

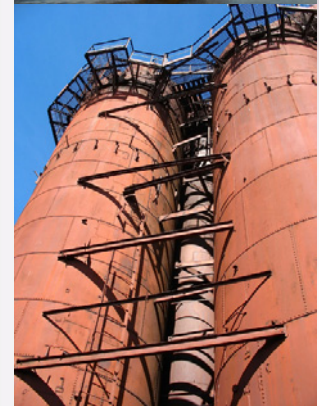
# Mutual Consultants



RaB0904

## Rationalisation and Balancing of Maintenance Schedules

### RaB



*“Packaging a list of maintenance tasks into a maintenance schedule which is optimised for work content and which contains a minimum of peaks and troughs over time”*

RaB

## *Overview of Rationalisation and Balancing of Maintenance Schedules (RaB)*

### Definition

Rationalisation and Balancing involves packaging a list of maintenance tasks for an asset into a maintenance schedule which is optimised for work content and which contains a minimum of peaks and troughs over time.

### The Problem

The maintenance requirements of any sizeable physical asset are likely to include a large number of maintenance tasks with a wide range of "natural" intervals. Determining how best to package these tasks into a sensible maintenance schedule can be a considerable challenge.

### Rationalisation

In practice the task intervals for a list of maintenance tasks for an asset have to be modified to suit local conditions; this is called 'Rationalisation'. The number of possibilities for rationalising the task intervals can be significant and so this stage of maintenance task development is usually sub-optimal. If it is performed correctly, the life-cycle costs will be optimised; if it is not, the life-cycle costs can easily be higher by 10% or more.

### Balancing

After rationalisation, it is often necessary to 'smooth' the workload in order to avoid excessive peaks and troughs. This process is called 'Balancing' and the nature of the industry and the operating context will dictate the extent to which balancing is necessary. Using our unique software, we can quickly balance the workload by "offsetting" the point at which tasks are first performed (but leaving the task intervals unaltered).

### Our Approach

We have developed unique software which enables us to optimise maintenance tasks quickly by automatically "rationalising" the task intervals to produce the minimum number of man-hours over the asset life-cycle. The software includes tools to simplify workload "balancing" (smoothing).

### Mutual Consultants' Role

We work with you to package your maintenance schedule and smooth the workload in order to minimise life cycle costs. The result is a more manageable, maintenance schedule that tells you both what must be done and when.

### Benefits

Your list of maintenance tasks is converted into a maintenance schedule which is:

- Rationalised to minimise the total man-hours over the life cycle
- Balanced to provide the smoothest possible workload over time
- Comprehensibly packaged and presented (you are told what is due and when it is due, not simply how often it should be done).

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# Rationalisation and Balancing

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**WHAT IS RATIONALISATION AND BALANCING?**

Rationalisation and Balancing involves packaging a list of maintenance tasks for an asset (ie scheduled jobs that have to be carried out at a specified interval) into a maintenance schedule which is optimised for work content and which contains a minimum of peaks and troughs over time.

**RATIONALISATION**

The principles of Rationalisation are illustrated best by the use of some simple examples. Let’s assume that, after a maintenance review, the following tasks have been identified for a particular machine:

Maintenance Task Details			
ID	Time	Interval	Hrs/Yr
A	1 hr	1 wk	52
B	2 hr	4 wk	26
C	8 hr	5 wk	83.2
D	20 hr	8 wk	130
E	50 hr	10 wk	260
F	100 hr	25 wk	208
<b>Total</b>			<b>759.2</b>

If each task can be done at the interval specified above (known as the “natural” interval) then the machine will undergo maintenance for 759.2 hours each year.

Historically, however, most organisations like their maintenance task intervals to be neat integer multiples of each other because this makes packaging and scheduling the resulting exams/inspections much simpler.

This means that the above tasks are unlikely to be performed at their natural intervals; for example, will the Production Manager tolerate the machine being down for 2 hours in week 4, followed by another 8 hours downtime a week later?

**The “Rationalisation” Problem**

When packaging these tasks into a maintenance schedule, task intervals are often forced to be multiples of the interval of the most frequent task or forced to fit into a sequence dictated by the least frequent task, or a combination of both.

Looking at the task intervals in the above example, it might be tempting, therefore, to combine them into “exams” that are performed at 1 week, 5 weeks and 25 weeks. These are known as the “rational” intervals.

The problem, however, is that some of the tasks can no longer be done at their natural interval; they are “slotted in” to one of the rational intervals.

If the consequences of failure are severe so that it is not possible to extend natural intervals then the above tasks would be “rationalised” into a 25 week cycle as follows:

Maintenance Task Details				Rationalised to 25 week cycle	
ID	Time	Interval	Hrs/Yr	Interval	Hrs/Yr
A	1 hr	1 wk	52	1 wk	156
B	2 hr	4 wk	26	1 wk	156
C	8 hr	5 wk	83.2	5 wk	811.2
D	20 hr	8 wk	130	5 wk	811.2
E	50 hr	10 wk	260	5 wk	811.2
F	100 hr	25 wk	208	25 wk	455
			<b>Total</b>	<b>Total</b>	<b>1175.2</b>

Some tasks are now being performed far too frequently, forcing the annual maintenance hours up to 1175.2, dramatically increasing life-cycle costs.

Just because our lives are regulated by a weekly cycle does not mean that a machine's maintenance should be. Manually driven maintenance management systems tended to work on daily, weekly and monthly cycles but with a computerised Maintenance Management System this need not be the case.

For example, the ideal task interval to, say, change a particular filter may be 10 days - as our lives are regulated around days of the week it is not uncommon to find that the task is done "every Monday morning" (ie every 7 days). With a computerised Maintenance Management System, however, it is possible to schedule this task to be performed every 10 days (ie not necessarily weekly or monthly etc). If this seemingly simple change is made, the effort and materials consumption for this particular task will be reduced by more than 40%.

These examples are trivial but for a sizeable installation it is difficult to optimise and minimise the life cycle costs if you are to achieve a balanced workload (because the number of possible task intervals can be very high). As a result, this stage of maintenance schedule development is rarely performed well (if at all).

### The “Rationalisation” Solution

There are significant savings to be made to the maintenance cost of an asset over its life-cycle if the maintenance task intervals are “rationalised” to their (near) optimal interval (particularly in a large plant with many tasks).

This is difficult to do for a sizeable installation because the number of possible task interval combinations to consider can be very high. As a result, this stage of maintenance schedule development is rarely performed well (if at all).

To illustrate the potential benefits, the above 25-week rationalisation is repeated, but this time with a maximum task interval of 24 weeks.

This provides many more “slots” into which the natural intervals can be placed.

Maintenance Task Details				Rationalised to 24 week cycle	
ID	Time	Interval	Hrs/Yr	Interval	Hrs/Yr
A	1 hr	1 wk	52	1 wk	52
B	2 hr	4 wk	26	2 wk	-
C	8 hr	5 wk	83.2	3 wk	-
D	20 hr	8 wk	130	4 wk	130
E	50 hr	10 wk	260	6 wk	-
F	100 hr	25 wk	208	8 wk	455
				12 wk	-
				24 wk	216.7
			<b>Total</b>	<b>Total</b>	
			<b>759.2</b>	<b>853.7</b>	

There has now been a massive drop in the total annual maintenance hours and, hence, a corresponding drop in life-cycle costs.

With a trivial example, the problem is easily solved. However, with hundreds, or even thousands, of natural task intervals it becomes impossible to solve it manually.

To address this problem, we have developed a unique software package which enables us to optimise your maintenance schedule quickly by automatically "rationalising" the task intervals to produce the minimum number of man-hours per complete exam cycle.

Rationalisation entails adjusting the natural task intervals so that they all become integer multiples of the minimum interval (in order to facilitate subsequent balancing and scheduling) whilst still remaining optimised for life cycle costs.

## BALANCING

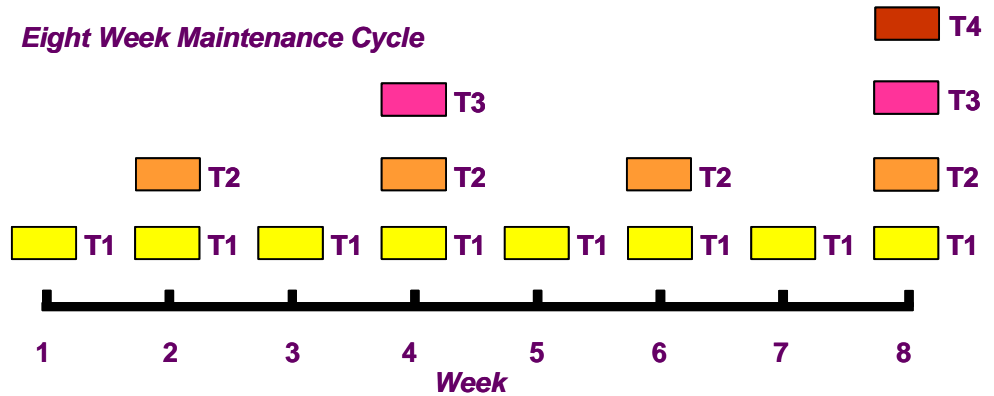
After maintenance task intervals have been rationalised, it is then necessary to smooth out peaks and troughs in the workload over time and to package the tasks into exams.

### The “Balancing” Problem

A side effect of rationalising task intervals for optimum life cycle cost is that it causes peaks and troughs in the maintenance workload. This is illustrated in the simple example below, which has 4 tasks arranged to repeat over an **eight-week** maintenance cycle:

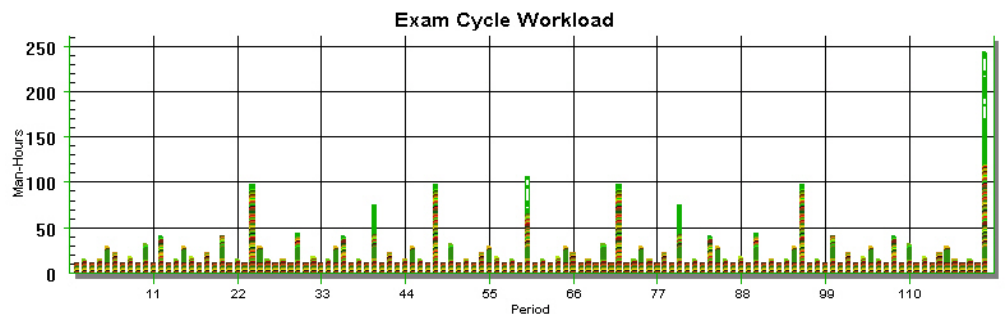
- Task T1 has an interval of **1 week** so it is performed **eight** times in the cycle

- Task T2 has an interval of **2 weeks** so it is performed **four** times in the cycle
- Task T3 has an interval of **4 weeks** so it is performed **twice** in the cycle
- Task T4 has an interval of **8 weeks** so it is performed only **once** in the cycle.



Clearly, there are weeks in this cycle (notably week 8) when the maintenance workload is greater than it is in other weeks. This unbalanced workload can make staff utilisation inefficient.

The following diagram is a more realistic illustration of this problem with a large number of maintenance tasks - the ratio of highest/lowest bar (representing peaks and troughs in workload) is about 24 to 1.



In practice, most maintenance departments balance their workload by working routine maintenance around breakdown maintenance. This only works, however, if the routine workload does not have excessive peaks and if the breakdown/corrective maintenance workload is not too excessive.

If there are excessive peaks in routine workloads or if the breakdown/corrective workload is very high, it is not uncommon for a backlog to develop of routine maintenance tasks. Running a backlog of routine maintenance tasks can have serious repercussions depending on the nature of the industry.

In the worst case, failure to carry out routine maintenance tasks that are important for safety or environmental integrity can expose the workforce and/or public to unacceptable at risks. If the backlog of tasks relates to plant output or availability there is likely to be a reduction in reliability which in turn will increase the breakdown/corrective workload.

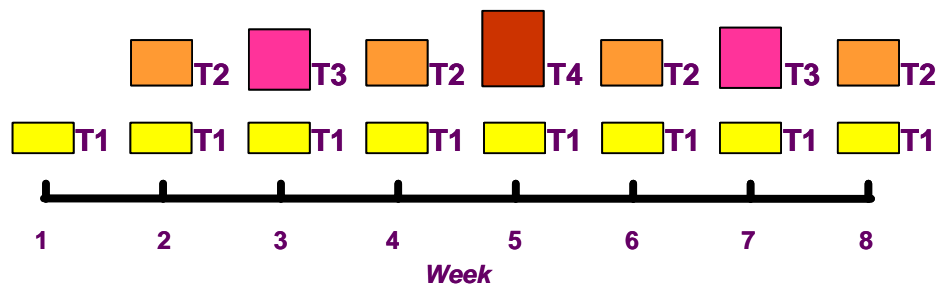
The situation can be helped if steps are taken to “balance” the routine maintenance workload so that the workload is smoothed to avoid excessive peaks and troughs. This process is called “Balancing” and the nature of the industry and the operating context will dictate the extent to which balancing is necessary.

The “Balancing” Solution

There are significant benefits to be gained by avoiding excessive peaks and troughs in routine maintenance workload. In particular, staff utilisation will be more efficient and one of the most common causes of a maintenance backlog will be removed.

The simple example illustrates what needs to be done:

*Balanced Eight Week Maintenance Cycle*



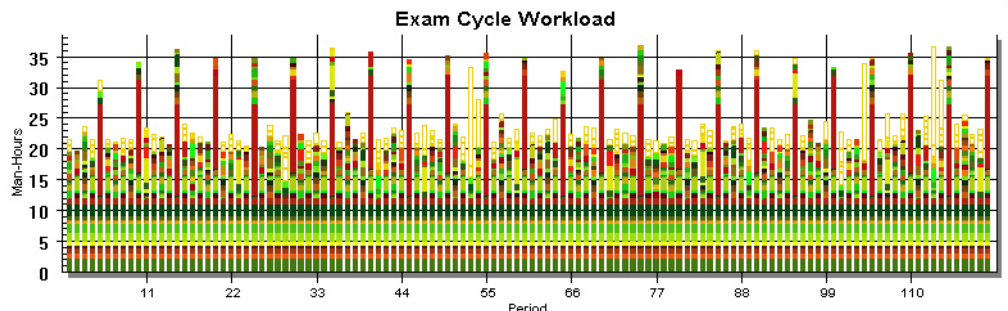
Task T3 retains its 4 week interval, but it has been brought forward by one week so that it is never done at the same time as task T2.

Task T4 retains its 8 week interval, but has been brought forward by 3 weeks. The result is a much smoother, more predictable workload.

Workload balancing is difficult to do for a sizeable installation and so this stage of maintenance schedule development is rarely performed.

To address this problem, we have developed a unique software package which enables us to "offset" the point at which tasks are first performed (but leaving the task intervals unaltered).

The following diagram illustrates the result of balancing the more realistic tasks shown in the previous section. The ratio of highest/lowest bar (representing peaks and troughs in workload) has dropped to around 2 to 1 from 24 to 1.



Without the assistance of the Balancing module of the software, it would be impossible to complete this part of the Rationalisation and Balancing process.

## PACKAGING TASKS

Once the tasks have been balanced, there will be a number of **unique combinations of tasks** which need to be performed one or more times throughout the whole exam cycle. Our Rationalisation and Balancing software identifies these unique combinations of tasks (or “task packages”) so that they can be named for future reference.

For the purposes of the discussion below:

- **"one period"** is defined to be the interval of the most frequently performed task within a maintenance schedule (perhaps 14 days, 4 weeks or whatever). No task is done more often than once per period, and all other tasks are done at intervals which are integer multiples of one period
- the **"maintenance cycle"** is the interval of the least frequently performed task in the maintenance schedule (often a multiple of years).

Once the maintenance schedule has been balanced it is necessary to identify the combinations of tasks which are required to be done at the end of each period in the whole maintenance cycle. In doing this, it will almost certainly be observed that some combinations of tasks occur more than once. Each unique combination of tasks can be defined as a “package”. Some packages may occur just once in the entire maintenance cycle and others may occur several times.

It is important to stress that packages which are performed several times in the maintenance cycle may not necessarily be performed at regular intervals. However, every individual task will always be performed at a regular interval (i.e. its rationalised interval) because it is likely to appear in more than one package. This is an inevitable complexity that is a consequence of a balanced maintenance schedule.

Traditionally it has been common practice to give names to packages of tasks for ease of identification, “10,000 mile service” on a car for example (implying it should be done every 10,000 miles). This way of naming can lead to confusion in a balanced schedule, because there may be a service carried out every 10,000 miles but it is not always comprised of the same tasks; a different service may be performed at say 20,000 and 40,000 miles.

The question of what each package of work is comprised and when it should be carried out is answered quickly by the software. In this way the complexity of a balanced schedule is simplified and a spare parts analysis can be readily carried out for each package of tasks (if required).

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## *BENEFITS*

Rationalisation and Balancing is a time-consuming piece of work ***if it is performed manually*** (ie without software tools) and, as a result, is rarely performed well (if at all).

Our unique software (the "RaB Toolkit") readily enables us to assist you to convert your list of maintenance tasks into a maintenance schedule which is:

- Rationalised to minimise the total man-hours over the life cycle
- Balanced to provide the smoothest possible workload over time
- Comprehensibly packaged and presented (you are told what is due and when it is due, not simply how often it should be done).

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## *MUTUAL CONSULTANTS' ROLE*

Our role is to work closely with the client during the application of the Rationalisation and Balancing software (the "RaB Toolkit") to ensure that the resulting maintenance schedule meets both the maintainer's and user's requirements.

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*For More Information  
Please Contact*

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