10 |
| 12000 | 58 | 35 | 10 | 20 | 54 | 31 | * | 20 | 40 | 25 | * | 23 | 78 | 48 | * | 11 |
| 14000 | 63 | 37 | 11 | 21 | 59 | 33 | * | 22 | 43 | 26 | 9 | 25 | 85 | 50 | * | 11 |
| 16000 | 68 | 39 | 12 | 23 | 64 | 35 | * | 24 | 46 | 26 | * | 28 | 92 | 51 | 17 | 12 |
| 18000 | 73 | 40 | 13 | 25 | 68 | 36 | * | 26 | 49 | 27 | * | 30 | 98 | 52 | * | 13 |
| 20000 | 78 | 42 | 14 | 27 | 72 | 38 | 12 | 27 | 52 | 27 | 11 | 32 | 104 | 54 | 20 | 14 |
| 22000 | 82 | 43 | 15 | 28 | 76 | 39 | * | 29 | 55 | 28 | * | 34 | 110 | 55 | * | 15 |
| 24000 | 86 | 45 | 16 | 30 | 80 | 41 | * | 31 | 58 | 28 | * | 36 | 115 | 56 | 23 | 16 |
| 26000 | [illegible] | 46 | [illegible] | 31 | 84 | 42 | * | 32 | 61 | 29 | 13 | 38 | 120 | 56 | * | 17 |
| 28000 | 94 | 48 | 18 | 33 | 88 | 43 | * | 34 | 64 | 29 | * | 40 | 125 | 57 | * | 19 |
| 30000 | 98 | 49 | 19 | 34 | 92 | 45 | 16 | 35 | 67 | 29 | 15 | 42 | 130 | 58 | 26 | 20 |
| 35000 | 106 | 52 | * | 37 | 100 | 47 | 18 | 39 | 72 | 30 | 17 | 46 | 143 | 60 | 29 | 24 |
| 40000 | 114 | 54 | 24 | 40 | 107 | 50 | 20 | 42 | 77 | 31 | 19 | 51 | 155 | 62 | 32 | 28 |
| 45000 | 122 | 57 | * | 43 | 114 | 52 | 22 | 46 | 82 | 31 | 21 | 55 | 166 | 63 | 35 | 33 |
| 50000 | 130 | 59 | 29 | 46 | 121 | 54 | 24 | 49 | 87 | 32 | 23 | 59 | 176 | 64 | 38 | 38 |
| 55000 | 138 | 61 | * | 49 | 128 | 57 | 26 | 52 | 92 | 32 | 25 | 62 | 186 | 66 | 41 | 43 |
| 60000 | 146 | 63 | 34 | 51 | 135 | 59 | 28 | 55 | 97 | 33 | 27 | 66 | 195 | 67 | 44 | 50 |
| 65000 | 153 | 65 | * | 54 | 142 | 60 | 30 | 57 | 102 | 33 | * | 70 | 204 | 68 | 47 | 56 |
| 70000 | 160 | 67 | 39 | 56 | 149 | 62 | 32 | 60 | 107 | 34 | * | 73 | 213 | 69 | 50 | 64 |
| 75000 | 167 | 69 | * | 59 | 155 | 64 | 34 | 63 | 112 | 34 | * | 76 | 222 | 70 | * | 71 |
| 80000 | 173 | 71 | 44 | 61 | 160 | 66 | 36 | 65 | 116 | 35 | * | 80 | 230 | 71 | 56 | 80 |
| 85000 | 179 | 72 | * | 63 | 165 | 67 | 38 | 68 | 120 | 35 | * | 83 | 238 | 71 | * | 88 |
| 90000 | 185 | 74 | 49 | 65 | 170 | 69 | 40 | 70 | 124 | 35 | * | 86 | 246 | 72 | 62 | 97 |
| 95000 | 190 | 75 | * | 68 | 175 | 70 | 42 | 73 | 128 | 36 | * | 89 | 253 | 73 | * | 107 |
| 100000 | 195 | 77 | 54 | 70 | 180 | 72 | 44 | 75 | 132 | 36 | * | 92 | 260 | 74 | 68 | 117 |

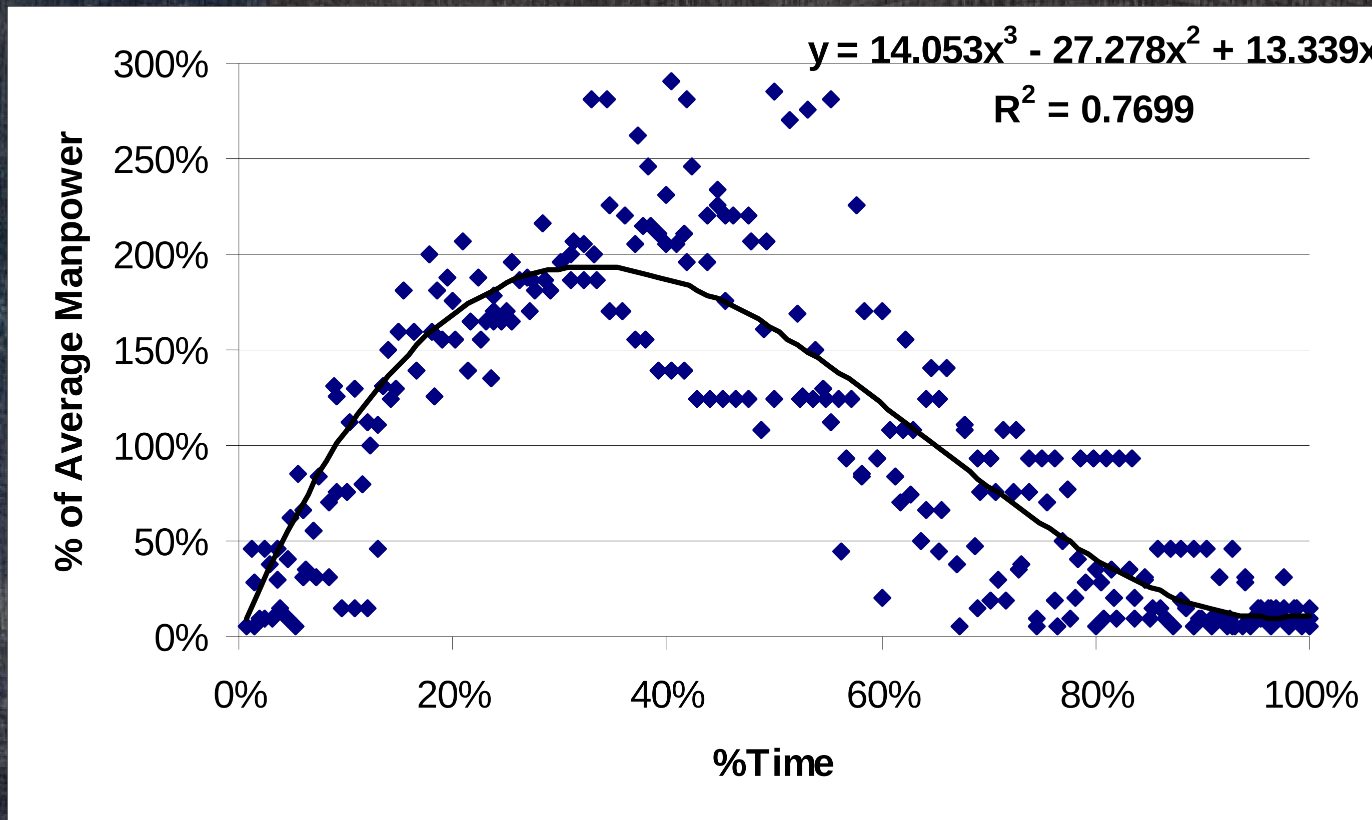
# Schedule Compression

"A reduction from the normal experienced time or optimal time typical for the type and size of project being planned within a given set of circumstance" (CII 1990)

# Schedule Compression & Acceleration



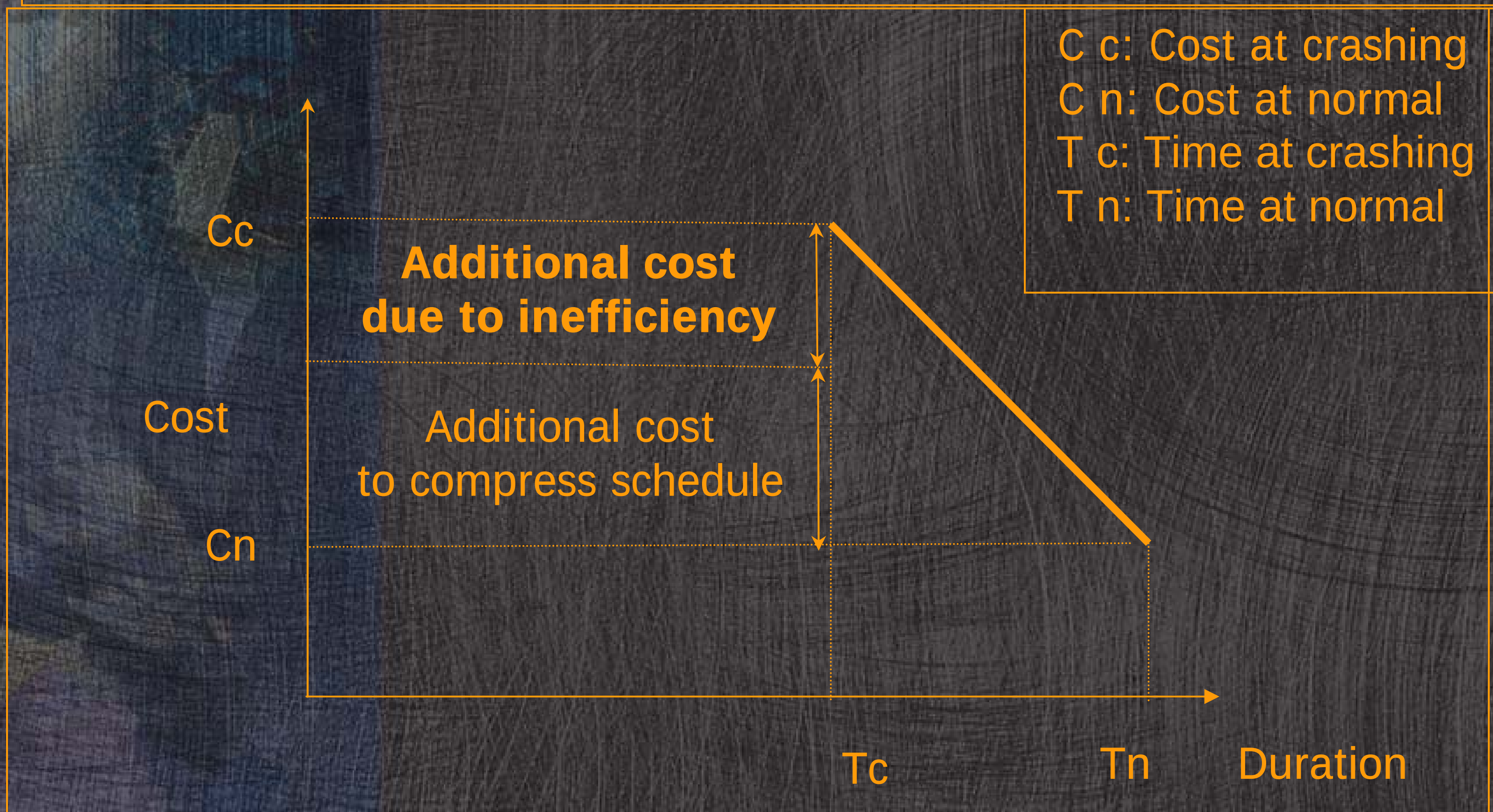
# Manpower Loading Sheet Metal Work



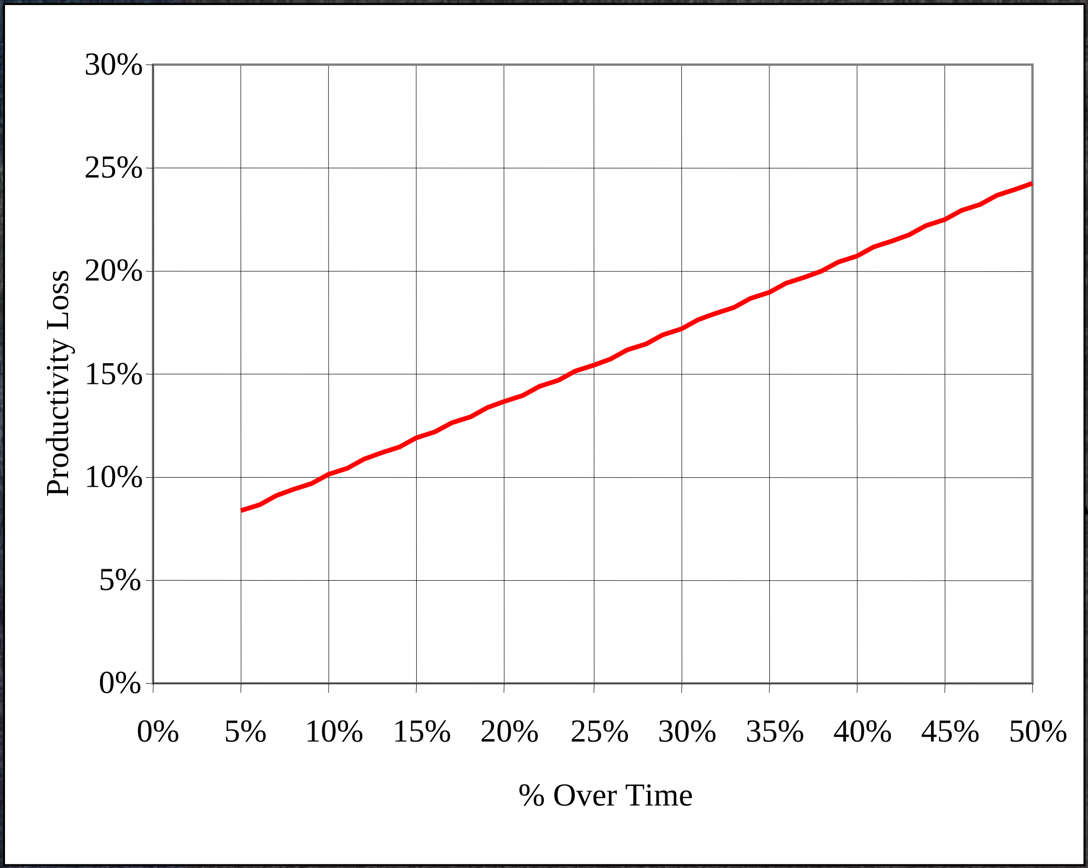
# Types of Schedule Compression & Acceleration

1. Mandated Acceleration
   * Owner's request
1. Constructive Acceleration
   * Late Start
   * Delay
   * Change Scope

# Why Schedule Compression is a Problem



# Overtime Impact (Hanna, 2006)



# 1. Effect of Overtime

## Effect of overtime on Productivity 50- and 60- Hour Work-Weeks

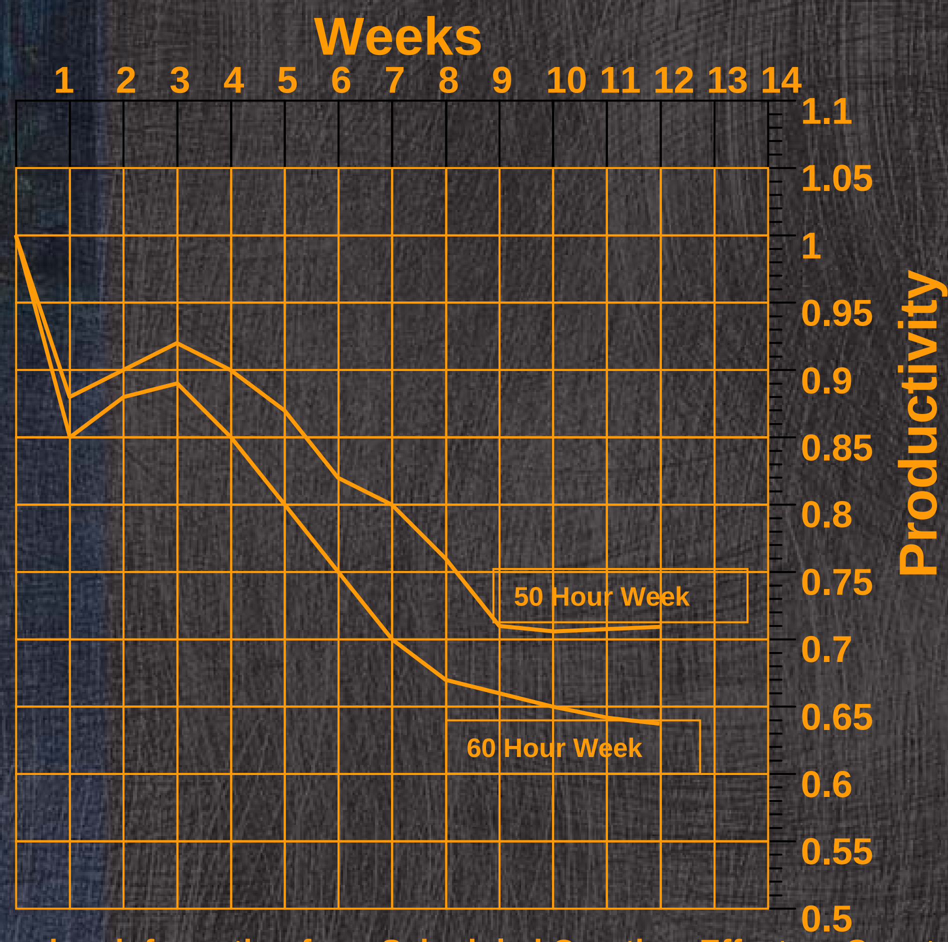


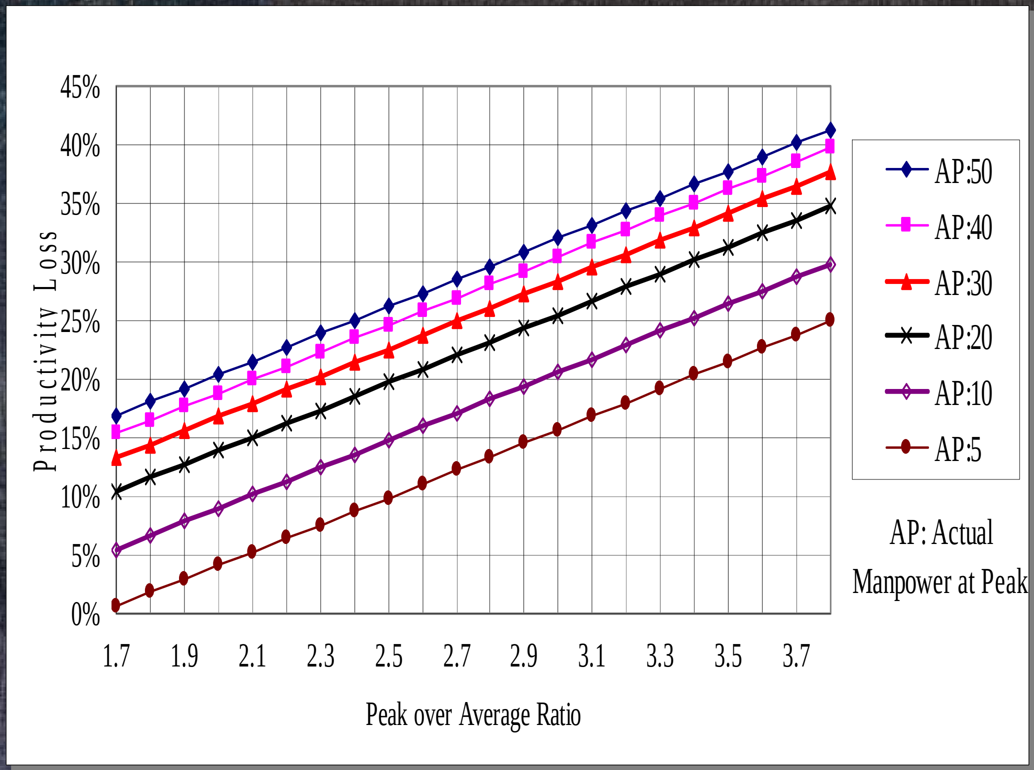

Figure is based on information from Scheduled Overtime Effect on Construction Projects, The Business Roundtable(1980)

# 1. Effect of Overtime (Cont.)
## Scheduled Overtime:

| Number of Overtime Work Weeks | Productivity Rate 40 Hour Week | Productivity Rate 50 Hour Week | Productivity Rate 60 Hour Week | Actual Hour Output 50 Hour Week | Actual Hour Output 60 Hour Week | Hours Gained Over 40 Hours 50 Hour Week | Hours Gained Over 40 Hours 60 Hour Week |
|---|---|---|---|---|---|---|---|
| 1-2 | 1.00 | 0.926 | 0.90 | 46.3 | 54.0 | 6.3 | 14.0 |
| 3-4 | 1.00 | 0.90 | 0.86 | 45.0 | 51.6 | 5.0 | 11.6 |
| 5-6 | 1.00 | 0.87 | 0.80 | 43.5 | 48.0 | 3.5 | 8.0 |
| 7-8 | 1.00 | 0.80 | 0.71 | 40.0 | 42.6 | 0.0 | 2.6 |
| 9-10 | 1.00 | 0.752 | 0.66 | 37.6 | 39.6 | -2.4 | -0.4 |
| 11 & up | 1.00 | 0.75 | | 36 | | -2.50 | |

**Scheduled Overtime Productivity Decreases in Terms of Hours per Week for 50 and 60-Hour Weeks (The Business Roundtable 1980)**

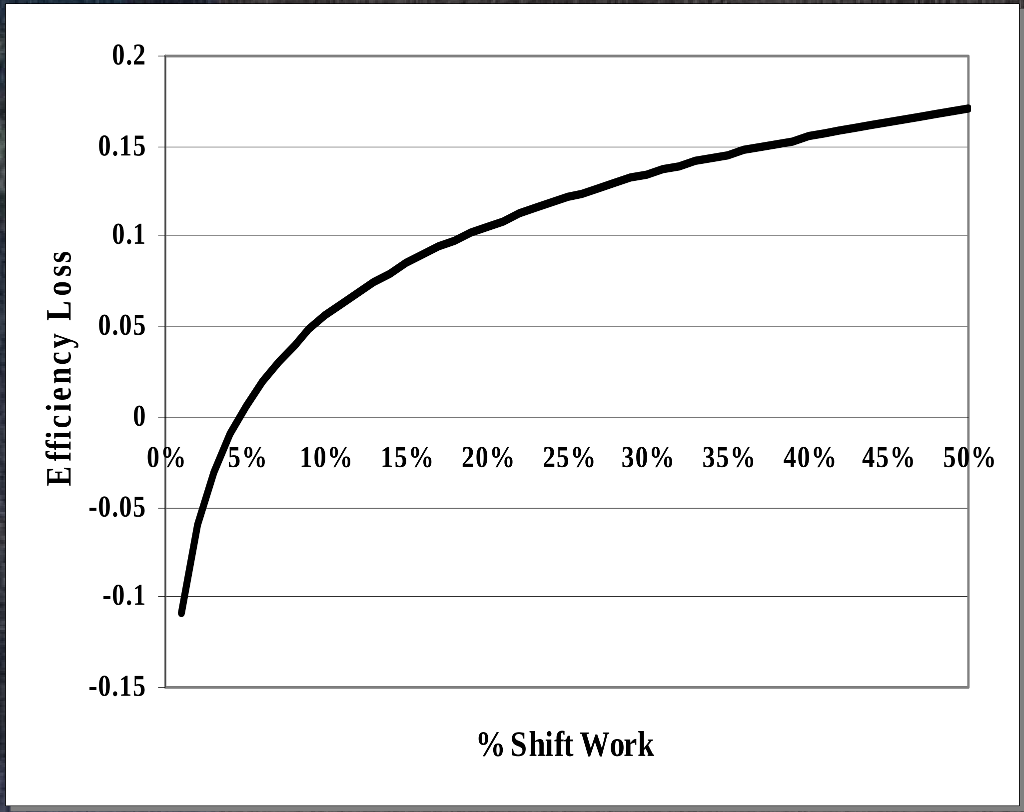
# Overmanning Impact (Hanna, 2006)




Applicable Range

- Peak/Avg. Ratio
  : 1.7~3.8
- Actual Peak
  : 4 ~ 50
- Project Size
  : 700 ~208,000 Manhrs

# Shift Work Impact (Hanna, 2006)




Applicable Range

- % Shift Work
  : 2%~53%
- Project Size
  : 3,000 ~ 550,000 Manhrs

## Concepts included in the Planned Schedule Compression Concept File

| Project Category | Concept |
|---|---|
| Organization | Provide Employees with Incentives |
| | Staff the Project with the Most Efficient Crews |
| | Avoid Interrupting Crews During Peak Productivity Times |
| | Provide Proactive Schedule Management during Compression Periods |
| | Participative Management |
| | Detailed Project Planning |
| | Reduction of Task Scope to Milestone Activities |
| | Increase the Supervisor to Worker Ratio |
| | Use CPM Scheduling Techniques for Project Control |
| | Include Anticipated Weather Delays in Work Schedule |
| Materials | Employ a Just-in-Time Material Delivery Plan |
| | Establish a Special Material Handling Crew for the Project |
| | Establish a Special Material Cleanup Crew for the Project |
| | Assign a Material Coordinator to the Project |
| | Establish a Clear Zone in the Material Lay-Down Area |
| | Improve Vendor Performance by Establishing a Vendor Management System |
| Equipment and Tools | Develop a Project Tool Management Program |
| | Increase the Inventory of Spare Parts, Tools, Etc. |
| Information | Complete a Constructability Analysis of the Plans Prior to Construction |
| Labor | Place the Crew on Overtime |
| | Add Additional Staff to the Project |
| | Add a Second Shift |
| | Change to Special Shifts |
| Support Services | Use a Set-up Crew |
| Construction Methods | Schedule Tasks in Repetition |
| | Create More Detailed Subcontractor Schedules |
| | Look for Short Cuts in the Process |
| | Plan for and Use Modular and Preassembled Components |
| | Brief the Crew Prior to Work Operations |