HYPERWIND

FMSO module - "PRACTICAL CASE" 1/2

FMSO MODULE

AIM The aim of this practical case study is to highlight the main benefits of using the FMSO module first when the preventive and / or the contractual maintenance tasks are scheduled and then when unexpected failures appear and the schedule has to be modified as corrective maintenance tasks are required and some already scheduled tasks may be obsolete.

CASE SETUP

- 1 wind farm / 4 Wind Turbines (WT)
- 3 maintenance teams
- 5 types of logistical means
- 5 types of failures
- 4 preventive + 5 corrective maintenace tasks
- 5 types of preliminay preparations

Logistical means

Type	Delay	Cost ($/hour)	Minimal reservation
	★	★	★
	★★	★★	★
	★★★	★★★	★★★
	★★	★★	★★
	★	★	★★

Preliminary preparations

Preparation	Cost	Duration
Drain the lubrication system	★★	★
Disconnect & shunt generator electric parts	★	★
Dismount the rotor	★★★	★★
Remove the gasket of the main bearing	★	★
Drain & fill the cooling system	★	★

Failures

Failure	Maintenance task	Criticality
F1 Grease pump KO	▲	⚠
F2 Blade crack	▲	🛑
F3 Main bearing clearance	▲	🛑
F4 Cooling system pump KO	▲	⚠
F5 Cooling system hoses cracks	▲	⚠

Maintenance tasks description

	Task	Logistical means	Preliminary preparation	Spare parts	Periodicity	Duration	Cost
Preventive	● Verify main bearing lubrication		• Main bearing gasket removal	-	Every 10 to 14 weeks	★	★
	● Verify main bearing clearance		• Main bearing gasket removal	-	Every 22 to 26 weeks	★	★
	● Verify generator insulation		• Disconnect & shunt generator electric parts	-	Every 48 to 54 weeks	★	★
	● Blades inspection	+	-	-	Every 22 to 26 weeks	★★	★★
Corrective	▲ Grease pump replacement		• Lubrification system draining • Main bearing gasket removal		-	★★	★★
	▲ Blade repair	+	-	-	-	★★	★★★
	▲ Main bearing replacement		• Rotor dismounting		-	★★★	★★★
	▲ Water pump replacement		• Cooling system draining & filling		-	★	★★
	▲ Cooling system hoses replacement		• Cooling system draining & filling	-	-	★	★

SCHEDULING THE PREVENTIVE MAINTENANCE TASKS

HOW IT WORKS

Optimal schedule

- ✓ Minimize total cost
- ✓ Comply with contractual constraints
- ✓ Compatible with operational constraints

Total cost = Maintenance cost + Production loss

Contractual constraints : maximum acceptable length for the period between two occurrences of a preventive maintenance

Operational constraints : maintenance teams & logistical means availability, tasks sequencing

	Mar.			Apr.				May				Jun.				Jul.				Aug.					Sep.
Weeks	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24	W25	W26	W27	W28	W29	W30	W31	W32	W33	W34	W35	W36
WT #1	●		●					●								● ●										
WT #2	●		●					●								● ●										
WT #3	●		●						●							● ●										
WT #4	●			●				●									● ●									

The use of logistical means is optimized : the blades of all the wind turbines are inspected with only one drone reservation

Two tasks that require the same preliminary preparation are grouped

Version A

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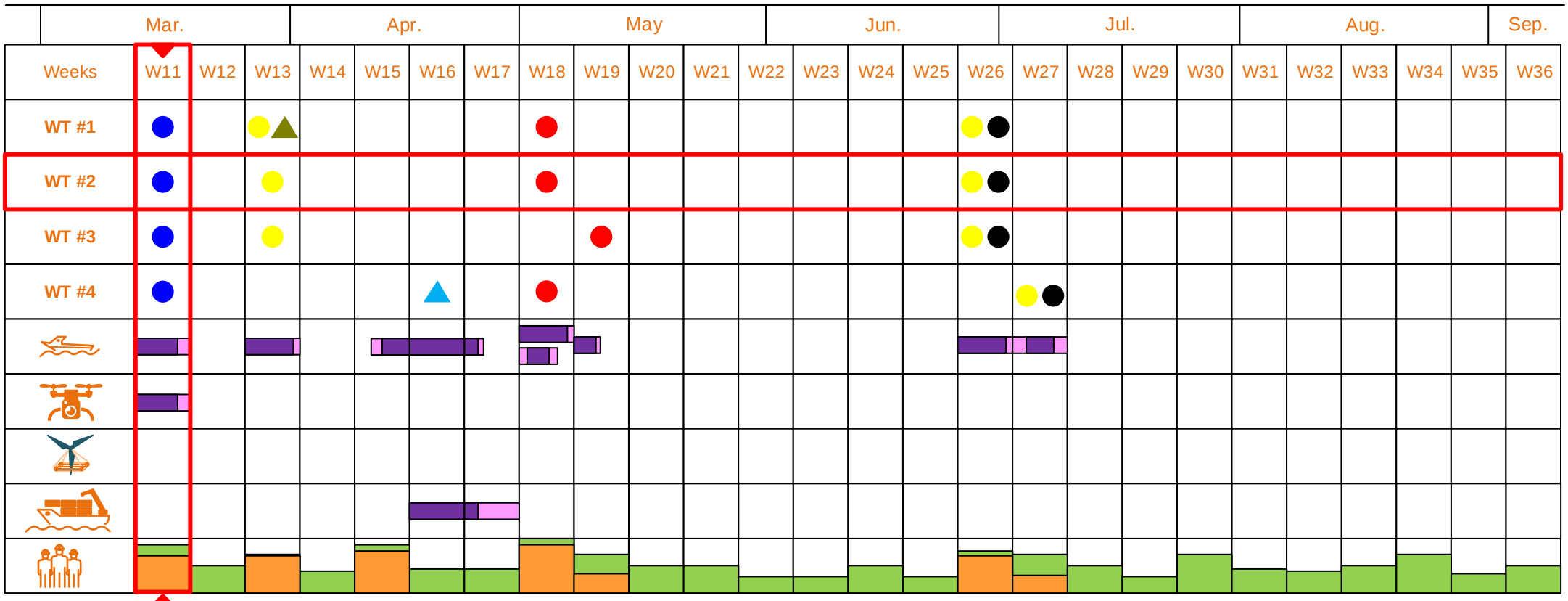
DYNAMIC UPDATE

As time goes by, different wind turbine failures occur and the maintenance schedule needs to be updated by incorporating the required corrective maintenance tasks. Some already scheduled tasks may became obsolete or need to be rescheduled.

CURRENT MAINTENANCE SCHEDULE



- Detection of a **« BLADE CRACK »** on WT #2
  - WT #2 will be stopped until the repair
  - All the tasks scheduled on WT #2 before the repair are potentially obsolete

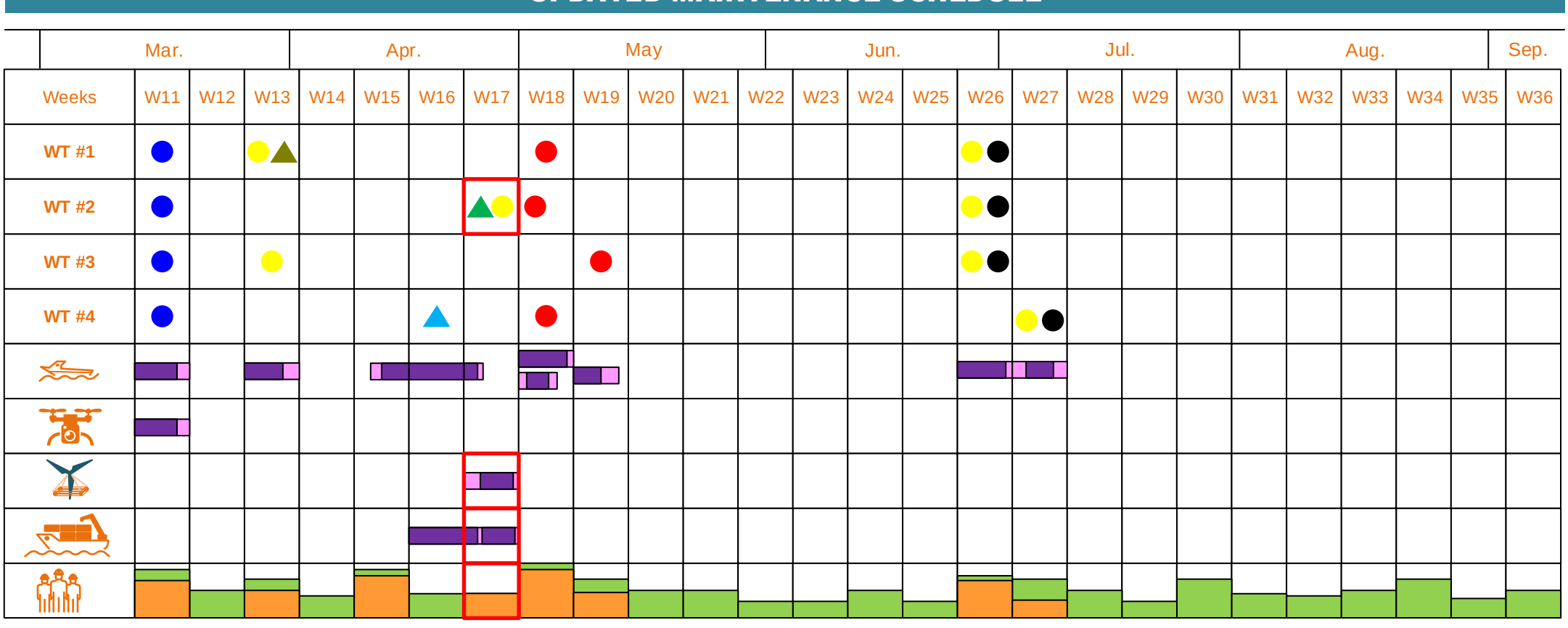
CONTEXT ANALYSIS

- No spare part is required
- Two logistical means required :
  - the « blade platform »
    - minimal reservation = 1 week
    - minimal delay before lease = 2 weeks
  - the « crane vessel »
    - minimal reservation = 2 weeks
  - minimal delay before lease = 3 weeks

Integration scenarios

Name	S1	S2
About	Schedule maintenance as soon as possible	Use remainders of existing logistical means reservations
When	W14	W17
Production loss	★	★★
Logistical means cost	★★★	-

UPDATED MAINTENANCE SCHEDULE



The task « Blade repair » ▲ is scheduled in W17 so that it can use the same reservation of as the task ▲ programmed on WT #4 during W16 and W17

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