



ENGINEER ACADEMY

Certified Maintenance & Reliability Professional (CMRP) BOK Guidance Course

Presented by

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Pillar 5: Work Management

Concept & strategy



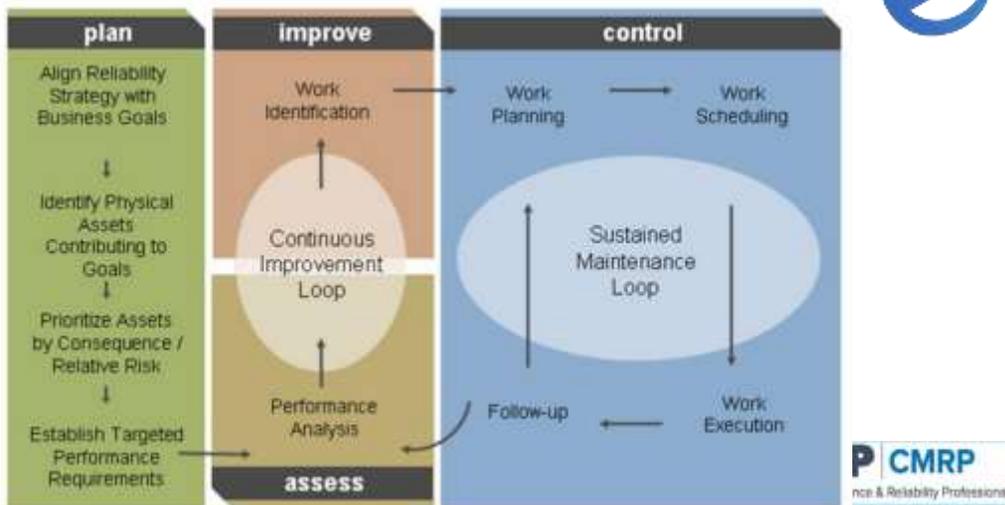
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This subject area focuses on the skills used to get the maintenance and reliability work done. It includes planning and scheduling activities, quality assurance of maintenance activities, stores and inventory management.



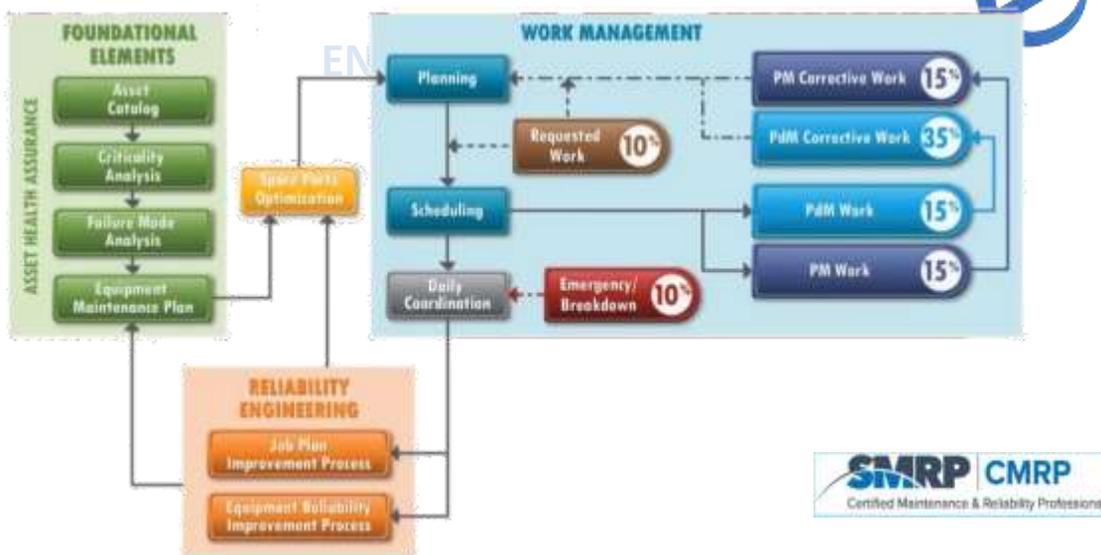
Pillar 5: Work Management

Concept & strategy



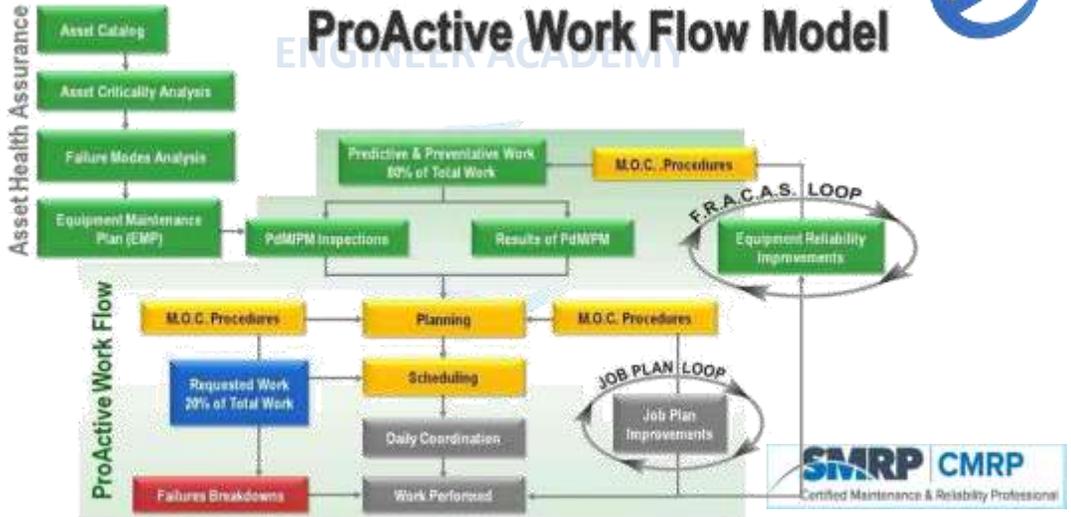
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Concept & strategy



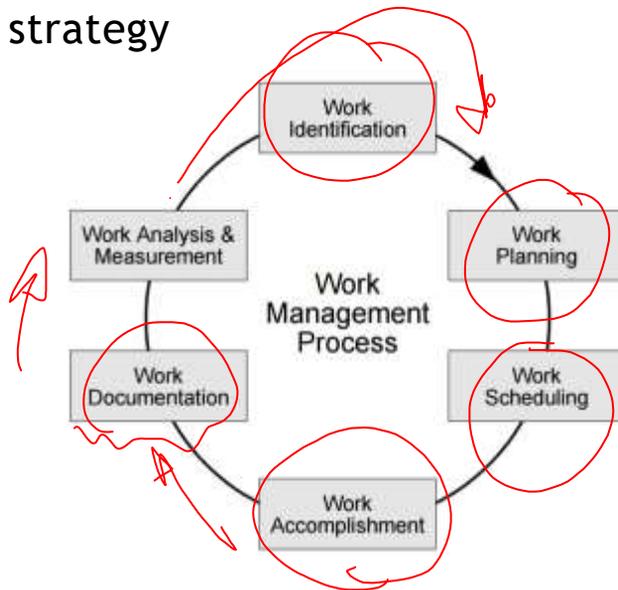
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Concept & strategy



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Concept & strategy



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5.1 Identify, validate, and approve work



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5.1 Identify, validate, and approve work

Work Identification

It is important for those who identify needed maintenance work to understand the different types of actions that can be taken and when they should be applied from a technical standpoint.

Of equal importance is the ability to assess the business justification for the maintenance plan and to develop the needed data support systems for it.

Planning, scheduling, reliability and supply chain efforts rely on the early identification of work to be successful.

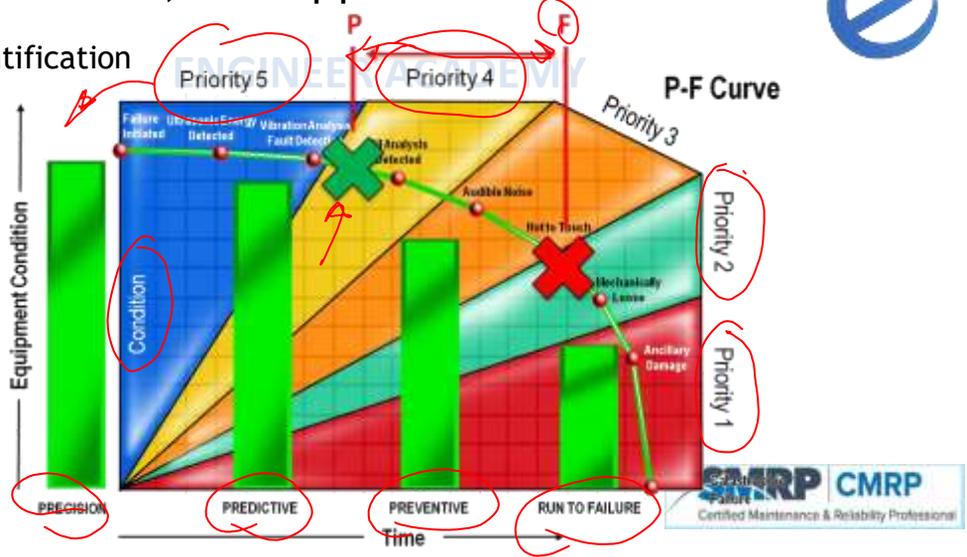


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5.1 Identify, validate, and approve work

Early Work Identification

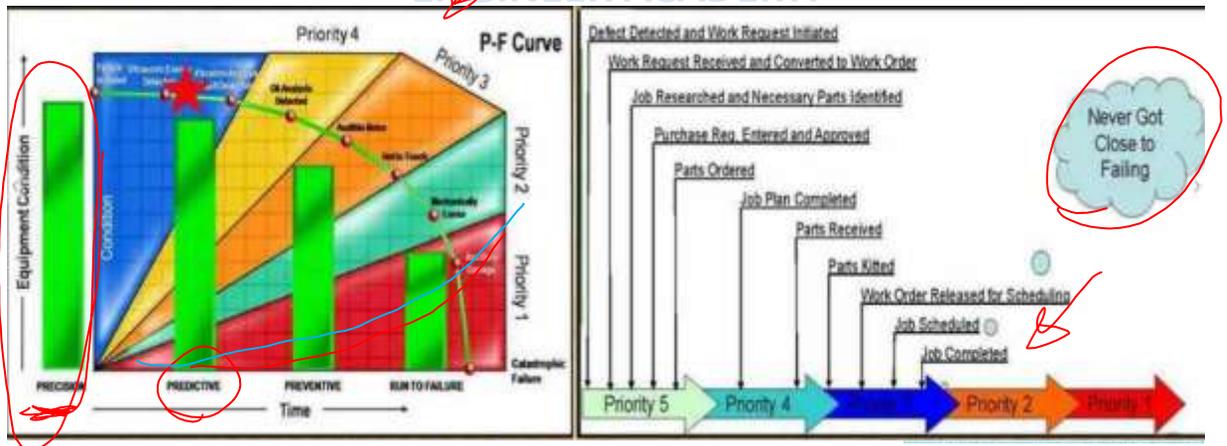


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5.1 Identify, validate, and approve work

Early Work Identification

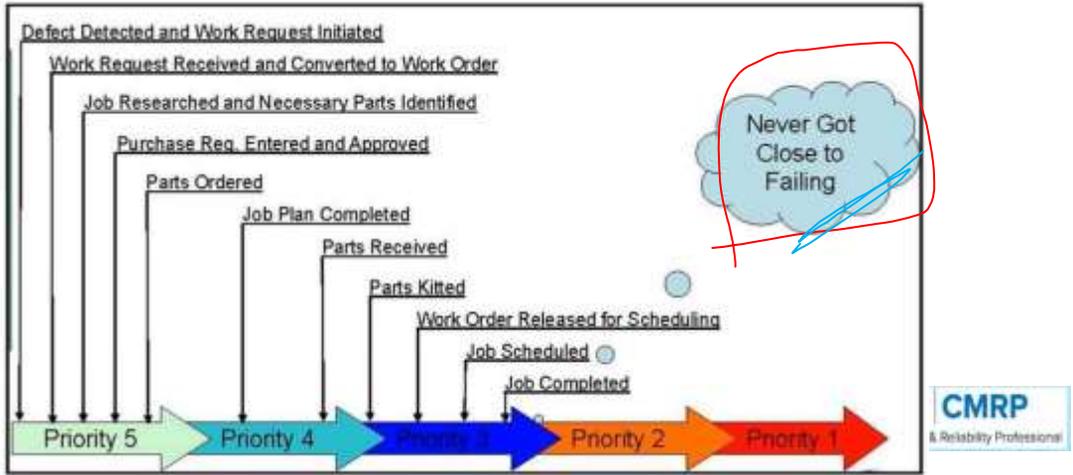


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5.1 Identify, validate, and approve work

Early Work Identification

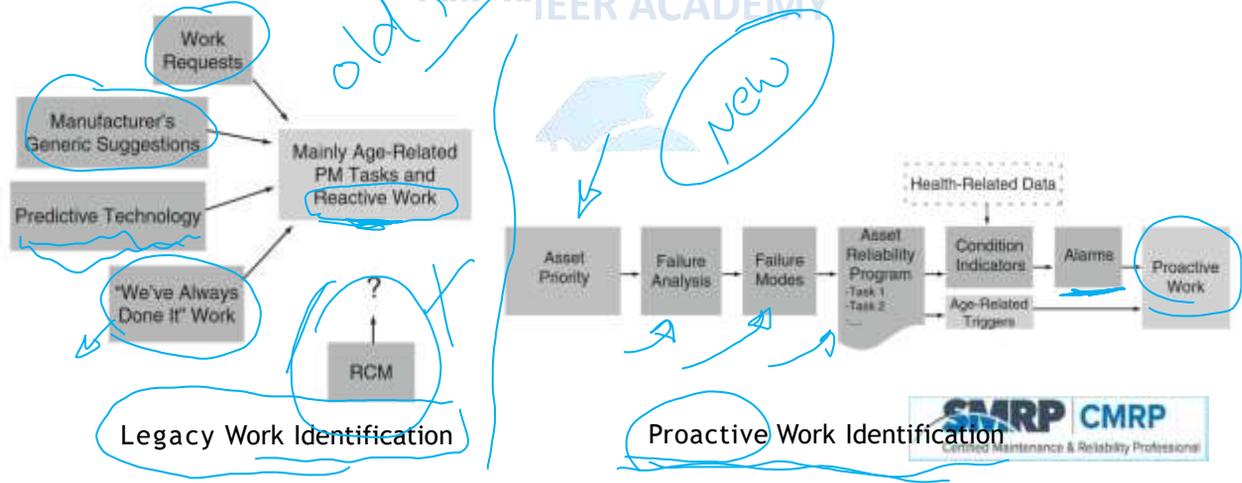


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5.1 Identify, validate, and approve work

Work Identification Sources



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1. Identify, validate, and approve work

Work Identification Sources

- RCM outputs:
 - PDM/CBM work
 - Preventive Maintenance
 - Failure finding tasks
 - RTF planned work
 - Modification & improvement work
- Process data and alarms
- Corrective work
- Emergency work
- Inspection and RBI outputs
- Autonomous maintenance outputs

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5.1 Identify, validate, and approve work

Identified Work Types

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An effective work identification process employs objective methods to manage planned and unplanned work

The work or task has to be validated and classified accurately based on various categories such as preventive maintenance, predictive inspection and testing, corrective maintenance or emergency work.

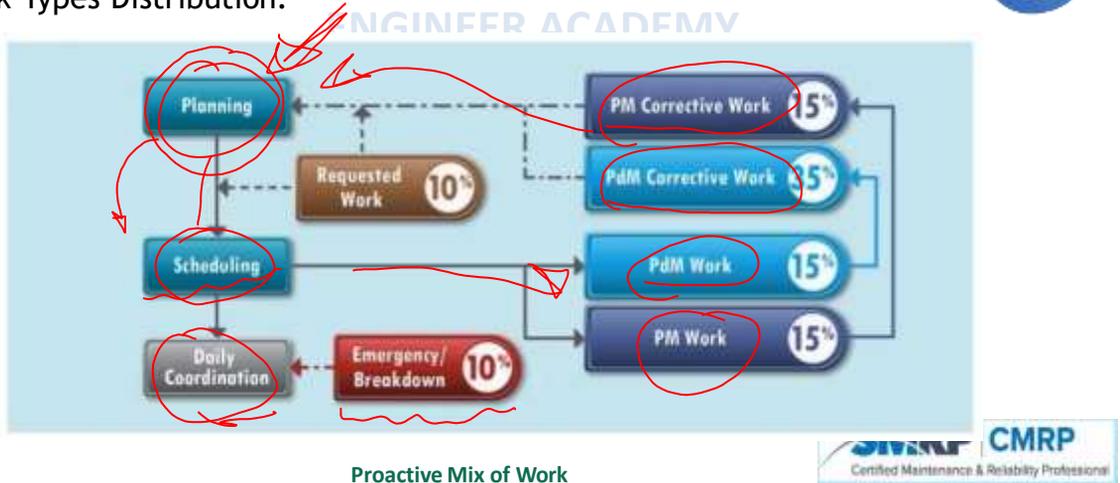


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5.1 Identify, validate, and approve work

Work Types Distribution:

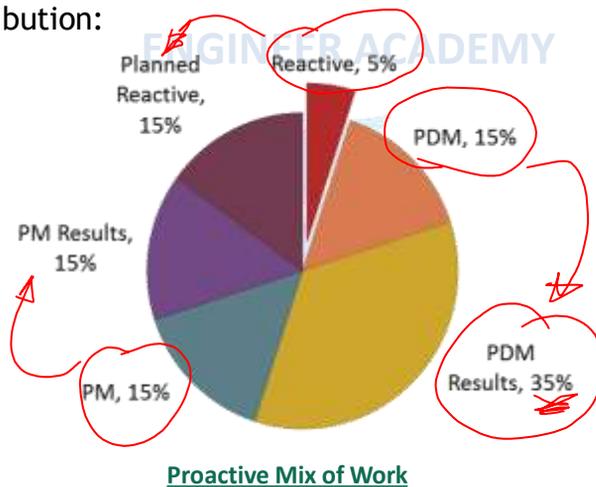


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5.1 Identify, validate, and approve work

Work Types Distribution:



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5.1 Identify, validate, and approve work

Major Maintenance Work Identification Issues:

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- Work Not Identified
- Work identified lately
- Work Identified but Ignored
- Lack of Description
- The Incorrect Equipment is Specified
- Poorly Defined and Communicated Standards
- Incorrectly Prioritized Work



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5.2 Prioritize work

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- Develop formal prioritizing system
- Implement formal prioritizing system



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5.2 Prioritize work

The prioritization of maintenance tasks and activities is defined as:

“the process for approving and selecting the most important work to be planned first, scheduling these tasks, and executing those tasks based on the priority assigned during the identification and planning processes”.



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5.2 Prioritize work

A well-defined and properly executed work prioritization process must be employed to effectively manage resources (manpower, time, tools, and materials) available to the maintenance professional.

An effective prioritization process will assure that:

The most serious problems (safety and environmental) are corrected expeditiously

Proactive maintenance strategies are executed

Critical equipment that has reached functional failure are quickly restored to meet operational requirements.

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5.2 Prioritize work

The following work must also be prioritized, planned, scheduled, and executed in an appropriate amount of time.

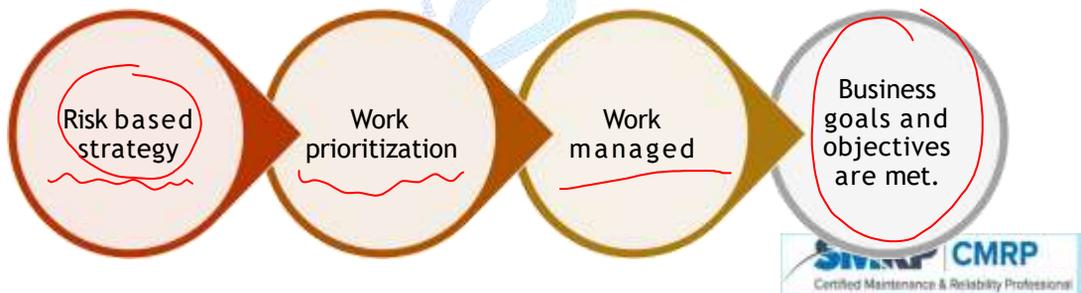


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5.2 Prioritize work

The most successful companies employ a risk-based strategy to assure that work is prioritized and managed to ensure their business goals and objectives are safeguarded.



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5.2 Prioritize work



Job Priority = Equipment Criticality X Job nature (Failure , Preventive, ... etc)

Example priority ranks

- 1 - Emergency. ✓
- 2 - Urgent. ✓
- 3 - Serious. ✓
- 4 - Noncritical Maintenance on Production Equipment. ✓
- 5 - Noncritical Maintenance on Nonproduction Equipment. ✓



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5.2 Prioritize work

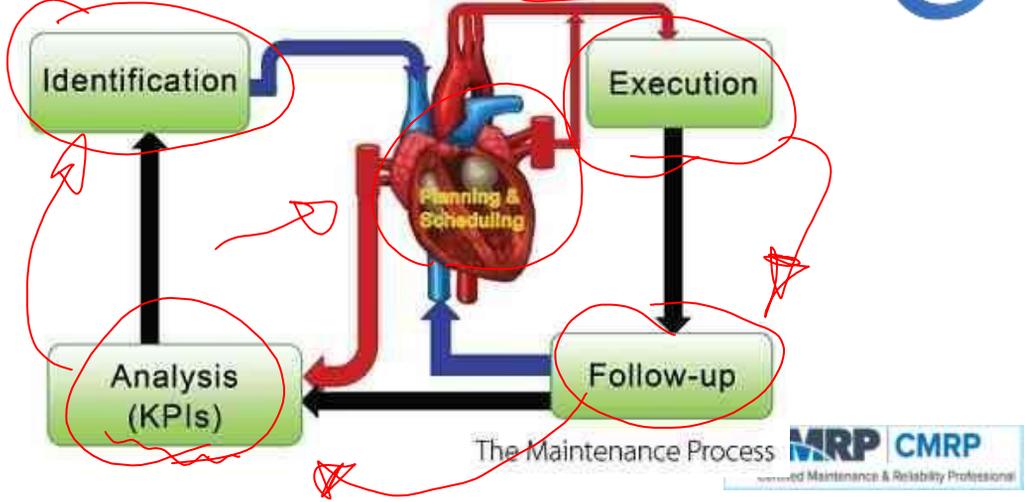


W/O Issuing Priority (based on Risk Level)		Asset Impact (Max Likely Consequences)						
Risk Level	Response	Health and Safety	Negligible	Low	Important	Severe	Catastrophic	
Red = Critical 1 & 2	Immediately allocate all necessary resources, and do the job	No threat to Safety or health if work not done	No threat to Safety or health if work not done	Can lead to health issues, injuries or ailments not requiring medical treatment	Can lead to health issues, injuries or ailments leading a minor injury or first aid	Can lead to serious health issues, injury or ailments leading hospitalization or	Can lead to life threatening health issues, injury or multiple serious	
Orange = High 3 & 4	Immediately plan and prepare, then do the job	Environmental	No threat to Environment if work not done	1) Below license requirements 2) Contamination contained in immediate plant area and addressed by local workers	1) Within license requirements 2) Contamination contained within site boundary and addressed by plant resources	1) Exceed license requirements 2) Contamination requires mobilization of external resources	1) Grossly exceeds license limits 2) Major contamination and local emergency services required	
Yellow = Medium 4 & 5	With priority, plan the work and then schedule the job		No threat to Production and Quality if work not done	1) Quality approaching acceptable	1) Occasional Quality problem detected	1) Quality problems often detected	1) Customer service impacted 2) Quality problems	
Green = Low 2 & 3	In a timely manner, plan the work and schedule the job	Production and Quality	No threat to Production and Quality if work not done	Sum Consequences and Impact of Delay to set Work Order Priority				
Blue = Slight 0 & 1	Gather work together and do as a scheduled campaign			Financial	<\$10K	<\$5K	<\$10K	<\$1,000K
	Work Order Priority (Impact of Delay)							
	Planned Work	Required Work	0	1	2	3	4	5
	Certain problems - if done after first scheduled date	Item has failed or failure to commence	5	5	6	7	8	9
	Absent certain problems - if done after first scheduled date	No effect if done within 3 days	4	4	5	6	7	8
	Likely problems - if done after first scheduled date	No effects if done within 10 days	3	3	4	5	6	7
	Possible problems - if done after first scheduled date	No effects if done within 3 months	2	2	3	4	5	6
	Unlikely problems - if done after first scheduled date	No effects if done within 3 months	1	1	2	3	4	5
	Negligible problems - if first scheduled several times	Major impact if done within 30	0	0	1	2	3	4



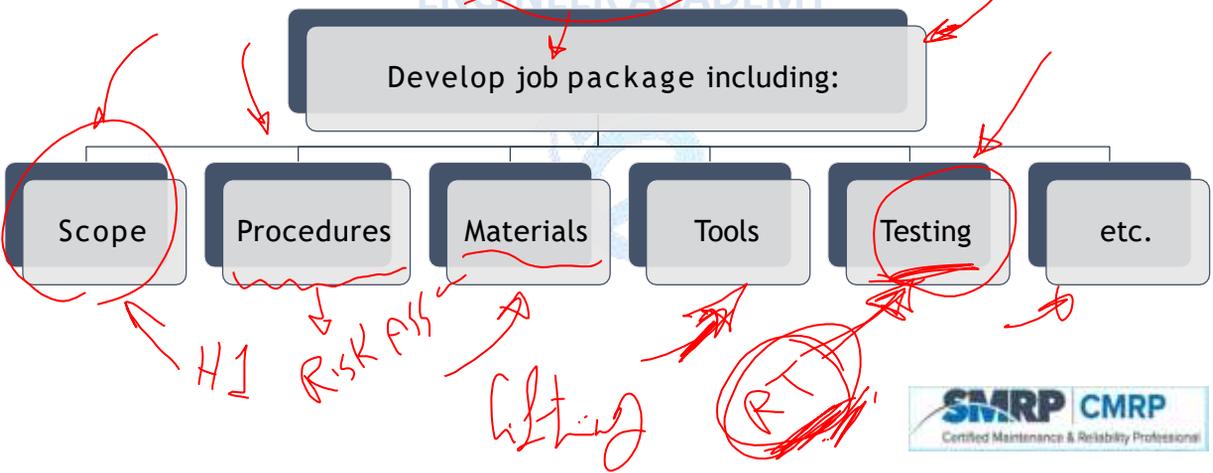
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5.3 Plan work



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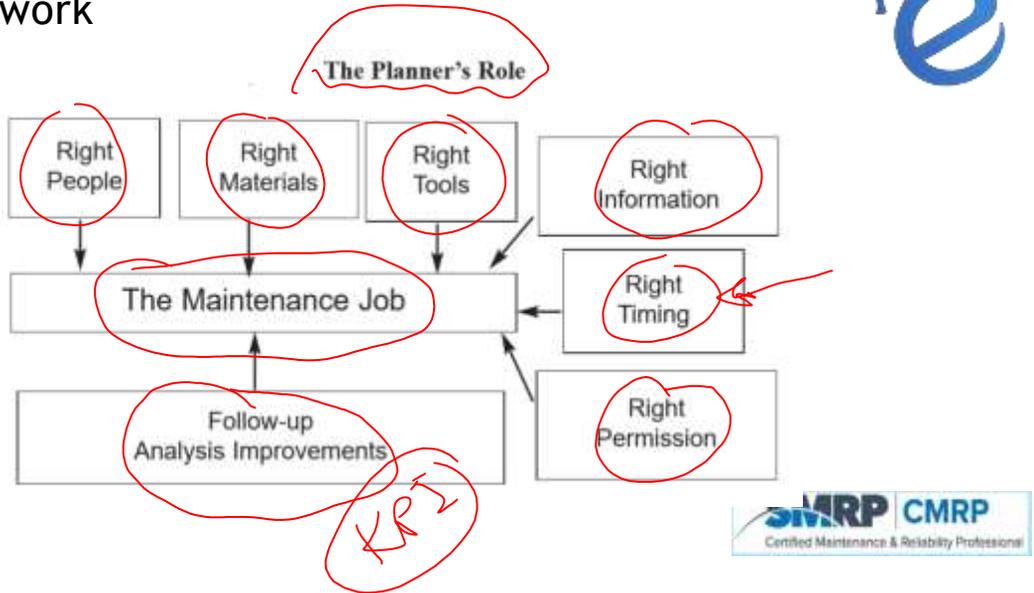
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5.3 Plan work



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5.3 Plan work

Sources for Planned Work

Main - plan

Sources of Planned Work	Percent of Total Planned Work
Results of PM/PdM inspections	30%
Scheduled component replacements	20%
Overhauls/rebuilds	15%
Internal Customer Input (Operators and Supervisors)	10%
Engineering project support	8%
Safety work	5%
Analysis of repair history	5%
Management directed work	4%
Service requests	2%
Accident damage	1%
Total Planned Work	100%

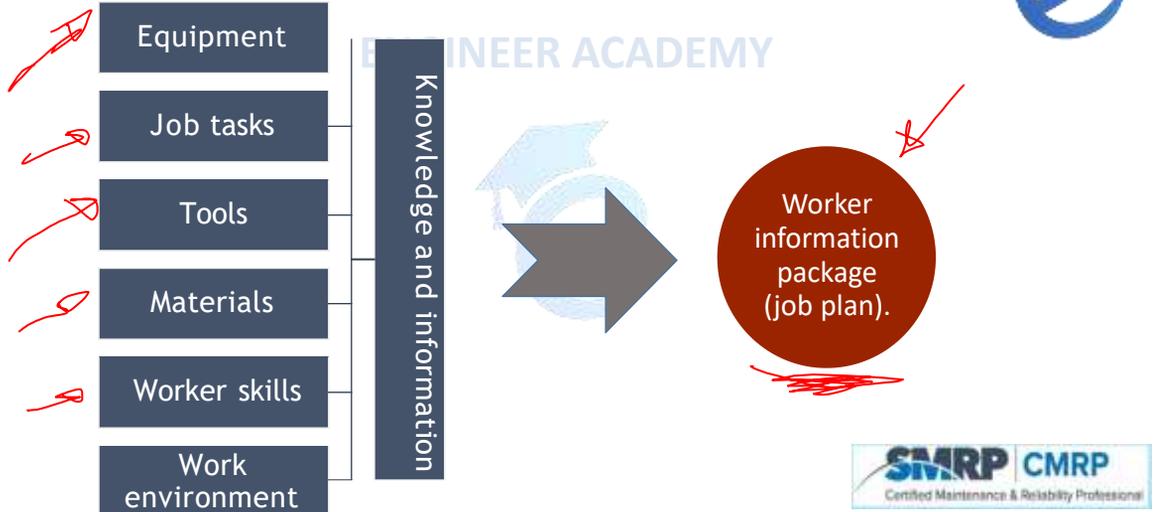


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5.3 Plan work

Knowledge & Information Entries for Job Plan



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5.3 Plan work

The planning function also includes

- Securing of permits and clearances
- Assuring availability of tools and materials
- Estimating time and material costs.



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5.3 Plan work

Work planning leads to increased efficiency and effectiveness of the maintenance workforce, thus producing business value by lowering costs.

Typical Maintenance Worker's Day - Reactive versus Pro-Active

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	Reactive without planning & scheduling	Proactive with planning and scheduling
Receiving Instructions	5%	3%
Obtaining tools and materials	12%	5%
Travel to and from job (both with and without tools and materials)	15%	10%
Coordination delays	8%	3%
Idle at job site	5%	2%
Late starts and early quits	5%	1%
Authorized breaks and relief	10%	10%
Excess personal time (extra breaks, phone calls, smoke breaks, slow return from lunch and breaks, etc)	5%	1%
Subtotal	65%	35%
Direct actual work accomplished (as a percentage of the whole day)	35%	65%

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5.3 Plan work

Work planning leads to increased efficiency and effectiveness of the maintenance workforce, thus producing business value by lowering costs.

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Two Crews without planning		Two Crews with planning	
2	Supervisors	2	Supervisors
0	Planner	1	Planner
20	Total Craftspeople both crews	9	Total Craftspeople both crews
35%	Direct work percentage	65%	Direct work percentage
7.0	Equivalent Full Time workers	12.4	Equivalent Full Time workers

Improved Output from Planning and Scheduling 77%

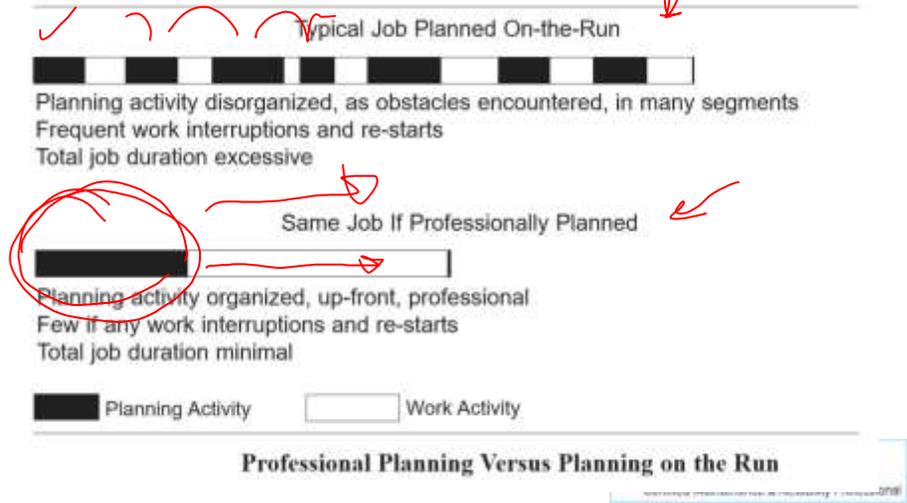
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5.3 Plan work

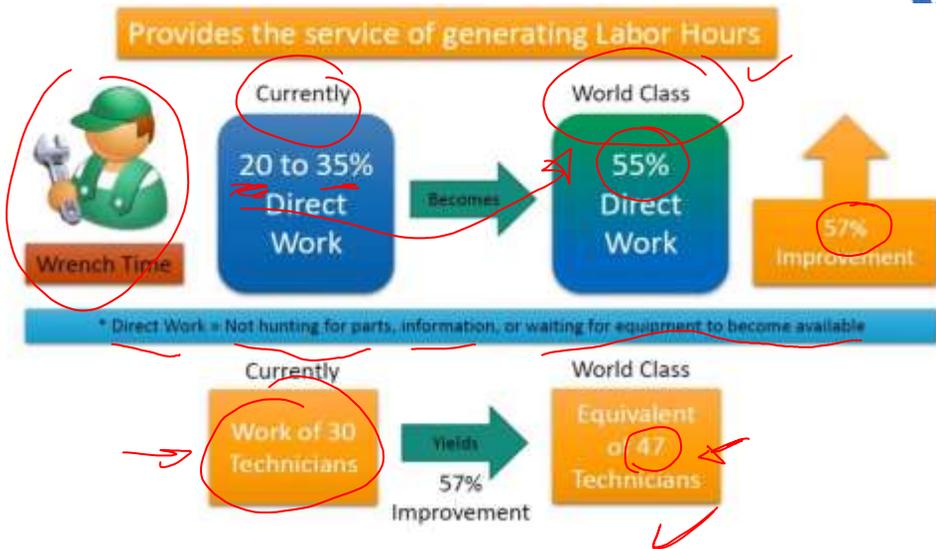
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5.3 Plan work

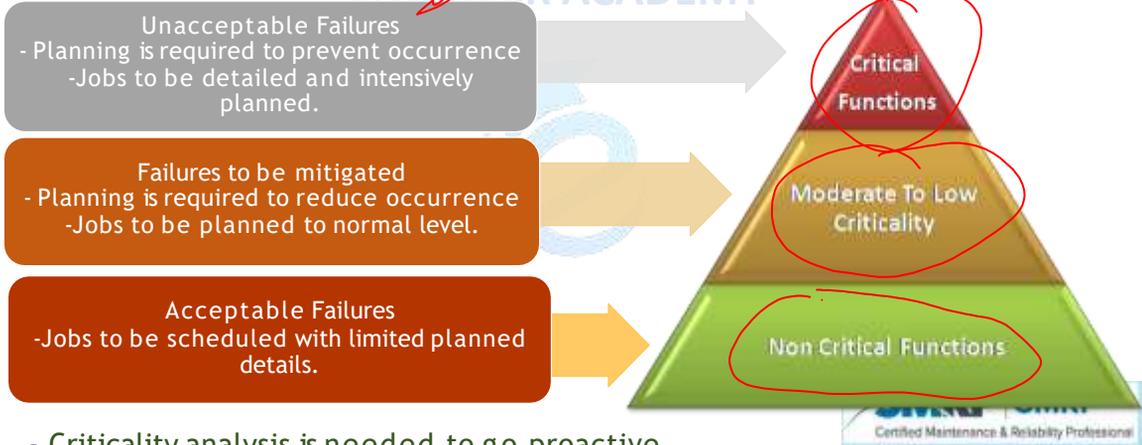


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5.3 Plan work

- What to plan and how much planning is enough. ?



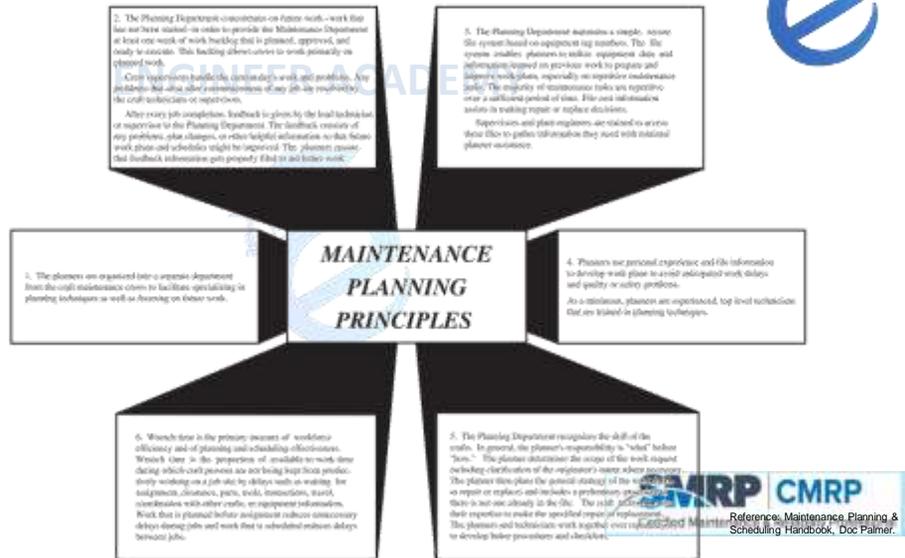
- Criticality analysis is needed to go proactive.

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5.3 Plan work

Planning Principles, Elements & Contents



The six maintenance planning principles.

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5.3 Plan work



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Planning Principles, Elements & Contents

1. The planners are organized into a separate department from the craft maintenance crews to facilitate specializing in planning techniques as well as focusing on future work.



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5.3 Plan work



Planning Principles, Elements & Contents

2. The Planning Department concentrates on future work--work that has not been started--in order to provide the Maintenance Department at least one week of work backlog that is planned, approved, and ready to execute. This backlog allows crews to work primarily on planned work.

Crew supervisors handle the current day's work and problems. Any problems that arise after commencement of any job are resolved by the craft technicians or supervisors.

After every job completion, feedback is given by the lead technician or supervisor to the Planning Department. The feedback consists of any problems, plan changes, or other helpful information so that future work plans and schedules might be improved. The planners ensure that feedback information gets properly filed to aid future work.



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5.3 Plan work

Planning Principles, Elements & Contents

3. The Planning Department maintains a simple, secure file system based on equipment tag numbers. The file system enables planners to utilize equipment data and information learned on previous work to prepare and improve work plans, especially on repetitive maintenance tasks. The majority of maintenance tasks are repetitive over a sufficient period of time. File cost information assists in making repair or replace decisions.

Supervisors and plant engineers are trained to access these files to gather information they need with minimal planner assistance.



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5.3 Plan work

Planning Principles, Elements & Contents

4. Planners use personal experience and file information to develop work plans to avoid anticipated work delays and quality or safety problems.

As a minimum, planners are experienced, top level technicians that are trained in planning techniques.



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what | ~~what~~



5.3 Plan work

Planning Principles, Elements & Contents

5. The Planning Department recognizes the skill of the crafts. In general, the planner's responsibility is "what" before "how." The planner determines the scope of the work request including clarification of the originator's intent where necessary. The planner then plans the general strategy of the work (such as repair or replace) and includes a preliminary procedure if there is not one already in the file. The craft technicians use their expertise to make the specified repair or replacement. The planners and technicians work together over repeated jobs to develop better procedures and checklists.

Certified Maintenance Planner Reference: Maintenance Planning & Scheduling Handbook, Doc Palmer.

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5.3 Plan work

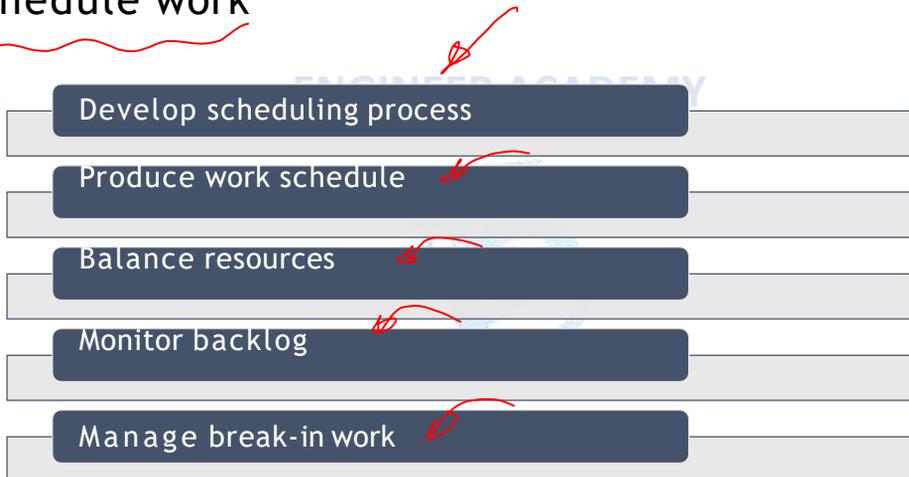
Planning Principles, Elements & Contents

6. Wrench time is the primary measure of workforce efficiency and of planning and scheduling effectiveness. Wrench time is the proportion of available-to-work time during which craft persons are not being kept from productively working on a job site by delays such as waiting for assignment, clearance, parts, tools, instructions, travel, coordination with other crafts, or equipment information. Work that is planned before assignment reduces unnecessary delays during jobs and work that is scheduled reduces delays between jobs.

Certified Maintenance Planner Reference: Maintenance Planning & Scheduling Handbook, Doc Palmer.

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5.4 Schedule work



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5.4 Schedule work



Implementing a scheduling process that incorporates the planning process will enable effective execution of work.

The needs of plant groups and the business need to be considered in the scheduling process.

An understanding of how to balance all factors and create a logical and achievable schedule is required.

The systems that are connected to and support the scheduling process need to be well understood.



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5.4 Schedule work

The purpose of scheduling is to ensure that resources are available at the specified time.

All activities need to be scheduled in order to optimize the resources including labor and material.

The scheduling function starts after planning of work is completed.

Work is scheduled after confirmation that all prerequisite work has been completed.



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5.4 Schedule work

Coordination and communication will require periodic meetings to:

- ✓ Review planned work
- ✓ Review production requirements
- ✓ Ensure material availability
- ✓ Check backlog activities.

(Ext)



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5.4 Schedule work

Work Scheduling is a process in which :

1. All resources required are scheduled within a specified time
2. Includes equipment or assets to be shutdown
3. Requires review of production and sales
4. Resource balancing and assignment agreed to by Maintenance , Operations & Engineering



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5.4 Schedule work

Work Scheduling Considerations:

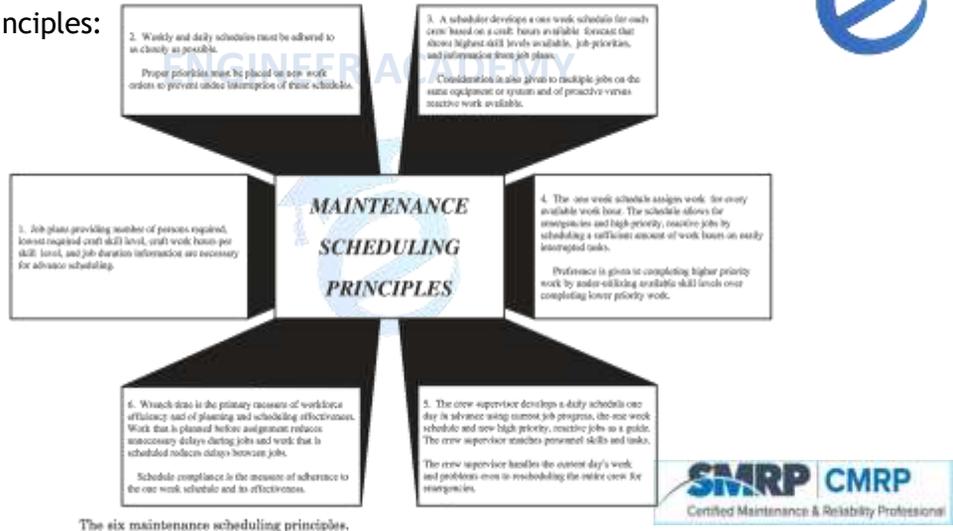
- ✓ Work priority
- ✓ Work already in progress
- ✓ Due or promised date
- ✓ Amount of weekly emergency and breakdown work
- Amount of weekly standing or mirror work
- Preventive maintenance due or overdue
- Amount of weekly work center capacity available



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5.4 Schedule work

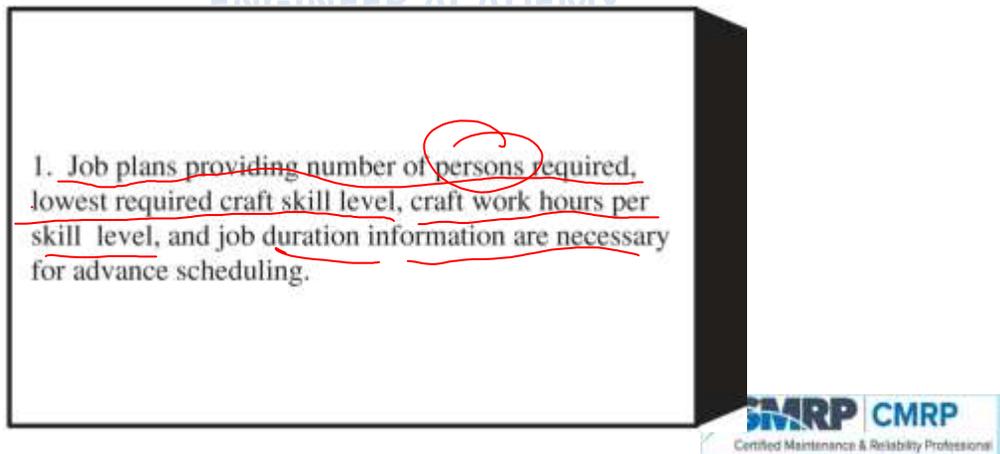
Work Scheduling Principles:



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5.4 Schedule work

Work Scheduling Principles:



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5.4 Schedule work

Work Scheduling Principles:

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2. Weekly and daily schedules must be adhered to as closely as possible.

Proper priorities must be placed on new work orders to prevent undue interruption of these schedules.



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5.4 Schedule work

Work Scheduling Principles:

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3. A scheduler develops a one week schedule for each crew based on a craft hours available forecast that shows highest skill levels available, job priorities, and information from job plans.

Consideration is also given to multiple jobs on the same equipment or system and of proactive versus reactive work available.



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5.4 Schedule work

Work Scheduling Principles:



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4. The one week schedule assigns work for every available work hour. The schedule allows for emergencies and high priority, reactive jobs by scheduling a sufficient amount of work hours on easily interrupted tasks.

Preference is given to completing higher priority work by under-utilizing available skill levels over completing lower priority work.

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5.4 Schedule work

Work Scheduling Principles:



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5. The crew supervisor develops a daily schedule one day in advance using current job progress, the one week schedule and new high priority, reactive jobs as a guide. The crew supervisor matches personnel skills and tasks.

The crew supervisor handles the current day's work and problems even to rescheduling the entire crew for emergencies.

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5.4 Schedule work

Work Scheduling Principles:

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6. Wrench time is the primary measure of workforce efficiency and of planning and scheduling effectiveness. Work that is planned before assignment reduces unnecessary delays during jobs and work that is scheduled reduces delays between jobs.

Schedule compliance is the measure of adherence to the one week schedule and its effectiveness.



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5.4 Schedule work

Scheduling Success factors:

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Should have management support and provided resources and tools

Should be done by experienced & educated professionals

Should be processed as backlog, weekly schedule, then daily work

Must be flexible enough to accommodate emergency work

Shouldn't be scheduled until being "READY"

Having accurate estimates, stores information and contractor information

Having good work order system and accurate work center availability



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5.4 Schedule work

What scheduling can bring to us:

- ✓ Uniform work load balance
- ✓ Utilized resources and saved wastes
- ✓ A time for every job
- ✓ Enables work monitoring
- ✓ Enables good preparation
- ✓ Allows for important work to be done
- ✓ Remove daily urgency pressures



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5.4 Schedule work

Planning & Scheduling in Maintenance Organization

Ratio to the number of technicians

<u>Function</u>	<u>Control Span</u>
Supervision	1:10
Planner/Scheduler	1:20
Maintenance Engineer	1:40

Control spans

Example
 $\frac{10}{20} = \frac{1}{2}$
 $\frac{20}{40} = \frac{1}{2}$



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5.5 Execute work

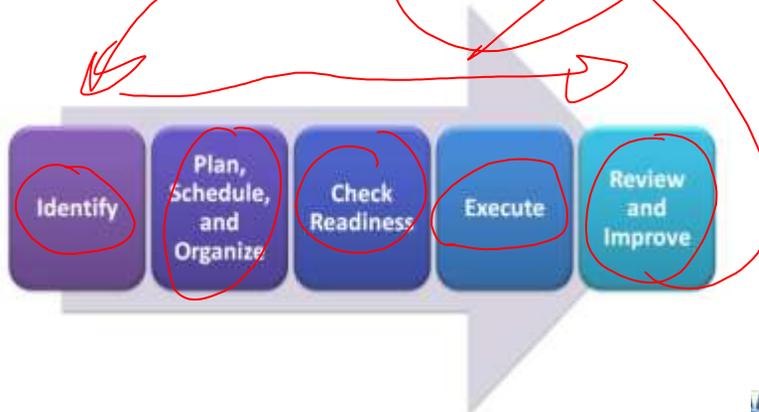


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5.5 Execute work

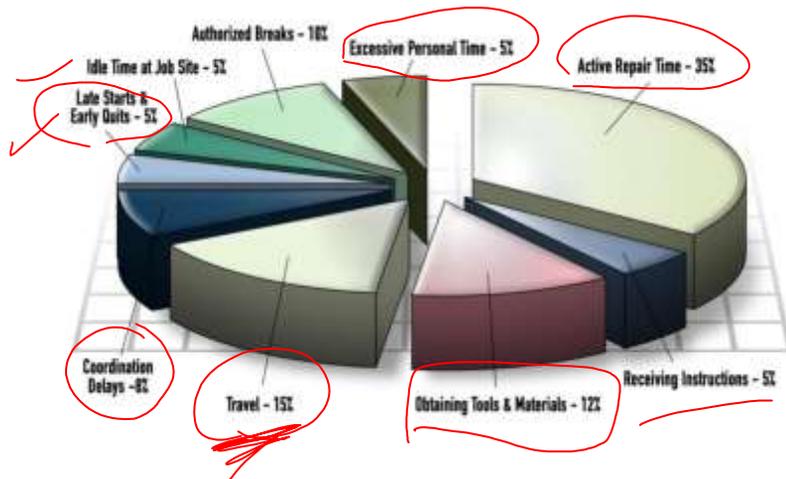
Execution Role in the Cycle:



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5.5 Execute work

What Problems do we have?



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5.5 Execute work

What needs to be focused on?

- The methods and best practices for effective use of maintenance resources.
- The skills of the maintenance workforce must satisfy the collective needs of the maintenance plan.
- The systems needed to properly support the management of critical resources should be readily available and well understood.
- The criteria for the appropriate use of the various methods of making spare parts available to the maintenance function, along with the benefits and the risks associated with each, need to be known.



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5.5 Execute work

What needs to be focused on? (Cont.)

- Methods for sound cost management of the maintenance function and how the value of the work performed impacts the business financial metrics needs to be thoroughly understood.
- Health, Safety and Environmental guidelines are used to develop and implement efficient, comprehensive and proactive programs to ensure a safe and environmentally compliant work environment.



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5.5 Execute work

Supervisors should consider several issues when making work assignments. For example, after reviewing the work order, the supervisor may ask:

- What level of experience is required to complete the work?
- Do I need an experienced craft technician or can an apprentice perform the assignment?
- Do I have someone on my crew who needs experience performing a certain task?
- Are there specialty skills required to perform this job?
- Is a technician with those skills available on this shift?



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5.5 Execute work

What Roles do we have?



Relationship Expectations

Operations	Maintenance Planners
Provide data, expert analysis, and advice on maintenance performance	Permit operations to describe, approve, and control timing of work to be done
Demonstrate equipment "ownership"	Coordinate equipment downtime
Perform failure analysis when equipment fails unexpectedly	Assist with development of annual overhaul/shutdown schedules
Provide maintenance personnel with assistance as needed during equipment outages	Communicate with work requestor for complete clarity of work to be performed
Be aware of equipment reliability status at all times	Discuss with operating unit how work will be performed and what will be involved
	Communicate with maintenance and operations expectations of work before equipment is taken out of service
Maintenance	Management/Supervisors
Provide expert craftsmanship and execution of precision maintenance techniques during maintenance activities	Keep all involved departments up-to-date on status of equipment activities and ensure smooth shift-to-shift turnovers
Communicate clearly with operating unit and within the maintenance department, details about and status of equipment during servicing	Ensure time to "fix it right the first time" so as not to impact operations needlessly
Communicate with operator before, during and after all equipment maintenance activities	

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5.5 Execute work

What Roles do we have?



RACI CHART FOR WORK EXECUTION

Tasks	Maintenance Supervisor	Maintenance Planner / Scheduler	Maintenance Manager	Production Supervisor	Tradesman	Reliability Engineer
Decisions / Functions						
Work Planning and Scheduling Process	C	R	A	C	C	
Managing with Leading and Lagging KPIs	R	R	R	R	I	I
Execute PM to Specifications	R	C	A		R	C
Execute CM Work to Specifications	R	C	A		R	C
Adjustments to PM Procedures based on KPIs	C	C	A		C	R
Adjustments to CM Procedures based on KPIs	C	C	A		C	R
Rework	R	C	A		R	C
Work Order Close-Out	A	C			R	C

Responsibility	"the Doer"
Accountable	"the Buck stops here"
Consulted	"in the Loop"
Informed	"kept in the picture"