Maintenance Planning and Scheduling

Workshop by Professor John Sharp
COrE Research Group, University of Salford, UK

With contributions from Dave Thompson Ramsoft, UK
Dave@ramsoftuk.com
Organisational Excellence

Organisational Excellence (high performance) is achieved by an organisation when it unleashes the potential of all its employees toward their stakeholders’ shared purpose.
Research Activities

– People Process Interface
– Process Based Management (quality and operations [maintenance])
– Development of employees & organisations
– Corporate Social Responsibility (CSR)

leading to

High performance teams & organisations.

www.ipamc.org

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
Maintenance Planning and Scheduling

In order to see maintenance planning and scheduling we need to see it in context of the organisational systems.

We need to see the role of maintenance within an organisation.
Maintenance

It is:

- Work necessary to maintain and preserve plant and capital equipment in a condition suitable for its designate purpose and includes preventive, predictive, and corrective (repair) maintenance (plus many more tools/techniques)
Organisational Vision Deployment

- VISION
- MISSION STATEMENT
- GOALS AND OBJECTIVES
- STRATEGY AND KEY PERFORMANCE INDICATORS
- PROCESSES AND PROCESS KPI’S
- PROCEDURES, WORK INSTRUCTIONS, ACTIVITIES AND TASKS
- DOCUMENTS AND RECORDS

Maintenance Strategies
Maintenance Processes
Maintenance Activities/Tasks
Maintenance Records(IT/IS)
Maintenance Strategies

Asset lifetime management requires:

- A comprehensive strategy (driven by the organisation) that covers:
  - Design, procurement, installation and operation
  - PM, RCM, TPM, CBM and breakdown are all included
  - Results orientated measures of performance (KPIs)
- Commitment to Continuous Improvement and defect elimination
- Organisational support
- Competent personnel
- Information (data) as an enabler
- Extends beyond finance
Maintenance Programs

• Emergency or breakdown maintenance
• Preventive maintenance (PM)
• Opportunistic maintenance
• Predictive or Condition based maintenance (CBM)
• Design out maintenance
• Total Productive Maintenance (TPM).
• RCM/modelling
• Lean and process redesign
Effective Maintenance Management

- Human resource management
- Financial aspect
- Continuous improvement
- Contracting out maintenance
- Policy deployment & organisation
- Maintenance approach
- Task planning and scheduling
- Information management & CMMS
- Spare part management
Maintenance Management

Program utilising such concepts as

- organisation,
- plans,
- procedures,
- schedules,
- cost control,
- periodic evaluation,

This includes feedback for the effective performance and control of Maintenance. Other aspects considered are

- health,
- safety,
- environmental compliance,
- quality control,
- security.
Primary Input

Production

Primary Output

Potential
Production
Capacity

Maintenance

Demand

Maintenance Planning and Scheduling

www.ipamc.org

Professor John Sharp, University of Salford, UK

"Maintenance Planning and Scheduling"
Why is Maintenance Difficult to Control

- Maintenance work is very diverse
- Specifying what is to be done is not easy
- Jobs have to be done in order of priority
- Tradesmen have different abilities
- Extent of job unknown
- Jobs can be dependent on parts availability
- Jobs must be co-ordinated with production requirements
- Jobs can be dependent on the weather
- Peaks and troughs of demand
Effective Work Planning and Control

Chance of success is much higher when there is a well designed system that is well documented and there is discipline in its use.

A correct and efficient planning function, requires that management provide guidance on the level of control necessary to ensure “Consistent” quality maintenance of plant equipment.
Objectives

Demand → Control → Resources

Work

Feedback

Systems To Be Maintained → Execution → Maintained Systems

Professor John Sharp, University of Salford, UK

“Maintenance Planning and Scheduling”
Objective

Aggregate Maintenance Planning

Aggregate Production Requirements

Preventive Maintenance Planning

Capacity Norms

Corrective Maintenance Classification

Production Requirements

Corrective Maintenance

Work Order Release

Advancable Orders

Postponable Orders

Rush Orders

Released Orders

Work Order Scheduling

Scheduled Orders

Orders Progress

Work Dispatching

Work

Work Progress

Firm Orders

Preventive Maintenance

Aggregate Maintenance Demands

Production Requirements

Aggregate Production Requirements

www.ipamc.org

Professor John Sharp, University of Salford, UK

“Maintenance Planning and Scheduling”
“Plans maybe useless, but planning is essential”

*General Macarthur*

“Failing to Plan…….
…is planning to fail”

*Juran*

Deming Continuous Improvement Cycle

Professor John Sharp, University of Salford, UK

“Maintenance Planning and Scheduling”
A World Class Maintenance Management System

- Work Identification
- Work Planning
- Work Scheduling
- Analysis
- History Recording
- Work Execution
Work Planning & Control

• Vital aspect of maintenance management and concerns:
  – Requesting work
  – Planning and estimating of work
  – Effective scheduling of work
  – Quality feedback of work done and other information into equipment history
  – Managing and controlling the workload
• Provides information for reliability analysis, supports decision making and continuous improvement
Planned versus Unplanned?

Downtime

Preparing
Repairing
Waiting
Spares
Repairing

Downtime

Preparing
Repairing
## Tradesman Utilisation

<table>
<thead>
<tr>
<th></th>
<th>Delegates Estimate</th>
<th>Typical Reported as Mr Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Repairing</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td>Travelling</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>No Job (standby)</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Waiting for spares/other trade, access</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Personal</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
Work Types

Maintenance Workload Analysis

**Plan**
- Right maintenance regime - mix of
  - Condition based
  - Fixed Time
  - Function Testing
  - Run to Failure
  - Watchkeeping

**Actuals**
- Actual Work Load

Analyze performance - is it effective?

www.ipamc.org

Professor John Sharp, University of Salford, UK
"Maintenance Planning and Scheduling"
Work Load – Need Clear Definitions

• Preventive maintenance
• Corrective Maintenance
• Emergency
• Minor work (standard work orders)
• Lubrication
• Condition Monitoring
• Overhauls
• Improvement Maintenance
• New Work/Installations
What is Your Work Load – Any Ideas?

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Day to Day %</th>
<th>All Work %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Work Types – should be meaningful and action generating

<table>
<thead>
<tr>
<th>Operator Work</th>
<th>End of Life Repairs</th>
<th>Emergency Repairs</th>
<th>Excessive Repairs</th>
<th>Work that Should not be done</th>
</tr>
</thead>
</table>

- **Preventive Maintenance**
- **Predictive Maintenance**

- **Maximise this type of maintenance**
- **Minimise the effort through better planning & scheduling**
- **Eliminate this type of maintenance**

---

**Professor John Sharp, University of Salford, UK**

“Maintenance Planning and Scheduling”

---

www.ipamc.org
# Tradesman Utilisation

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive</td>
<td>Activities that aim to prevent, checking bolting, lube tasks, filter changes</td>
</tr>
<tr>
<td>Predictive</td>
<td>Equipment monitoring and work arising from the monitoring</td>
</tr>
<tr>
<td>Emergency</td>
<td>Likely to incur rework</td>
</tr>
<tr>
<td>Excessive</td>
<td>Work such as rework or worst actor repairs</td>
</tr>
<tr>
<td>Work that shouldn’t be done</td>
<td>Work that doesn’t meet business objectives of cost, production</td>
</tr>
<tr>
<td>End of life Task</td>
<td>Replacement or adjustments with TTF when expected</td>
</tr>
<tr>
<td>Operator Task</td>
<td>Maintenance task carried out by operators</td>
</tr>
</tbody>
</table>

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
Work Order

• Provides instruction to the persons performing the work
• Specifies the manpower estimate
• Specifies material and tool requirements
• Collects data on equipment, resource performance and costs
• Provides facility to record details on failures and their causes
Work Order Design

• Consist of:
  – Work request
  – Work instruction
  – Tradesman’s Feedback

• Best Practices
  – Simple to read
  – Quick to Complete
  – Logical layout
  – Used for all types of work
  – Utilise codes and tick boxes to reduce text to minimum
Key Planning Codes

• Work Type ✓
• Equipment Criticality ✓
• Job Priority
• Trade Type
• Job Status
• Waiting codes
• Shutdown Effect Codes
• Abbreviated Codes
Failure Reporting Codes

- Problem
- Failure Cause (Failure Mode)
- Action
- Root Cause
- Critical, Degraded or Incipient
- Effect on Production
Waiting Codes

- On Planning
- On Parts and Materials
- On Tools or Equipment
- On Access to Equipment
- On Workshop Services
- On Transport
- On Other Trades
Job Priority

• To assist maintenance to prioritise the planning of work
• Priorities must be well understood and applied
• Mis-use of priority codes should be monitored
• A prioritisation system may be used, based on both:
  – Equipment Criticality
  – Job Priority
Job Priority Codes

• Emergency used to indicate that a production unit is out of service and there is financial loss to the company or there is a danger to life or equipment. There is no job planning.

• High priority used to indicate situations where there is considerable risk that financial loss may occur unless action is taken. High Priority means action must commence within a fixed time period, i.e. one or two days, so that the job must be completed within a stated time period. We have job planning but the job goes to the top of the queue.
Low Job Priority Codes

Used to schedule work on which timing is not important, i.e. the start date can be delayed,

- 3 delivery to be effected within 5 - 15 days
- 4 delivery to be effected within 15 - 30 days
- 5 delivery to be effected over 30 days.
### Work Management

<table>
<thead>
<tr>
<th></th>
<th>Requested</th>
<th>Preventive</th>
<th>Emergency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Request</td>
<td>X</td>
<td></td>
<td>X (Verbal)</td>
</tr>
<tr>
<td>2. Accept</td>
<td>X</td>
<td></td>
<td>X (Verbal)</td>
</tr>
<tr>
<td>3. Plan &amp; Estimate</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Approve</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Schedule</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Issue</td>
<td>X</td>
<td>X</td>
<td>X (Verbal)</td>
</tr>
<tr>
<td>7. Feedback</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8. Review</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>9. Close Out</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Work Management

1. Request
   - Clear instruction, allow Spv to assign problem code

2. Accepting

3. Plan 4. Schedule

4. Execute job as per instruction

5. Review & Approve

6. Issue

7. Do Job
   - Report findings & work performed
   - Suggest improvements, e.g. to amend job plan

8. Review & Complete
   - Return spares

9. Review & Close Out
Work Request

• Must provide sufficient information to plan
• As a minimum will contain
  – Equipment Tag No (Where it is to be done)
  – Details of work required (What is to be done)
  – Date required and time if appropriate (When it is to be done)
  – Priority
  – Any issues relating to Safety
  – Any other relevant information
Accepting

- Check information quality, e.g. booked to correct tag number
- General visualisation of the work required, complexity, where to be done, costs
  - Repair at site
  - Repair at workshop
  - Permanent or Temporary repair
- Confirm Job Priority
- Assign labour group and area (or Lead Craft if appropriate)
- Pass to Planner (depends who accepts)
Linking Job Plans to CMMS Work Orders

- One-Off Job Plan
  - One off type work, these jobs plans are not held in the Job Plan library but only created within the work order.

- Corrective Maintenance Job Plan
  - Repeat repair work may represent up to 80% of the total repair work. These jobs plans are stored in the CMMS until required.

- PM Job Plan
  - Are automatically called up each time the PM job is issued, e.g. monthly, 3 monthly, annually, etc.

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
Work Planning

- A plan is not just a list of tasks, the basics of any plan
  - Who will perform?
  - What needs to be done?
  - How should the job be done
  - Why should it be done this way?
  - Which tools and equipment are required
- Is there an existing plan available in the CMMS?
Job Plan Package

- Detailed job specification
- Location diagram
- Reference to Operation and Maintenance Manuals
- List of Spares
- Sketches or drawings to ensure clarity of what is required
- Fault finding guides
- C.O.S.H.H sheets
- etc
Estimating

How Much

• Man-hours
• Spares and Materials

Methods

• Experience
• Historical times from the CMMS
• Benchmarks
• Rates

Good Planners Use a Mix of Approaches

www.ipamc.org
A World Class Maintenance Management System

-work identification → work planning → work scheduling

-analysis ← history recording ← work execution
Effective Schedules

Assist management in controlling and directing maintenance activities and:
• enhance the ability to assess progress.
• reflect the long-range plan and
• day-to-day activities.
• enhance the efficient use of resources
• decrease duplication of support work
• decreasing maintenance personnel idle time
• ensure completion of planned tasks.

The schedule should be the road map for reaching plant maintenance goals.

www.ipamc.org
Scheduling: Integral to Maintenance Management

It should be performed concurrently with the planning activities. The integrated schedule should be based upon such details as:

- work scope,
- importance to plant goals,
- prerequisites and interrelations,
- resources, and
- constraints,

That are developed during the planning process.
Schedule: Is a tool

Used to assist in

- managing maintenance activities.
- prevention of performance deterioration
- identification and sequencing maintenance tasks.
- coordinate activities and track progress.
- grouping individual work items and integrating major tasks,

In doing this more efficient use of support resources will be achieved.
Schedule: Progress reporting.

The process is dynamic (PDCA) use effective daily schedules to

- implement maintenance activity plans
- track and periodically assess performance

Effectiveness of the daily scheduling process during normal operation should be a good indicator of

- how effective the daily schedule is during outages.
Job Scheduling

• Assigning of work to a specific period of time
  – Can be long, medium or short range
• Preparation of short range maintenance plan
• Matching workload to the resources available

To ensure manpower, materials, tools, and access to the equipment are available when required.
### Scheduling Priority

<table>
<thead>
<tr>
<th>Equipment Criticality</th>
<th>1 Safety Work</th>
<th>2 Urgent</th>
<th>3 Normal 1</th>
<th>4 Normal 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Very low</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Job Priority:

- Safety Work: High
- Urgent: Low
- Normal 1: Very low
- Normal 2: Low
General Scheduling Notes

- Production and maintenance plans should be coordinated to provide a single asset based schedule of activities.
- Work should be planned at least 1 week in advance (it takes time to plan).
- The daily schedules are driven by the weekly plan, but are subject to amendments caused by changes in the production schedule.
- Last minute revisions must be minimal, agreed by maintenance and production and the impact to the plan understood.
General Scheduling Notes

• Pay particular attention to jobs that require plant downtime, ensure as much work as possible is performed off line
  – Preparation of permits, Collection of spares, Support tasks (Isolation, scaffolding, lagging)
• At the weekly planning meeting report on equipment and planning performance. Report all tasks that caused the plan to be amended
• Daily scheduling – target tomorrow’s schedule compiled by 3pm today
General Scheduling Notes

- Not all breakdowns are emergencies
- Utilise natural windows of opportunity before requesting plant downtime
- Do not schedule a task unless all resources are available
- On maintenance days schedule jobs with highest priority first
- At weekly planning meeting plan by Job. Identify those that require Production involvement and coordinate
- Daily scheduling is by resource. Target 100% resource utilisation.
- Do not allow slack at beginning of day ‘just in case of a breakdown’
Execution

Execute Maintenance Job.
• Initiate and perform maintenance job
• Collect job information as defined.
• Tidy workplace
• Return spares

Execute Post Maintenance Test.
• Verify facilities and equipment items fulfil their functions on return to service.

Complete Maintenance Job.
• Job closeout to including all documentation.
• Ensure historical information is captured.
A World Class Maintenance Management System

![Diagram showing the process flow of Work Identification, Work Planning, Work Scheduling, Analysis, History Recording, and Work Execution.]

www.ipamc.org

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
Quality Feedback is Essential

Improving/Modify

Equipment in Maintenance

Failure Reports etc

WO Feedback Report

MTBF/MTTR

Performance Costs

Management Review
Level 3

Technical Review
Level 4

Supervisor Review
Level 2

1st Line Review
Level 1

Failure
Reports

www.ipamc.org

Professor John Sharp, University of Salford, UK
"Maintenance Planning and Scheduling"
Job Review

- Review by production/operations of:
  - Work done
  - Quality
- Review by maintenance of completed work orders:
  - Quality of the feedback
  - Variance on man-hours, downtime
  - Follow up work
  - Recommendations
  - May need discussion with the maintainer
CMMS Failure Reporting

Symptom
What the operator sees the “tell tail sign”

Failure Mode
What the tradesman finds wrong

Effect
Downtime, seriousness i.e. total, partial loss and whether planned or unplanned

Failure Cause
The root cause of the failure

Repair Action
What the tradesman does to rectify the fault

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
Simple Failure Reporting
(Maximo CMMS)

Failure Class

1. Problem
Starting
Braking

2. Failure Mode
Battery
Starter

3. Action
Replaced
Recharged
Replaced
The ISO 14224 Standard

Developed from the work carried out by the OREDA organisation (Offshore Reliability Data) who have developed a database of Reliability data.

**ISO14224 defines data collection guidelines aimed at:**
- Helping companies to benchmark themselves or
- As a basis to design new plant/system configurations

**ISO14224 Consists of:**
- Glossary
- Equipment Specific (Equipment Classes, Boundary, Maintainable items, Technical Data, Failure Modes (problems))
- Root Cause codes
- Action Codes
- Method of Detection Codes
- Maintenance Data per event to be collected
- Failure Data per event to be collected
Maintainer’s Feedback

1. Written Job Report
2. Man hours Used
3. Spares Used
4. Repair time (Job Start/Finish)
5. Consequences (i.e.) Downtime
6. Follow up & Extra Work
7. Ideas & Suggestions

Work Order

www.ipamc.org

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
<table>
<thead>
<tr>
<th>Learn from Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>How can we eliminate this failure occurring in the future??</td>
</tr>
<tr>
<td>Could this failure be detected before failure &amp; how??</td>
</tr>
<tr>
<td>Was Fault Finding difficult, can this be improved and how??</td>
</tr>
<tr>
<td>How can planning be improved??</td>
</tr>
<tr>
<td>Would a special tool/equipment improve job execution??</td>
</tr>
<tr>
<td>How else can we reduce the repair time or number of man hours required??</td>
</tr>
<tr>
<td>Did you have all the information to do the job first time?</td>
</tr>
<tr>
<td>Should this job be compiled as a Standard Job, i.e. a potential repeat job?</td>
</tr>
</tbody>
</table>
Work Control

- Work order closing - out
- Reporting work order status
- Backlog control
Typical Work Control Reports

Work status

• Outstanding, e.g. work outstanding for a specified period
• Waiting to start
• In-progress,
• Pending
• Completed
• Man-hours outstanding
• Exception reports - estimated vrs actual

% compliance to plan
Backlog Control

• Backlog is necessary for planning to give flexibility
• An increasing backlog may be a sign of insufficient resources or poor productivity
• Backlog will fluctuate through the year, consider use of contractors to control
• Set targets for backlog per trade
• Regularly review backlog jobs (Part of weekly planning meeting)
  – Are they still valid?
  – What has been the effect of missing the job?
Backlog Definition

• What is your definition and how do you calculate this value?
Backlog

• Usual to calculate for all trades and for main trades
• Backlog can be measured by:
  – Man-hours
  – Man- weeks
  – Crew weeks
• Typical Backlog target is 5 to 6 crew weeks (2003 SMRP Conference)
Measuring Backlog

Backlog (Hours) = Backlog Man- Hours

Backlog (man-weeks) = \( \frac{Backlog \text{ Hours}}{\text{Hours worked per week}} \)

Backlog (Crew Weeks) = \( \frac{Backlog \text{ Hours}}{\text{Available Hours per week}} \)
Effective Planning Program

Should have key elements:
• management commitment to the program
• management defined level of detail required in the work instructions
• consistency in planning between disciplines
• reviews by experienced individuals to minimise and eliminate errors
• feedback to facilitate future planning activities
• use of history profiles
Scope of Maintenance Management

It is essential that maintenance management assign responsibilities and outline methods that may be used in overall planning, scheduling, and coordination functions to accomplish the following:

• Identify and screen plant deficiencies.
• Control minor maintenance work activities within the plant work control system.
• Determine the level of detail necessary to accomplish maintenance tasks and troubleshooting.
• Use maintenance history in planning corrective maintenance and repetitive job tasks.
• Identify needed support to perform maintenance.
• Prepare and assemble a maintenance work package.
• Procedures and work package approval.
• Work package closeout and maintenance history update.
Cutting Maintenance Cost & Increasing Value

Cutting costs has become a high priority, due to the recent economic conditions. Maintenance shutdowns are a major part of the annual budget, and are a target for cost reduction. Using effective maintenance management:

- Costs can be reduced by 30-50 percent from historical levels.
- Using simple and effective maintenance techniques can effect major improvements,
- is critical to the operation of most facilities.
- Without well-planned and executed shutdowns, equipment reliability suffers.
- Proficient maintenance management reduces downtime costs and increases the value of maintenance.
- Maintenance management is about waste reduction (all types of waste).
Maintenance Activities
Continuous Improvement in Maintenance

Strategy & Planning

Maintenance Operations

Continuous Improvement Projects

Performance Measurement

Professor John Sharp, University of Salford, UK
“Maintenance Planning and Scheduling”
Types of information systems

- Computerised maintenance management System - CMMS
- Enterprise Requirements Planning - ERP
- Customer Relationship Management - CRM
- Advanced Planning and Scheduling - APS
- Product Data Management - PDM
- Manufacturing Execution Systems - MES
- Warehouse Management Systems - WMS
- Electronic Procurement Systems - EPS
CONCLUSIONS

Maintenance planning and scheduling contributes to the organisation’s vision and operational objectives, thereby adding value.

Planning and scheduling must be dynamic such that it continually improves.
Thank you for your attention.

Questions?