Shift Work Schedules

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Senior Project Manager

Shiftwork Interventions Symposium
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Overview

1. A model of alertness and fatigue
   - Examples

2. Shift schedule dynamics
   - Speed of Rotation
   - Direction of Rotation
   - Length of Shifts

3. Two examples of schedules
Application of Shift Work Scheduling Principles and Tools for Optimizing Console Based Operations
Application of Model to a Railroad Collision

Effectiveness

Adjustable Criterion Line

Lower Percentile (e.g. 20%)

Work Periods in Red

CRITICAL EVENT
Collision with train taking siding
07:54b
People are not good at judging their own sleepiness

Van Dongen, Maislin, Mullington, & Dinges (2003). The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep, 26, 117-126.
Shift Work Good Practices (Fatigue and Effectiveness)

1. Minimize disruption to circadian rhythms
2. Forward rotation of shifts
3. Short shifts – not longer than 8 hours
4. Minimize consecutive night shifts
5. At least 24 hours off after night shifts
6. Avoid long periods of sleeplessness
7. At least 2 days off each week on average
Shift Work Good Practices
(Psychosocial)

1. Predictable shifts
2. Maximize free days on weekends
3. Good quality time off
4. Equity for all workers
5. Flexibility
6. Employee participation in design and implementation
7. Education and training

These good practices cannot all be achieved simultaneously in practice!
Types of Shift Work

• Fixed or permanent
  – All Days (e.g., 7 am to 3 pm)
  – All Afternoons or evenings (e.g., 3-11 pm)
  – All Nights (e.g., 11 pm to 7 am)
• Rotational (Day -> Afternoon -> Night)
• Split (e.g., 5-9 am, then 2-6 pm)
• Irregular
Shift Work Design Considerations

Characteristics of the work done on shift

- Intensity
- Pace
- Physical load
- Mental load
- Consequences of error
- Breaks, rest, relief, meals

- Shorter shifts (8 hr) for higher loads
Number of Consecutive Shifts (Speed of Rotation)

- **Fast Rotations:** up to 3 shifts in a row of the same time period (days, evenings, or nights)

- **Slow Rotations:** 4 – 10 shifts in a row of the same time period

- **Very Slow Rotation:** > 10 shifts in a row of the same time period
Consecutive Shifts
Speed of Rotation

Fast rotation (2–3 shifts before change)
- 2-3 consecutive night shifts have least effects on circadian rhythms
- No adaption occurs
- Small sleep deficit
- Reduced performance on night shift
- No adaption means days off are OK
Consecutive Shifts
Speed of Rotation

- Slow rotation (4-10 shifts in a row)
  - Some adaption occurs at wrong time (end of sequence)
  - Accumulation of sleep deficit
  - Desynchronized on days off
  - Reduced performance on night shift
Consecutive Shifts
Speed of Rotation

- Very slow rotation (11 or more shifts in a row)
  - Adaption occurs, not complete
  - Sleep deficit can be minimized
  - Performance on night shifts increases after the 4 day lull
  - Can be serious psychosocial effects
## Consecutive Shifts
### Speed of Rotation

## Summary

<table>
<thead>
<tr>
<th>Shift type</th>
<th>Fast Rotation</th>
<th>Weekly (slow) Rotation</th>
<th>Very slow Rotation</th>
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<tbody>
<tr>
<td>Disruption of Circadian Rhythm</td>
<td>Least</td>
<td>Worst</td>
<td>Some</td>
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<tr>
<td>Accumulation of sleep deficit</td>
<td>Minimal</td>
<td>Worst</td>
<td>Maybe</td>
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<tr>
<td>Weeks without free evenings</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Performance during night shift</td>
<td>Reduced</td>
<td>Reduced</td>
<td>Better</td>
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</table>
Permanent Shifts

Employee:
• Adaptation (incomplete) occurs
• Very predictable -- plan social and family obligations
• Social isolation
• Circadian disruption on days off

Employer:

**Advantages**
• Easier to change coverage to match skills or number of staff

**Disadvantages**
• Reduced management interaction & communication
• Scheduling training
• Unbalanced workforce
• Recruiting
Direction of Rotation

**Body Clock**
- For most people, the internal body clock is slightly longer than 24 hrs

Legend
- Wake
- Sleep

Normal cycle with light
No environmental cues

Relative Clock Hour
18 24 6 12
Direction of Rotation

- It is easier to stay up later than to get up earlier
- For most shift-workers, adaption to a forward moving schedule is easier than a backward moving schedule.

Day -> Afternoon -> Night is preferred
Longer Shifts

**Longer Shifts (e.g., 12 hours)**
- For work with variable or lower load
- Need structured breaks and meal times

**Advantages**
- More days off and more free weekends
- Less commuting
- Fewer shift changes and less downtime

**Disadvantages**
- Reduced management interaction
- Training and meetings
- More fatigue
- Higher risk of incidents
Days Off

Employee time off based on duration of shift

Scheduled days off per year based upon shift duration.

- 8-Hr Shifts
- 10 - Hr Shifts
- 12-Hr Shifts
Types of Schedules

Common Patterns:

- 8 hours: 2-2-3 or 2-2-2-3
- 12 hours: 3’s and 2’s or 4’s and 5’s
- 10 hours: 3-2-2 (better for uneven coverage - police)
- 24 hours: 1-xxx-1-xxx or 1-xx-1-xxxx (fire and EMS)

Note: these patterns work for evenly balanced requirements. Once the balance is gone, patterns must be adjusted.
Case 1: Hospital

- A common nursing schedule
- Shift pattern is called 3’s and 2’s
- 12 hour shifts for 24 hour coverage
- Advantage: 3-day weekends
- Problem: long sequence of nights; long work weeks

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<td>X</td>
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<tr>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>24</td>
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<tr>
<td>Week 4</td>
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<td>N</td>
<td>X</td>
<td>X</td>
<td>N</td>
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### Case 1: Hospital

#### Alternative Schedule

- Interchange nights and days from weeks 2 and 4
- Avoid long sequence of nights (circadian disruption)
- Still have long work weeks

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**Average Hours**: 42
Case 2: Manufacturing

- 8-hour shifts (D, A, N)
- 9-week cycle
- Staff needed = 9
- 2 people per shift
- Rapid forward rotation
- Only 2 full weekends
- 2 long work weeks

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Case 2: Manufacturing

Alternative Schedule
• 8-hour shifts (D, A, N)
• 5-week cycle
• Rapid forward rotation
• Staff needed = 5
• 1 person per shift
• More full weekends
• No long work weeks
• Fewer weekly hours

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<td>Week 1</td>
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<td>X</td>
<td>A</td>
<td>A</td>
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<td>Week 4</td>
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<td>Week 5</td>
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</table>

Average Hours

33.6
Final Words
Shift Scheduling

- Complex process
- Use scheduling software to investigate alternatives
- Consider work load, pace and breaks
- Consider fatigue and effectiveness models
- Consider specific psychosocial factors
- Involve workers and supervisors
- Ensure employees trained and knowledgeable about risks and trade-offs
1. Waage, S. et al., 2012: Subjective and objective sleepiness among oil rig workers during three different shift schedules. Sleep Medicine, 13 (64-72).
References


Resources

**CCOHS OSH Answers**
- Rotational Shift work  
  [http://www.ccohs.ca/oshanswers/ergonomics/shiftwrk.html](http://www.ccohs.ca/oshanswers/ergonomics/shiftwrk.html)
- Extended Workday  
  [http://www.ccohs.ca/oshanswers/ergonomics/workday.html](http://www.ccohs.ca/oshanswers/ergonomics/workday.html)

**Carex Canada**
- Shift Work Occupational Exposure Profile  

**Dietitians of Canada**
- Nutrition for Shift workers  
  [http://www.dietitians.ca/getattachment/7e936b10-0fcc-4f62-ae70-5aeeb3b50a15/FactSheet---Special-Nutritional-considerations-for-Shift-workers.pdf.aspx](http://www.dietitians.ca/getattachment/7e936b10-0fcc-4f62-ae70-5aeeb3b50a15/FactSheet---Special-Nutritional-considerations-for-Shift-workers.pdf.aspx)

**Government of Nova Scotia**
- Healthy Eating - Shift workers  
Resources

NIOSH
- Plain Language about Shift Work

National Institute of General Medical Science
- Circadian Rythms

Occupational Health Clinics for Ontario Workers
- Shiftwork: Health Effects & Solutions
Resources

National Center for Intermodal Transportation
  http://www.ncit.msstate.edu/events/events_10.html

North Atlantic Treaty Organization

National Institute for Occupational Safety and Health (NIOSH)
- Overtime and Extended Work Shifts: Recent Findings on Illnesses, Injuries and Health Behaviors
  http://www.cdc.gov/niosh/docs/2004-143/
Thank You

For further information:

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905-570-8094

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