

**DISTRIBUTION OF CRAFT MANAGEMENT SKILLS  
IN A TIER II WORK TEAM**

CARL T. HAAS, PH.D., P.E.

RICHARD L. TUCKER, PH.D., P.E.

ROBERT W. GLOVER, PH.D.

DEREK EDWARD

CENTER FOR CONSTRUCTION INDUSTRY STUDIES

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by

Carl T. Haas, Ph.D., P.E.

Richard L. Tucker, Ph.D., P.E.

Robert W. Glover, Ph.D.

Derek Edward

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## **Executive Summary**

The construction industry is facing many challenges due to its inability to recruit, train and retain enough workers to meet its demands. The Sloan Center for Construction Industry Studies (CCIS) Work Force workgroup at the University of Texas at Austin has proposed a Two-Tier work force strategy as a “step-change” initiative to help tackle these issues being faced by the construction industry. A Tier II project is perceived as being staffed by a level of workers possessing higher than normal levels of technical and management skills, with appropriate systems being put in place to manage the project itself and to better utilize these higher skills. The expected results of these changes are greater productivity and improved compensation for Tier II workers.

This report summarizes the Craft Management skills set of the Tier II worker, as developed in Edward (2001). Distribution principles and procedures for craft management skills are also proposed. They are summarized in the “Conclusions” section of this report.

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# **Distribution of Craft Management Skills in a Tier II Work Team**

## **I. Background**

The Tier II Work Team may be defined along the lines of a self-managed work team geared towards the construction industry. The major characteristics of a self-managed or self-directed work team are that it should possess within its ranks the requisite skills to assume total control of its day-to-day operations. It should be autonomous in deciding how shifts are organized, in disciplinary matters and in the organization of the work. As an extension of this, the team assumes responsibility for the training of its members (Roth, 99).

A key skill area within a Tier II work team is that of craft management skills. While obviously required, it is necessary to determine how those skills are to be best structured within these autonomous groups once the Tier II project scheme becomes a reality, and how these skills are to be phased in during the interim period.

## **II. The Two Tier Work Force Strategy**

A Tier II project, by definition, will have a certain percentage of Tier II workers possessing superior technical skills and some established lower level management skills. The main goal of the Tier II project would be to use fewer, better-trained workers to construct a product of higher quality, on schedule, at comparable cost and with improved safety. The Tier II concept was developed in a consultative process with industry (Borcherding et al, 2001).

The Tier II craft worker is seen as being able to add value to a project, not only in the traditional technical sense, but also by contributing to the management of the work. As such, the Tier II craft worker would be expected to not only possess superior technical skills, but also significant lower level management skills as well. Another requirement

would be that the worker be certified in both these areas and be well experienced in their field of employment on construction projects. The development of workers who possess the initiative, information and the requisite skills to better make decisions at the workplace, is seen as a major goal of this strategy.

The Tier II worker would be expected to be:

- i. Highly technically skilled – in that they should be certified in at least one craft, but would preferably be multi-skilled, have a high level of technical experience in the crafts in which they are certified, and be subject to continuous technical training.
- ii. Possess lower level management skills – be familiar with the rudimentary aspects of workplace administration, planning, job management, and be computer literate, in order to enhance their ability to manage a crew. They would also be expected to possess a superior work record.

While any one Tier II worker may not possess all of the above-mentioned skills, they would be expected to meet a minimum criterion as per an assessment index, and would be required to make a contribution to the management of the work crew. As such, the complementary set of these skills are expected to reside within a Tier II work team.

### **III. Craft Management Skills Metrics**

#### **Individual Worker Management Skills Score**

The Individual Worker Management Skills Score was developed by the CCIS Work Force workgroup to assess each worker on a given project as part of a process for determining for whether how well the project meets Tier II implementation conditions. The worker assessment is based on the examination of five (5) areas or elements of the prescribed worker management skills. For each element, three (3) scores have been developed, and each worker is to be assessed relative to these. Of these baseline scores, a '10' corresponds to an ideal or target / future state. A '5' is intended to signify current

‘best practice’ and a ‘0’ an unacceptable level or standard. This metric is presented in **Table-1**.

Elements	Weights	Evaluation Criteria	Score	Max Score = 10 x Weight
<b>Administrative</b> ( <i>cost management, scheduling, material management, RFI, and estimating</i> )	1.0	Certified in at least 4 administrative skills Certified in 2 administrative skills No certified administrative skills	10 5 0	10
<b>Computer</b> ( <i>e-mail / internet, word processing, spreadsheet, scheduling, estimating, CAD, and material management</i> )	1.0	Certified in at least 5 computer skills Certified in 3 computer skills No certified computer skills	10 5 0	10
<b>Planning</b> ( <i>material, equipment, tools and information request, short-term planning, and scheduling</i> )	3.0	Certified in planning skills 160 hours of training but not certified in planning skills No training and certification	10 5 0	30
<b>Job Management</b> ( <i>crew coordination, inter- and intra- craft coordination, selection of work means and methods, and leadership</i> )	2.0	Certified in job management functions 160 hours of training but not certified in job management functions No training and certification	10 5 0	20
<b>Work Record</b> ( <i>safety, attendance / truancy, quality, productivity, and initiative</i> )	3.0	Superior in all categories Superior in some, modest in others Weak in most categories	10 5 0	30
	10.0			Total = 100

**Table-1 Individual Worker Management Skills Score**

### Project Craft Management Skills Index

After each Tier II worker on a project has been assessed on an individual basis, an index can be determined that is representative of the craft management skills component of the entire Tier II work force. This ‘management capital’ index or Project Craft Management Skills Index is determined by the use of the average individual management score of the Tier II workers (Borcherding et al, 2001). This index is illustrated by **Table-2**.

Elements	Weights	Evaluation Criteria	Score
<b>Average Score from Individual Evaluation on Management Skills *</b>	10.0	Greater than 75 points	10
		Greater than 50 points	5
		Less than 25 points	0
	10.0		

\* for project's key crafts

**Table-2 Project Craft Management Skills Index**

This Project Craft Management Skills Index can then be weighted for importance and used in conjunction with four other project assessment indices. These indices collectively make up the Tier II Project Index used for determining whether a project meets the criteria for Tier II status (Borcherding et al, 2001).

### **Craft Management Skills - Definitions**

The desired Craft Management Skills, as outlined by the metric, are divided into five (5) subcategories or elements. These Tier II management skill elements and their associated evaluation criteria are further defined; in terms of what is expected of the Tier II craftsman, as follows:

1. Administrative Skills
  - a. Cost reporting / management – the ability to use job codes for reporting and the charging of expenditure and unit costs to work packages, as well as the entry of this data into a central database;
  - b. Time reporting / scheduling – the preparation of crew activity time reports and the entry of this data into a central database;
  - c. Materials management / quantity take-off / estimating – knowledge of the procedures involved in quantity take-off and estimating for the planning of work, the procurement and management of materials from project storerooms, including checking the schedules to verify its arrival to ensure work continuity;
  - d. Requests for Information (RFI's) & information management – ability to submit RFI's to management where clarification is necessary on the job and to gather the information necessary for making these requests;
  - e. Safety – the completion of the Occupational Safety and Health Administration training requirements for the trades/crafts the crew's work encompasses, empowerment of the crewmen to stop unsafe work and modify work procedures for safety, and the maintenance of records for lost time accidents. The ability to conduct toolbox safety meetings.

## 2. Computer Skills

- a. Use of email / internet – ability to use email and the internet to send and receive RFI's, and to search project databases for clarification of work methods;
- b. Use of word processing (for reporting) and spreadsheets – use of software and standard templates for reporting and data entry;
- c. Use of project specific software (for scheduling, planning and management) – use of project scheduling, estimating and quantity take-off software where necessary for planning of work, or job verification;
- d. Use of basic Computer Assisted Design – ability to use CAD to receive updated drawings and change orders, and to view 2D/3D drawings for clarification.

## 3. Planning

- a. Requests for tools, materials and equipment – appropriate access to channels to request tools, materials and equipment necessary to complete assigned work items;
- b. Field sketches – training in basic drafting and CAD use to prepare field sketches to help clarify work requirements to crew;
- c. Short term planning (up to 3 weeks) – training in planning and scheduling to allow for up to 3 week look ahead, based on work items and budgets assigned.

## 4. Job Management

- a. Crew coordination at inter and intra craft levels – ability to communicate within the crew, as well as to liaise with crews in the same craft and in other trades to coordinate the utilization of available work space;
- b. Selection of means / methods for executing work – training in method analysis, fair understanding of work processes to allow for the selection of the methods and means for executing the work assigned to the crew;
- c. Leadership – training in motivation, mentoring of younger workers (Tier I), team building, performance assessment and the fostering of loyalty to the project.

## 5. Work Record

- a. Safety – personal safety record, number of recordable incidents and lost time accidents involved in;
- b. Attendance and truancy – personal attendance record on projects worked, days absent other than sick leave;
- c. Quality of work / workmanship – workmanship and percentage of rework typically necessary to correct defects in quality, on work completed by crew;
- d. Productivity – recorded ability of crew to deliver assigned work items within budgeted cost and on schedule;
- e. Initiative – supervisor’s assessment of crewman’s ability and willingness to make decisions where necessary, or to be innovative in devising means of tackling work.

## V. Related Literature

Several related bodies of literature and industry studies can be compared to the Tier II strategy. They add perspective and complement the Tier II strategy. All are reviewed in Edward (2001) and are briefly summarized below.

A self-managed work team (SMWT) can be defined as a group of workers who are responsible for managing and performing technical tasks resulting in the delivery of a product or service. These teams typically consist of 5 to 15 workers who are responsible for undertaking most management aspects and all the technical aspects of the job at hand (Yeatts et al, 1998). A review of the principles behind SMWT’s reinforces the Tier II structure that was developed in a consultative process with industry and presented earlier.

Self-managed work teams are a concept born of sociotechnical systems theory, which stresses the need for the joint optimization of the social and technical systems within an

organization. Essentially, the needs of one system must be sensitive to that of the other and vice versa. On a Tier II work crew, for instance, the social system would be the crewmembers and the management of their relationships and interactions. Likewise, the technological systems would encompass the tools, techniques, procedures, strategies, skills, knowledge and devices used to accomplish the assigned tasks (Yeatts et al, 1998). The performance of the team will ultimately be related to the amount and relevance of the talent available to it, which can be applied to the work. Talent must not only be available, but the team must be able to optimize and allocate it, as well as to make the effort to apply it to the job at hand. The workers must be motivated to undertake the work, and need to be committed to the success of the team. As such, management skills are essential to help optimize the available team talent and resources (Yeatts et al, 1998).

According to the classic commissioned by the Business Roundtable study “First and Second Level Supervisory Training”, construction supervision at the workplace is the most crucial element in the construction process (BRT, 1982). Supervisors who are unable to plan work, to communicate with workers and to direct work adequately act as major weaknesses. The report further concludes that formal training is needed to enhance these skills in order to improve productivity on construction projects (BRT, 1982).

The Laborers-AGC Education and Training Fund report, “Supervisor Skills Standards for the Construction Craft Laborer” examined the work practices of construction supervisors to establish the nature of the fieldwork performed at that level. The major goal of the study was to set parameters for training curricula and required skill sets for construction supervisory personnel (Laborers-AGC, 2001).

The AGC-Laborers document is a good reference that presented thorough descriptions of:

- The different processes or activities in which construction supervisors are typically involved
- Conventional industry standards of proficiency, health and safety, and production requirements that serve as performance criteria
- The key tasks of these supervisors, and

- The workplace skills, knowledge and aptitudes (WSKA's) that are routinely employed by them.

## **V. Craft Management Skills Distribution**

To allow for the best distribution of the craft management skills within a Tier II work group or crew, there is a need to examine:

- i. The composition of a typical crew
- ii. The best means of selecting the team leaders who will be administering and / or delegating these management responsibilities, and finally
- iii. The allocation of the management skills set within the work crew.

### **Review of Traditional and Tier II Crew Compositions**

A review was conducted of typical crew mixes on construction projects to determine the ratio of skilled workers to the group of semiskilled and unskilled workers normally employed in executing work at the crew level (hereafter denoted as the skilled to semi / unskilled ratio). Three sources were utilized, namely Richardson's General Construction Estimating Standards (Richardson Engineering Services, 1998), RS Means Building Construction Cost Data (RS Means, 1999) and the CII Model Plant Baseline Staffing Plan (CII, 1988). The CII Model Plant data was used to establish typical crew compositions on an industrial construction project in an open-shop setting, while the RS Means and Richardson's data was used to determine the crew mixes that would exist on a similar project in a unionized setting.

In examining this data, the criteria used for generating the crew mixes were as follows:

- The crew foreman was not considered in generating the skilled to semi / unskilled labor ratios or crew mixes, since they are generally non-working foremen. In the Tier II context, the traditional foreman will not contribute to the direct work performed by the crew.

- Operating Engineers were also not included when the crew mix ratios were generated since they were not considered to be a target group for Tier II status.
- The skilled component in the crew mix ratio consisted of journeymen, while the semiskilled / unskilled component was comprised of any helpers, laborers, apprentices, and task-trained workers (e.g. Rodmen and Concrete Finishers).
- The crafts or trades which constitute the skilled or journeyman level in this analysis are listed as follows (Houston-Gulf Coast Building and Construction Trades Council, 2001):
  - i. Asbestos Workers
  - ii. Boilermakers
  - iii. Bricklayers
  - iv. Carpenters – Millwrights
  - v. Cement Masons
  - vi. Electricians
  - vii. Floor Layers
  - viii. Glaziers
  - ix. Iron Workers
  - x. Linemen
  - xi. Painters
  - xii. Pipe Fitters
  - xiii. Plumbers
  - xiv. Sheet Metal Workers
  - xv. Sprinkler Fitters
  - xvi. Elevator Constructors
  - xvii. (Operating Engineers – excluded)
- It was assumed that the skilled group would form the main source of recruitment for Tier II workers.
- Key crews were identified based on the nature of the work assigned to them, as well as the versatility of the crew in terms of being assigned to another type of work (multi-tasking capability). As such, a laborer crew was not considered to be a key crew.

- The RS Means data was used to identify the crews most representative of each CSI work division or subdivision as appropriate. This was based on an examination of the crew assignments within each CSI division for all key activities, with the most prevalent crews being taken as representative of that subdivision.

The findings of this exercise with regards to the open / merit-shop conditions existing on the industrial plant project modeled by the CII Model Plant data are summarized by **Table-3** and **Figures 1** and **2** as follows:

**Table-3 Summary of Crew Mix Data (CII, 1998)**

**CONSTRUCTION CREWS / CREW MIXES (CII - OPEN SHOP)**

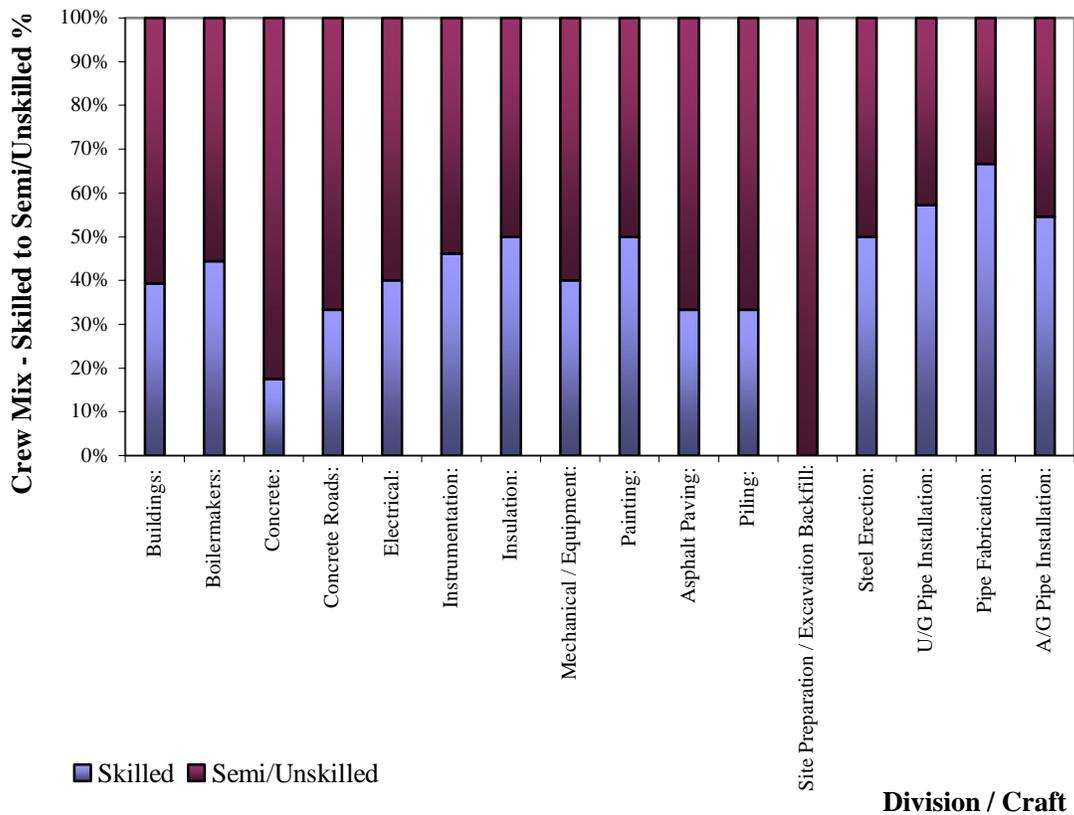
**Summary: Crew Mix from CII Model Plant (Craft Manpower)**

<b>Division / Craft</b>	<b>Skilled</b>	<b>Semi/Unskilled</b>
Buildings:	39%	61%
Boilermakers:	44%	56%
Concrete:	17%	83%
Concrete Roads:	33%	67%
Electrical:	40%	60%
Instrumentation:	46%	54%
Insulation:	50%	50%
Mechanical / Equipment:	40%	60%
Painting:	50%	50%
Asphalt Paving:	33%	67%
Piling:	33%	67%
Site Preparation / Excavation Backfill:	0%	100%
Steel Erection:	50%	50%
U/G Pipe Installation:	57%	43%
Pipe Fabrication:	67%	33%
A/G Pipe Installation:	55%	45%
<b>Direct hours on project</b>	<b>172,830</b>	<b>232,498</b>
<b>% Direct hours on project</b>	<b>43%</b>	<b>57%</b>

All data Copyright 1988, CII Model Plant Update, CII, Austin, TX  
 Publication 2-2 (Nov. 1998) Addendum 1, Phase 1 - Baseline Staffing Plan  
 Research Team 137 - Multiskilled Craft Capability in Construction

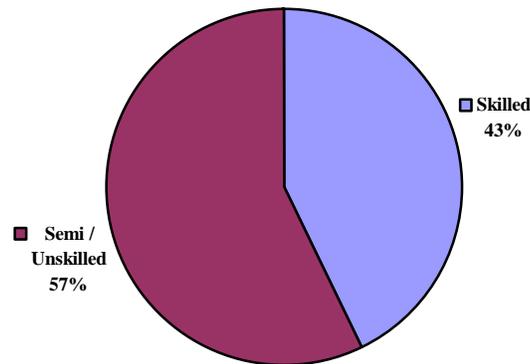
Table-3 illustrates that a crew mix of 43% skilled to 57% semi / unskilled labor would exist on a typical industrial project in an open-shop type environment. Thus on a representative ten (10) man crew, one would expect four (4) craftsmen and six (6) helpers.

**Chart of CII Model Plant Crew Mixes**



**Figure-1 Chart of CII Model Plant Crew Mixes (CII, 1998)**

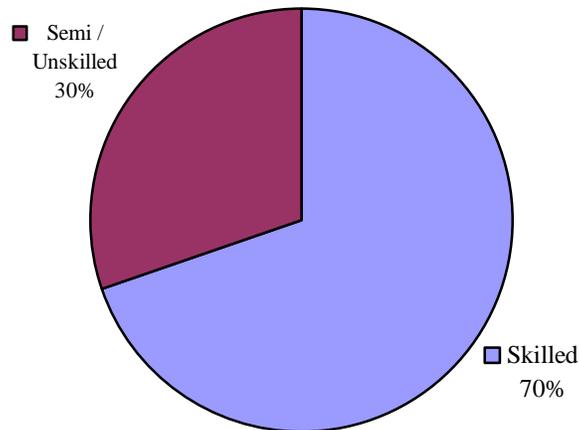
**Ratio of Skilled to Semi / Unskilled Hours of Direct Work on CII Model Plant Project**



**Figure-2 Chart of Ratio of Skilled to Semi / Unskilled Labor Hours of Direct Work on CII Model Plant Project – Open Shop (CII, 1998)**

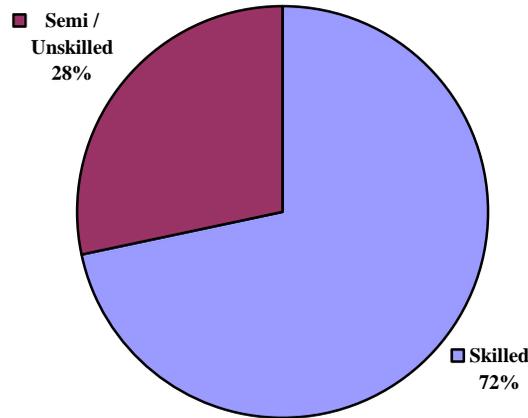
Figure-3 below, illustrates the average RS Means' crew mix ratio of skilled to semi / unskilled workers; across all selected CSI divisions, within the union context. Figure-4 illustrates the Richardson's Chemical Plant average crew mix data, also for a union environment. Both these presented data sets represent un-weighted averages.

**Skilled vs Semi / Unskilled Workers (Direct Work) - RS Means (1999)**



**Figure-3 Chart of Crew Mix Ratio of Skilled to Semi / Unskilled Workers Performing Direct Work – RS Means Building Construction Cost Data (1999)**

**Skilled vs Semi / Unskilled Workers (Direct Work) - Richardson's Chemical Plant Data**



**Figure-4 Chart of Crew Mix Ratio of Skilled to Semi / Unskilled Workers Performing Direct Work – Richardson General Construction Estimating Standards (1998)**

The RS Means data presented in **Figure-3** indicates an un-weighted crew mix of 70% skilled to 30% semi / unskilled workers on a unionized project. This union crew mix ratio conforms closely to that indicated by the Richardson data. The Richardson Engineering Construction Estimating data illustrated in **Figure-4** indicates a crew mix of approximately 72% skilled to 28% unskilled workers in a union setting. As such, a representative ten (10) man crew would comprise seven (7) skilled and three (3) semi / unskilled workers.

The Tier II metrics set an evaluation criterion of 40% Tier II workers present on key crews to achieve an ideal score of '10'. In order to incorporate 40% of Tier II workers on key crews on an open-shop / merit-shop type project (such as that outlined by the CII Model Plant data) nearly all the journeymen would have to be Tier II workers, given the 43% split of skilled or craft workers observed on that type of project. On a unionized project however (as illustrated by the RS Means' and Richardson's data), a more favorable situation exists in that about 70% of the work force is expected to be at the skilled or craftsman level. Thus, on a union project roughly 60% of the journeymen would have to be at the Tier II level for the project to attain the highest evaluation criteria

in terms of Tier II crew mix. It is worth noting that the multi-skilling element of the Craft Utilization Index has a similar target of 40% to achieve a perfect score of '10'. Based on the high proportion of skilled workers of union projects; they may indeed be more conducive to the implementation of Tier II, provided that the potential union labor restrictions on multiskilling can be resolved.

### **Possible Crew Leadership Selection Schemes**

Based on the desired optimization of the Craft Management skill set within a Tier II crew as a whole, the following distributions of the Craft Management administrator's role within a crew can be proposed:

- i. Principal Foreman Appointed by Management – the contractor may decide to appoint a principal Crew Foreman. This person would then act in the capacity of the traditional 'working' foreman.
- ii. Principal Foreman Selected by Crew – the self-managing crew would be empowered to pick a Foreman from among the Tier II workers in the crew. The person selected would then undertake the Foreman duties.
- iii. Rotating Foreman – the Foreman's duties may be rotated between the Tier II workers on a work package basis, or over a certain time period. This may encompass the rotation of the foreman duties between either all qualified team members, or all interested and duly qualified team members.
- iv. No Foreman – the Tier II members of the crew could undertake the Foreman's duties by committee. Responsibilities would be allocated based on the competence of the Tier II crewmen in the various management areas.
- v. Dual Foreman Roles – in this approach two Tier II crewmen assume the Foreman's duties. One would undertake the management, planning and administrative responsibilities, and the other the technical, quality and training responsibilities.

### **Possible Craft Management Skills Distribution Schemes**

By application of the research done by Yeatts et al, (1998) on team performance to the Tier II work crews which are essentially modified self-managed work teams, it would be expected that:

- i. Crew performance will be substandard where the crew has not been properly trained or does not have the requisite talent within its ranks to fulfill all its assignments at a Tier II level.
- ii. A crew will perform adequately, where for any one of the tasks typically assigned to it; there is at least one Tier II crewmember having the requisite knowledge, skills and abilities (KSAs) to perform it.
- iii. Crews will perform at their best or at a high performing team level when all Tier II crewmembers can perform all of the typically assigned tasks.

It will not always be possible or practical to have every Tier II crewmember skilled in every task the crew is expected to perform. As such, there is a need to determine the most cost effective and reasonable level of multi-skilling that should exist within a crew, or the threshold level that must be met for the crew to function effectively. Based on this, the needs for skills upgrading and training can be adequately planned, and the point of diminishing returns determined.

Having considered the proposed distribution schemes, the most efficient manner of training Tier II workers will most probably be through the gradual introduction of structured modules of these skill sets. A given worker targeted for Tier II status can be introduced to a structured management module comprised of related subjects, and then allowed to perform related duties on the crew initially. The crew membership would have to be carefully balanced to include all the given craft management skills to enable it to perform at the expected high performance level. The 'Work Record' element; contained in the individual craft workers evaluation for Craft Management Skills, would provide a means of selecting and matching the workers who will comprise the Tier II crew.

### **Benefits of Proposed Craft Management Skill Distribution Systems**

It is important to note that the crew's talent level is affected by environmental factors such as training and education, and as such, can be upgraded at anytime. Even where the competency in a particular area exists within a crew, there must be a continuous process of work evaluation to determine where improvement is necessary, as well as a willingness to defer to the crewmembers that possess the most competence in the area under consideration.

The assigned leader and all other crewmembers need to be subject to performance reviews on a regular basis. This is key to the improvement process within the self-managed work team. By rotating the leadership of the group, several group members can be given a chance to hone their management skills. Since all team crewmembers remain responsible for their assigned share of the technical work or the oversight of this work, they each have a chance to enhance their technical skills on a daily and assignment-by-assignment basis.

Given the fact that the team leader remains responsible for his or her share of the technical work, there naturally has to be a limit on the extent of the management responsibility that can be delegated to that person without overburdening them. Becker-Reems' (1994) research indicated that this role should be limited to one of scheduling the work, making work assignments, monitoring team performance and maintaining team records. The line and staff management on a Tier II construction project will continue to have responsibility to manage these groups, albeit to a lesser extent.

Ultimately, the team remains responsible for executing the work assigned to it in the most efficient manner. This involves the design of work procedures and the resolution of work related problems to accomplish their assignments. Teams must be well trained and the relevant information have ready access to allow them to make good decisions at all times.

### **IIIX. Conclusions and Recommendations**

Based on the preceding work, the following conclusions are made:

1. The most efficient manner of training Tier II workers will be through the gradual introduction of structured modules of skill sets. At present, the average craft worker shows technical skills that are superior to their current management skills. Where a worker has attained the competencies required to achieve Tier II status, it is most likely that he or she would already have been promoted to Foreman, General Foreman, or Superintendent. Certainly the key challenge may well be one of recruiting Craftsmen with superior technical skills, and then bringing them up to speed on their management skills. The crew membership should also initially be balanced to incorporate all given craft management skills to enable the crew to perform most efficiently.
2. One of the ultimate goals of the Tier II strategy is to incorporate up to 40% of Tier II workers (as well as multi-skilled workers) on key crews. In order to achieve this on an open-shop / merit-shop type project nearly all the journeymen would have to be Tier II workers, given the 43% split of skilled workers observed on that type of project. Conversely, on a unionized project where about 70% of the work force is expected to be at the skilled level, only about 60% of the journeymen would have to be at the Tier II level for the project to attain the highest evaluation criteria in terms of Tier II crew mix.
3. With the existing Crew Foreman used as a benchmark, it would be most valuable if most of the skills and duties of that position were moved down to the self-managing crew level. However, it is important that the crew members remain focused mainly on value-adding or direct work and as such, the scope of their management duties should be restricted to day-to-day activities, such as short term planning etc. A Tier II project must have a strong management base to provide the environment in which a self-managing work crew can thrive.
4. The review of self-managing work team (SMWT) literature has pointed towards the validity of the criteria set in the Tier II metrics for evaluating Craft Management Skills at the crew level. Certainly, the criteria typically required to

measure the productivity and effectiveness of SMWT's, have all been incorporated into the Tier II metrics.

5. The Tier II strategy should offer career paths for workers who wish to move into line management or supervisory positions by providing opportunities to develop and strengthen their management skills.
6. Teams need to establish performance goals with measurable criteria, and monitor their attainment of these goals. Peer appraisals allow team members to evaluate each other to highlight strengths and identify where improvements can be made (Frei et al, 1993). These appraisals can form a key component of each team member's 'Work Record', as measured by the Tier II assessment metrics.
7. By introducing multi-skilled Tier II workers into a system the variability in the crew's capability can be significantly reduced. Since team members are able to substitute for one other, daily production uncertainties due to absences and illness can be reduced. Tier II workers are essentially multiskilled work given their multifaceted technical and management skills.

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