Performance Influencing Factors

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Performance Influencing factors (PIF)
Human Reliability

- How do we measure human performance?
- How do we measure human reliability?
- Conditions that influence human performance have been represented via several ‘context factors’
- These context factors are referred to by different terms according to method:
  - PSF (performance shaping factors)
  - PIF (performance influencing factors)
  - IF (influencing factors)
  - PAF (performance affecting factors)
  - EPC (error producing conditions)
  - CPC (common performance conditions), and so on.
- These factors are used as causes or contributors to unsafe, human actions in event analysis.
Performance Influencing Factor (PIF)

- PIF is a factor that combines with basic human error tendencies to create error-likely situations. So, it can be used to determine the likelihood of error or effective human performance.
- PIF depends on human conditions (physically / emotionally) and the work environment or conditions.
- External factors are considered to have greater impact.
- PIFs such as quality of procedures, level of time stress, and effectiveness of training, will vary on a continuum from the best practicable to worst possible.
Example of Internal & External PIFs

**Internal PIF**
- Emotional state
- Intelligence
- Motivation/attitude
- Perceptual abilities
- Physical condition
- Sex differences
- Skill level
- Social factors
- Strength / endurance
- Stress level
- Task knowledge
- Training/experience

**External PIF**
- Inadequate workspace and layout
- Poor environmental conditions
- Inadequate design
- Inadequate training and job aids
- Poor supervision
More Example of PIFs

Policy & Organizational Culture
- Safety beliefs
- Attitudes towards blame
- Reporting and Feedback System
- Reward Systems
- Third Party
- Policy for procedures and training
- Policies for design
- Policies for systems of work
- Level of participation
- Management communications and feedback

Job & Task Characteristics
- Systems of work
- Maintenance
- Control room design
- Control panel design
- Job aids and procedures
- Training
- Task allocation
- Field workplace design
Example of PIFs

Process Environment Demands
- Control room environment
- Field work environment
- Levels of demands on personnel
- Complexity of process events
- Perceived risk
- Suddenness of onset of events
- Requirements for concurrent tasks
- Work pattern

Work Group Issues
- Functional interfaces
- Distribution of workload and resources
- Clarity of responsibilities
- Communication – internal & external
- Authority and leaderships
- Group planning and orientation

Work Group Issues
- Competence
- Motivation
- Interpersonal style
- Learning style
- Thinking style
## Example of PIF Rating

<table>
<thead>
<tr>
<th>PIF Eval. Scale (Qualitative and Quantitative)</th>
<th>Procedures</th>
<th>Physical Work Environment</th>
</tr>
</thead>
</table>
| WORST 1                                      | • No written procedures, or standard way of performing tasks  
• Not integrated with training  | • High levels of noise  
• Poor lighting  
• High or very low temperatures and high humidity or wind chill factors  | |
| AVERAGE 5                                    | • Written procedures available, but not always used  
• Standardized method for performing task  | • Moderate noise levels  
• Temperature and humidity range  | |
| BEST 9                                       | • Detailed procedures and checklists available  
• Procedures developed using task analysis  
• Integrated with training  | • Noise levels at ideal levels  
• Lighting design based on analysis of task requirements  
• Temperature and humidity at ideal levels  |
Example - Fatigue

Fatigue is caused by (1) Time at Work, (2) Amount of Sleep, (3) Shift Rotation

<table>
<thead>
<tr>
<th>Scale</th>
<th>Time at Work</th>
<th>Amount of Sleep</th>
<th>Shift Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Work shifts of twelve hours or longer, with few breaks and are unhappy with their working environment</td>
<td>Less than five hours sleep and have no opportunities to reclaim lost sleep during the week</td>
<td>Worker frequently change shift, start earlier than previous shifts and undertake shifts of longer than 12 hours</td>
</tr>
<tr>
<td>2</td>
<td>Workers work regular shifts of eight hours or less, have regular breaks and are happy in environment</td>
<td>Have at least eight hours sleep per night with regular and frequent rest days</td>
<td>Workers do the same shift all the time and work shifts of 8 hours or less</td>
</tr>
<tr>
<td>3,4,5,6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
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</tbody>
</table>
Example - Fatigue

Using these scales, the task expert decides that the amount of sleep that the workers achieve and the shift rotation schedules are fairly close to the best case scenarios describes in the scales.

\[
\text{Fatigue} = \frac{3 + 8 + 7}{3} = 6
\]
PIF Example: Operator Behavior

Fig. 1. Organization of PIF groups and high-level interdependencies.

Operator Behavior (i.e., I, D, and A)

Physical Factors

Mental State
- Cognitive Modes and Tendencies
- Emotional Arousal
- Strains and Feelings
- Perception and Appraisal
- Intrinsic Characteristics

Memorized Information

External Factors
- Team-Related Factors
- Organizational Factors
- Environmental Factors
- Conditioning Events and Hidden Faults

Internal PIFs

External PIFs

As stated earlier, PIFs are grouped into internal PIFs and external PIFs. The internal PIFs are further divided into three groups: Intrinsic Characteristics, Mental State, and Memorized Information. The external PIFs are divided into four groups: Physical Factors, Mental State, and Memorized Information.
Full Set PIF Taxonomies

- Detailed set of PIF is developed for human factor analysis
  - CSNI taxonomy (Rasmussen, 1981)
  - THERP (Swain and Guttman, 1983)
  - HEART (Williams, 1988)
  - PHECA (Whalley, 1987)
  - PSF taxonomy (Bellamy, 1991)
  - Influencing factors (Gerdes, 1997)
PIF Taxonomy for Human Reliability Analysis (HRA)

- Quantification of HEP: SLIM (Embrey, 1984), PLG-SLIM (Chu et al., 1994), INTENT (Gertman et al., 1992), STAHR (Phillips, Humphreys, Embrey & Selby, 1990), and HRMS (Kirwan, 1997)

- Analysis of errors of commission: Macwan’s PIF taxonomy for errors of commission (Macwan & Mosleh, 1994), Julius’ PIF taxonomy for errors of commission (Julius, Jorgenson, Parry & Mosleh, 1995), and A THEANA (US NRC, 2000)

- Overall context assessment and error analysis: HRMS, CREAM (Hollnagel, 1998; Hollnagel, Kaarstad & Lee, 1999), and INCORECT (Kontogiannis, 1997)

- Database for HRA: Taylor-Adams’ PSF taxonomy for CORE-DATA (Taylor-Adams, 1995), and Rogers’ PSF taxonomy for CORE-DATA (Gibson et al., 1998).
PIF Development for HRA
(Example of Accident Modeling)

<table>
<thead>
<tr>
<th>Full Set PIF</th>
<th>HRA PIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Factors</td>
<td>• Competence</td>
</tr>
<tr>
<td>• Attention</td>
<td>• Adequacy of training &amp; experience</td>
</tr>
<tr>
<td>• Intelligence</td>
<td></td>
</tr>
<tr>
<td>• Knowledge</td>
<td>• Stress</td>
</tr>
<tr>
<td>• experiences</td>
<td>• Workload</td>
</tr>
<tr>
<td>Psychological States</td>
<td>• Stress</td>
</tr>
<tr>
<td>• Stress</td>
<td>• Workload</td>
</tr>
<tr>
<td>• Burden</td>
<td>• motivation</td>
</tr>
<tr>
<td>Personal States</td>
<td></td>
</tr>
<tr>
<td>Self-esteem</td>
<td></td>
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<tr>
<td>Self-confidence</td>
<td></td>
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<tr>
<td>Sense of responsibility</td>
<td></td>
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<tr>
<td>Morale &amp; motivation</td>
<td></td>
</tr>
</tbody>
</table>

## PIFs for HRA
(Example of Accident Modeling)

<table>
<thead>
<tr>
<th>PIF Group</th>
<th>Representative PIF</th>
<th>Sub-items</th>
</tr>
</thead>
</table>
| Human     | 1. Training & Experience | Adequacy of training (frequency, recent training, fidelity of simulation program)  
Experiences/practices of real operating events  
Learning of the past events/experiences  
Career of the operators |
| Task      | 2. Availability & quality of procedures | Availability  
Format or type  
Clarity of instruction and terminology Decision-making criterion  
Logic structure |
|          | 3. Simultaneous goals/tasks | Number of simultaneous goals/tasks  
Priority between goals/tasks  
Conflict between goals |
|          | 4. Task type/attributes | Type of man–machine interaction  
Dynamic/step-by-step  
Task criticality/consequences  
Degree of discrepancy with familiar tasks |

## PIFs for HRA
*(Example of Accident Modeling)* - cont’d

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<thead>
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<th>PIF Group</th>
<th>Representative PIF</th>
<th>Sub-items</th>
</tr>
</thead>
</table>
| System    | 5. Availability and quality of information | Information availability (instrumentation fail/stuck)  
Clearness of meaning (direct indication/interpretation required/ambiguous/unreliable information)  
Distinguishability of information  
Control display relationships |
|          | 6. Status and trend of critical parameters | Value of critical parameters  
Trend of critical parameters (rate of change of critical parameters)  
Number of dynamic changing variables  
Degree of alarm avalanche |
|          | 7. Status of safety system/component | Success/fail state of safety system/component  
Level of trust on the system/component  
Number of failed/stuck components  
Previous operation history and current status of safety system |
|          | 8. Time pressure | Available time vs. required time |
## PIFs for HRA
(Example of Accident Modeling)- cont’d

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<th>Representative PIF</th>
<th>Sub-items</th>
</tr>
</thead>
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<tr>
<td><strong>Environment</strong></td>
<td>9. Working environmental features</td>
<td>Task location: (MCR/local CR/local area)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accessibility</td>
</tr>
<tr>
<td></td>
<td>10. Team cooperation and communication</td>
<td>Clearness in role/responsibility definition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direction, type, method, protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standardization in instruction/information delivery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Team collaboration/cooperation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adequacy of distributed workload</td>
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<tr>
<td></td>
<td>11. Plant policy and safety culture</td>
<td>Plant specific prioritized (or preference for/objection to) goals/strategies</td>
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<tr>
<td></td>
<td></td>
<td>Attitude toward EOP/AMP training</td>
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<tr>
<td></td>
<td></td>
<td>Safety/economy tradeoff</td>
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<tr>
<td></td>
<td></td>
<td>Routine violations</td>
</tr>
</tbody>
</table>
END OF LECTURE