7 Timetable test 1
The Combing Chart

The ***First Law*** of Timetabling states that: *the sets of data received on the Data Collection Forms are almost certainly incompatible!* Because of the wide range of options that we offer in our schools and because we usually allow departments some freedom in choosing the staff to teach the groups, the sets of data we receive almost certainly contain some mathematical impossibilities.

The ***Second Law*** states: *Any impossibilities in the data will force the Timetabler to make compromises during the actual scheduling stage of the timetable, and any compromises then are likely to damage the quality of the timetable!*

All scheduling is likely to involve some compromise, although obviously we wish the compromising to be as inconsequential as possible. Compromises made in a logical way at this present stage are likely to have less consequence and be more acceptable to the staff than compromises forced on the timetabler during the scheduling stage.

The compromises that have come to be accepted by the teaching staff vary somewhat from school to school. Timetablers naturally vary in the amount of patience and ingenuity they can maintain in order to obtain a better solution. Some of the compromises that may be forced during scheduling are listed in the box on the next page.

There is no known method of determining whether a given set of data can be timetabled without compromise (other than by completing a full timetable).

However, there are tests which will detect some of the ***im***possibilities and pinpoint the ***reasons*** for them. This chapter covers the first of these tests.

Some of the compromises that may occur during scheduling:

1 Alteration to the requested period spread. This happens most frequently to English, Maths and Modern Languages.
eg. French scheduled for 5 periods on 4 days instead of 1 period per day.

2 Alteration to the requested period breakdown.
eg. Art or Science scheduled as single periods in Year 7 although doubles were requested.

3 Specialist subjects taught in ordinary classrooms.
eg. all four periods of Science taught in a classroom.

4 The requested teacher replaced by an alternative in the same department.
eg. a young new teacher replaces the Head of Department for a tough Year 10 class.

5 The requested teacher replaced by an alternative in the same department for some periods during the week.
eg. class 9A has two teachers for Maths (called 'split teaching').

6 The requested teacher replaced by a member of another department.
eg. some time ago, a Deputy was heard to say (at the scheduling stage):
'Those two Technology teachers will have to teach Maths.'

7 Setting scheduled for only some of the periods.
eg. Year 9 Maths setted for only 3 out of the 4 periods.

8 Multiple periods spanning a break or a lunchtime.
eg. a double period of Science across a break.

9 Alteration to the expected number of periods.
eg. Yr 12 Chemistry allocated only 4 periods instead of the usual 5 periods.

10 Inability to allocate any teacher.
eg. a Deputy was heard to say (at the scheduling stage):
'This Year 10 subject will have to be cancelled.'

In considering the feasibility tests in this chapter (and the next three chapters) it is important to remember that it is ***teachers*** that clash, ***not subjects***.
ie. conflicts are not introduced directly by the curriculum on which we have decided, but only indirectly by way of the staff who are chosen to teach the groups.

For some groups the Subject Leader's choice of a teacher will be made for sound educational reasons; for other groups the choice may be arbitrary.
Once the feasibility tests have pinpointed an area of difficulty, one can look for simple and acceptable modifications to the data on the Data Collection Forms.

These modifications may be crucial but simple. Perhaps, by happenstance, a certain teacher is due to teach 7A, according to the Data Collection Form.
For timetabling, the feasibility tests show that it would be far better if he taught 7B instead. The Head of Department does not mind, the teacher does not mind, but for the timetabler the difference could be crucial.

7.2 Teacher teams

Teams of teachers are obviously more difficult to schedule than single teachers. The number and size of the teacher teams in our schools tend to increase as Subject Leaders request them for a variety of reasons:

- to allow team teaching or ‘setting’ (by attainment or ability level), eg. in Mathematics, English, Languages,
- to allow a choice of subjects, eg. in the option pools,
- to allow separation by sex, eg. for PE,
- to reduce class size, eg. if two classes are scheduled together and allocated three teachers,
- to allow a cycle of rotation during the year, eg. in Technology.

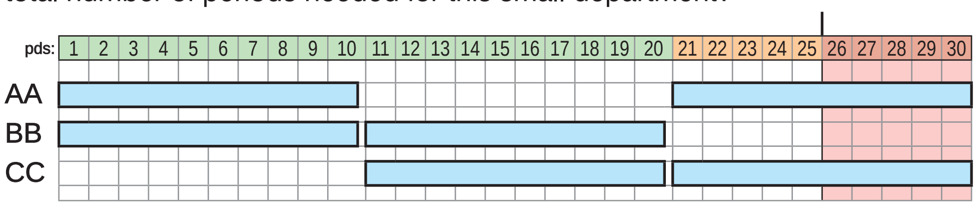
The way in which these teams are chosen can have a huge effect on the scheduling difficulty and final quality of the timetable.

In choosing the teams for these activities, we want the teams to be compatible so they can be timetabled within the number of periods in the timetable cycle.

Worked Example 1

Consider a small department consisting of three teachers, AA, BB, and CC.
Each is due to teach for 20 periods, in a 25-period week.
On the Data Collection Form, the Subject Leader requests that:
teachers AA and BB teach together for 10 periods
and teachers BB and CC teach together for 10 periods
and teachers AA and CC teach together for 10 periods
Question: is this possible?

To see if this is a reasonable request, we can draw a **time-chart** (see below).
The vertical axis (see below) shows the three teachers.
The horizontal axis shows a length of time in periods.
By drawing a horizontal bar for each teacher in a teacher-team, we can see the total number of periods needed for this small department:



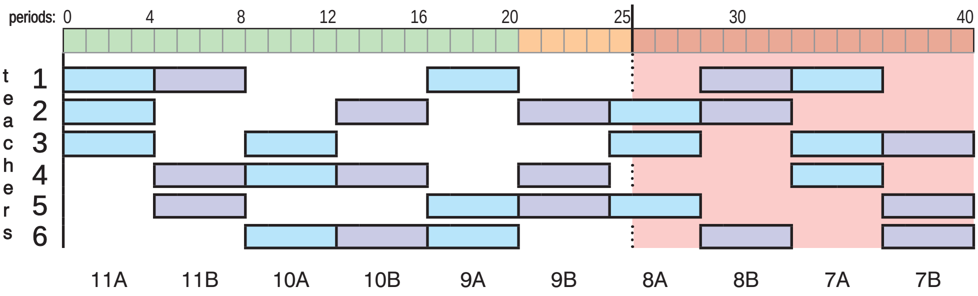
We can see that this arrangement requires 30 periods (even though each teacher teaches only 20 periods). It could not possibly fit into the 25-period week, just because the staff are in teams.

The red area shows the periods needed beyond the 25-period week – the staff would have to teach at the weekend!
The chosen teams were not compatible with the available timeframe.

Worked Example 2

A small Mathematics department consists of 6 teachers, numbered 1 to 6. Each teacher is to teach for 20 periods. They are in an 11–16 school (Years 7–11) where each of the five year-groups is divided into 2 half-year ‘bands’ (called A and B). Each band requires a team of 3 teachers, for 4 periods.

The Head of Maths might request the teams shown here:



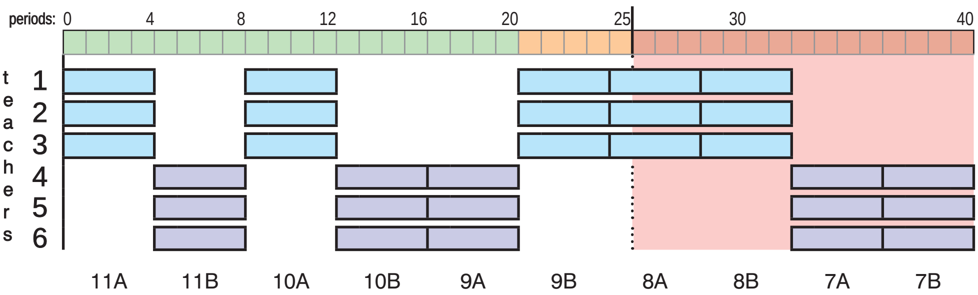
The chart shows that the team for Year 11 band A is made of teachers 1, 2, 3. For band 11B, the teachers are 1, 4, 5. These two teams cannot teach at the same time because they have teacher 1 in common (and teacher 1 cannot teach two classes at the same time).

For 10A the teachers are 3, 4, 6. This team cannot teach at the same time as the 11A team (because of teacher 3), nor can this team teach at the same time as the 11B team (because of teacher 4). The three teams considered so far would need 3 x 4 = 12 periods of the week.

Inspecting the other teams one by one shows that *none* of them can teach at the same time as any other team. Each team overlaps every other team.

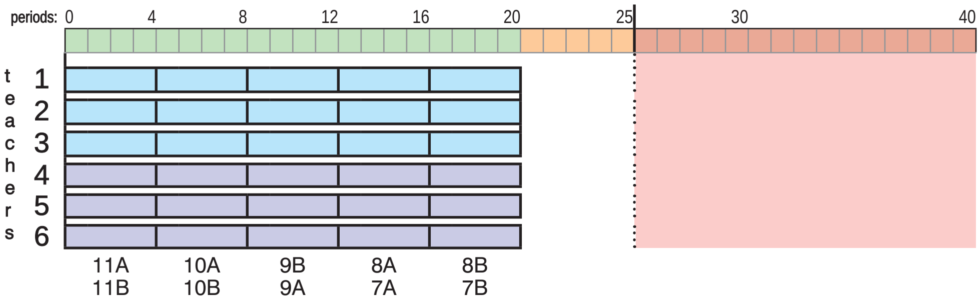
Each teacher teaches five classes, each of 4 periods, and so teaches 20 periods per week. However, since no team can exist at the same time as any other team, the total length of time needed for the teams to teach all 10 bands is 10 x 4 = 40 periods. In a 25-period week this is clearly impossible.

That example was an extreme case where all the teams clash.
Now consider an ideal situation, unlikely to be obtained in practice but something to aim for. The diagram below shows the ***same*** Maths department with the *same* 6 teachers teaching the *same* number of groups:



In the diagram the team for 11A does not overlap the team for 11B. The teams are said to be non-overlapping or ***disjoint*** or compatible. This means that 11A and 11B can be timetabled at the same time. Similarly with 10A, 10B etc.

Comparing the two diagrams above for this Maths department, we can see the difference between them: the second diagram can be squeezed up by sliding the 4, 5, 6 teams to the left, under the 1, 2, 3 teams.
The whole diagram will then fit into a time of only 20 periods, as shown below:



It is clear that these non-overlapping ('disjoint'), compatible teams give much greater flexibility at the scheduling stage.

In fact there are two advantages with non-overlapping teams:

- Non-overlapping teams will fit into a smaller number of periods (overlapping teams may not fit into the school week).
- There is a greater number of different ways of fitting non-overlapping teams. In the last diagram, the labels show 11A paired with 11B, but 11A could well be paired with 10B while 11B could be paired with 8A etc. This interchangeability gives you much greater flexibility at the scheduling stage.

These diagrams are called '**Combing Charts**'. The horizontal bars for the teams can be thought of as the teeth of combs which allow or prevent other teams moving or 'combing' to the left.

7.3 The Principle of Compatibility

In the light of the previous section let us see how a department might choose ***ideal*** teacher teams. Consider a large department – English, Maths or perhaps Science – consisting of 12 teachers, numbered 1–12.

Suppose that for one of the year-groups we need a team of 6 teachers.
Clearly there are many ways of choosing 6 teachers, but suppose we choose the teachers numbered from 1 to 6. This team is marked as 6-team-**A** in the diagram on the next page.

Suppose now that we need a team of 6 teachers for another year-group.
There are only two possibilities if we want non-overlapping teams – either we choose the team of the *same* 6 teachers (6-team-A) **or** we choose the team of the *other* 6 teachers (6-team-**B**).

continued...

The chapter continues with: