

7200 SPLICED TREBLE DODGING MINOR (178 METHODS)

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I was looking for a new Treble Dodging Minor compositional challenge and, having previously composed a peal of 7200 changes comprising all 147 standard methods, wondered what the shortest length might be that I could get all the standard 178 methods into.

The standard 178 methods are the 147 plus those methods which (just like the 147) have Plain Bob lead ends and do not have 5ths place made above the treble (and therefore have the same overworks as the 147), but which also have the place notation 1236 between the 3-4 and 5-6 sections (these are excluded from the 147 because of the requirement to have at least two pairs of bells crossing between each row); there are 11 Surprise and 20 3rds Place Delight methods which have these features, and they add nine new frontworks to those already included in the 147.

I do not really like ringing “long-length” peals so, if at all possible, I wanted to try to keep to the same length as the 147, i.e. 7200 changes, but incorporating an additional 31 methods into the same length seemed an unlikely proposition to start with. However I came up with a plan which I thought might work so set about trying to achieve this; the process I followed can be broken down into a number of logical steps.

Step 1

The key to the composition of 147 methods in 7200 changes was finding a set of 60 full courses which between them contained every possible row ten times, and which could then be manipulated by various splicing techniques to incorporate the additional methods not already included in those 60 courses; one of the additional important factors with this composition was that all methods with right-place work above the treble were rung in-course and all methods with wrong-place work above the treble were rung out-of-course (the reason for this is explained later on).

It seemed likely that this would be the best approach for the 178 too, so the first step was to categorise each of the new 31 methods in the same way as I had the original 147; this categorisation involves analysing the rows in the 5-6 sections of each method, as this is where the majority of the splicing actually takes place, the 1-2 and 3-4 sections are generally left to look after themselves by ensuring that each overwork is rung in full extents (this is explained further later).

This categorisation breaks down the 5-6 sections of every method into three parts (a, b and c). Consider the following 5-6 sections from the lead 56342 of Cambridge S:

+	253416	a
-	524361	b
-	542316)
+	<u>453261</u>) c
+	542361)
-	453216) c
-	435261	b
+	342516	a

Part (a) is defined as all positive rows with the treble in 5ths. Part (b) is defined as all negative rows with the treble in 6ths. Part (c) is defined as all negative rows with the treble in 5ths and all positive rows with the treble in 6ths (these rows can be taken together because they will always appear as consecutive rows regardless of what method is being rung).

For this categorisation only the 5-6 sections where the 6 is dodging in 5-6 are considered; this is sufficient because the composition is to be based on full courses of each method so whatever rules apply for the 5-6 sections when the 6 is dodging in 5-6 will also apply to all the other 5-6 sections.

The categorisation also only considers the 5-6 sections from the plain course for right-place methods above the treble, and course 54236 for wrong-place methods above the treble. Using course 54236 for wrong-place methods above the treble means 5-6 sections are being compared like-for-like, i.e. they all start with positive rows and the crossing pairs at the half-lead are the same (e.g. when 2 is pivot then 3 and 4 cross and 5 and 6 cross, when 6 is pivot then 2 and 3 cross and 4 and 5 cross, and so on). Whatever rules apply for the plain course (or course 54236) will also apply to all the other courses in a similar way.

The following tables show all the distinct combinations of the rows in the 5-6 sections for every one of the 178 methods. 6ths place versions of methods which also have a 2nds place version, and also all lead splicers, are omitted from these tables to make them less cluttered. Where more than one method has the same distinct set of rows in the 5-6 sections then these are grouped together; looking at the first block of rows as an example, this shows that the plain courses of Norwich S, Kirkstall 4D and Shelford 3D, plus the course 54236 of Tewkesbury 4D, all contain the same rows in their 5-6 sections. The other groupings are explained below.

	Group 1				Group 2			Group 3			
	A	J	K	N	B	D	F	C	E	L	S
	No,Ki,Te,Sf	Bs,Gl	Es,Kt	Fi,Fu	Wk	Bu,Ti,Ne, Lf,Cu,Lo,Wg	Bo,Sa, Pn,C3,Eh	El,Fo, Ws,Li	Bm,Ke	Di,Tr	Se,Of
+	532416	532416	245316	234516	532416	532416	253416	532416	532416	245316	543216
-	354261	543261	423561	325461	253461	354261	524361	354261	325461	423561	452361
-	534216	534216	425316	425316	254316	345216	254316	352416	352416	243516	352416
+	<u>352461</u>	<u>352461</u>	<u>243561</u>	<u>243561</u>	<u>523461</u>	<u>432561</u>	<u>523461</u>	<u>534261</u>	<u>534261</u>	<u>425361</u>	<u>534261</u>
+	243561	243561	352461	352461	432561	523461	432561	425361	425361	534261	425361
-	425316	425316	534216	534216	345216	254316	345216	243516	243516	352416	243516
-	245361	452361	532461	234561	342561	245361	435261	245361	234561	532461	543261
+	423516	423516	354216	325416	423516	423516	342516	423516	423516	354216	452316
		Cn			Po,Cj	Cz	Wm,We	Bl	Be,So,Sg		
+		245316			435216	435216	532416	543216	325416		
-		452361			342561	354261	524361	354261	234561		
-		425316			345216	345216	254316	352416	243516		
+		<u>243561</u>			<u>432561</u>	<u>432561</u>	<u>523461</u>	<u>534261</u>	<u>425361</u>		
+		352461			523461	523461	432561	425361	534261		
-		534216			254316	254316	345216	243516	352416		
-		543261			253461	245361	435261	245361	325461		
+		354216			524316	524316	423516	452316	234516		
		Rc,Fr			Nm	C2	Ww	Qu	Dn		
+		543216			253416	253416	435216	245316	543216		
-		452361			523461	245361	435261	245361	325461		
-		425316			254316	254316	345216	243516	352416		
+		<u>243561</u>			<u>523461</u>	<u>523461</u>	<u>432561</u>	<u>425361</u>	<u>534261</u>		
+		352461			432561	432561	523461	534261	425361		
-		534216			345216	345216	254316	352416	243516		
-		543261			432561	354261	524361	354261	234561		
+		452316			342516	342516	524316	354216	452316		
		Cc							Bw		
+		325416							245316		
-		543261							234561		
-		534216							243516		
+		<u>352461</u>							<u>425361</u>		
+		243561							534261		
-		425316							352416		
-		452361							325461		
+		234516							354216		

	Group 4			Group 5			Group 6	
	G	M	P	H	I	O	Q	R
	Cm,Ip,Ci, Nb,C1,Mp	Ox,Ms,Dk, Ey,Do,Wl	C5	Yo,Ak	Du,Bv, Nw,Ch	Wd	Fl,La	Cp,Bd
+	253416	543216	524316	253416	253416	253416	253416	524316
-	524361	452361	253461	342561	234561	524361	524361	253461
-	542316	453216	453216	324516	324516	324516	523416	523416
+	<u>453261</u>	<u>542361</u>	<u>542361</u>	<u>235461</u>	<u>235461</u>	<u>235461</u>	<u>254361</u>	<u>254361</u>
+	542361	453261	453261	324561	324561	324561	345261	345261
-	453216	542316	542316	235416	235416	235416	432516	432516
-	435261	543261	342561	253461	325461	435261	435261	342561
+	342516	452316	435216	342516	342516	342516	342516	435216
		By		Ta,Ca,Bn	Ol,Ma,Ce, Av,Pv,Cx			
+		435216		325416	325416			
-		543261		342561	234561			
-		542316		324516	235416			
+		<u>453261</u>		<u>235461</u>	<u>324561</u>			
+		542361		324561	235461			
-		453216		235416	324516			
-		452361		253461	325461			
+		524316		234516	234516			
				Bh,Bp				
+				435216				
-				342561				
-				324516				
+				<u>235461</u>				
+				324561				
-				235416				
-				253461				
+				524316				
+								
-								
-								
+								
+								
-								
-								
+								

Looking at the various groupings in these tables the following observations can be made:

- (i) All methods which appear in the same group (i.e. groups 1 to 6) have the same negative rows with the treble in 5ths AND the same positive rows with the treble in 6ths, i.e. part (c) as defined above.
- (ii) The following columns all have the same negative rows with the treble in 6ths, i.e. part (b) as defined above.

Columns A, C and D
Columns F, G, O and Q
Columns E, I and N
Columns K and L
Columns J, M and S
Columns B, H, P and R

- (iii) The following groupings of methods share the same positive rows with the treble in 5ths, i.e. part (a) as defined above.

Group 101 (Green)

All Cambridge-over S from standard 147
 All Carlisle-over S from standard 147
 All Peveril-over TB from standard 147
 Wd, Fl, La, Eh/Rm

Group 102 (Blue)

All Norwich-over S from standard 147
 All London-over S from standard 147
 All Cambridge-over 4D from standard 147
 All Carlisle-over 4D from standard 147
 Fy, Re, Sf, Wg

Group 103 (Yellow)

All Norwich-over 4D from standard 147
 All London-over 4D from standard 147
 All Peveril-over 3D from standard 147
 Fi/Nh, Fu/C4, Hf, To, Mi

Group 104 (Pink)

All Oxford-over 3D from standard 147
 All Kent-over TB from standard 147

Group 105 (Orange)

All Oxford-over TB from standard 147
 All Wilmslow-over 3D from standard 147
 Se/Ha, Of, Si/Da, Pb/Hp

Group 106 (Red)

All Wilmslow-over TB from standard 147
 All Kent-over 3D from standard 147
 C5/Pa, Cp/Cq, Bd/Bf, Al/Hi

- (iv) All methods which appear in the same column have the same negative rows with the treble in 6ths AND the same negative rows with the treble in 5ths AND the same positive rows with the treble in 6ths, i.e. they have matching parts (b) and (c) as defined above.

So how does categorising each method by these 3 parts of their 5-6 sections help? Bear in mind firstly that, to ring an extent of any single method, all the 720 rows are contained in six different full courses, those courses being the ones starting from 23456 (the plain course), 42356, 34256, 54326, 53246 and 52436, each containing 5 leads. Each of these courses has an out-of-course counterpart where, for any given pivot bell, the remaining crossing pairs are the same, this means that the relationships between the 5 leads in each course are identical. I've already mentioned that the out-of-course counterpart for the plain course is course 54236, the full list of counterparts is as follows:

In-course	Out-of-course	Pivot 2		Pivot 3		Pivot 4		Pivot 5		Pivot 6	
		Crossing		Crossing		Crossing		Crossing		Crossing	
23456	54236	3+4	5+6	2+5	4+6	2+6	3+5	2+4	3+6	2+3	4+5
42356	53426	3+6	4+5	2+5	4+6	2+3	5+6	2+6	3+4	2+4	3+5
34256	52346	3+6	4+5	2+4	5+6	2+6	3+5	2+3	4+6	2+5	3+4
54326	32456	3+5	4+6	2+4	5+6	2+5	3+6	2+6	3+4	2+3	4+5
53246	24356	3+4	5+6	2+6	4+5	2+5	3+6	2+3	4+6	2+4	3+5
52436	43256	3+5	4+6	2+6	4+5	2+3	5+6	2+4	3+6	2+5	3+4

As an example, look at all the rows in the 5-6 sections from a plain course of Cambridge S and compare them to those in the course 54236 of Mendip TB, you will see that they are identical.

Looking at the categories we have identified, the tables show us that, for example, all the methods in Group 101 (Green) have the same positive rows with the treble in 5ths in their plain courses (or course 54236 for methods with wrong-place overworks), i.e. rows 253416 and 342516 when the 6 is dodging in

5-6. There are of course 12 possible positive rows in the format16 and if we were ringing an extent of Cambridge S, for example, the remaining 10 rows in this format would appear in pairs in each of the other 5 courses required to ring the extent, those being courses 42356, 34256, 54326, 53246 and 52436.

But we now know from our method categorisation exercise that we can also obtain those same missing 10 rows using other methods from Group 101 (Green) for each of these courses so, for example, if in addition to the plain course of Cambridge S we also ring course 42356 of York S, course 52346 of Chester S, course 32456 of Mendip TB, course 24356 of Westmorland 3D and course 43256 of Easthampstead 3D, then these six courses between them will contain not only all 12 of the positive rows in the format16 but in fact all 60 possible positive rows with the treble in 5ths. Let's look at the resulting rows in the format16 to confirm this is true:

Cambridge S
(23456)

+ 253416
- 524361
- 542316
+ 453261
+ 542361
- 453216
- 435261
+ 342516

York S
(42356)

+ 452316
+ 425361
- 243516
- 234561
- 452361
- 425316
+ 243561
+ 234516

Chester S
(52346)

+ 354216
+ 345261
- 432516
- 342561
- 435261
- 345216
+ 432561
+ 423516

Mendip TB
(32456)

+ 524316
- 253461
- 235416
+ 324561
+ 235461
- 324516
- 342561
+ 435216

Westmorland 3D
(24356)

- 534216
+ 352461
+ 325416
- 234561
- 452361
+ 543216
+ 534261
- 352416

Easthampstead 3D
(43256)

- 534216
+ 352461
+ 532416
- 354261
- 423561
+ 245316
+ 425361
- 243516

So what we have managed to do here is split the full set of positive rows with the treble in 5ths (part (a)) between 6 different courses, which have 4 different overworks and 6 different underworks and 3 different classes (Surprise, Treble Bob and 3rds Place Delight). By using the same technique for parts (b) and (c) of the 5-6 sections as well, we can generate a set of courses which between them will contain every different row but could contain many different overworks and underworks.

However, all the different pieces of the "puzzle" must fit together so the composition we end up with contains each of the 720 different rows the same number of times, this means a series of constraints will apply as soon as you make the choice to ring a particular course of a particular method. Say for example that we have chosen to include the plain course of Cambridge S in the composition, this automatically imposes the following constraints:

- (i) The composition must also include courses 42356, 34256, 54326, 53246 and 52436 of methods with the same Cambridge overwork, this will mean that we will have a complete set of 480 different changes with the treble dodging in 1-2 or 3-4; these methods could be either Surprise or 4ths Place Delight as the place notation for these is the same in the 1-2 and 3-4 sections.
- (ii) In terms of its part (a) definition, Cambridge S belongs to Group 101 (Green). This means that the composition must also include courses 42356, 34256, 54326, 53246 and 52436 (or their out-of-course counterparts) of methods which also belong to Group 101 (Green) so that we get a complete set of the 60 different positive rows with the treble in 5ths.
- (iii) In terms of its part (b) definition, Cambridge S is in column G in the table. This means that the composition must also include courses 42356, 34256, 54326, 53246 and 52436 (or their out-of-course counterparts) of methods which are in columns F, G, O or Q in the table so that we get a complete set of the 60 different negative rows with the treble in 6ths.
- (iv) In terms of its part (c) definition, Cambridge S is in Group 4 in the table. This means that the composition must also include courses 42356, 34256, 54326, 53246 and 52436 (or their out-of-course counterparts) of methods which are also in Group 4 (i.e. columns G, M or P in the table) so that we get a complete set of the 60 different negative rows with the treble in 5ths AND a complete set of the 60 different positive rows with the treble in 6ths.

The complexity of these constraints means that the puzzle we are trying to complete is a very difficult one, and it's only going to get more difficult when we add the requirement that the solution we come up with will need to allow us to get all 178 methods in!

Step 2

My next step was to try to determine how many extents would be required to include all the methods and whether I might manage to squeeze them into 10 extents. I had already decided that there would be at least one extent of each of the eight different overworks (so that 1-2 and 3-4 sections could be left to look after themselves). As the composition was to be based on a set of full courses then I needed to make sure that, for each overwork, there would be sufficient plain leads of each lead-end order to include every method.

The following table groups the methods by their pivot bell rather than their specific lead-end orders because at this stage the distinction between 2nds and 6ths place methods is not important, various techniques (explained later) can be used to get both from the same original course. The table also assumes that any one course can only contain 4 plain leads (at least one of them will always have a call) although (as explained later) there are some circumstances where all 5 leads can be rung plain.

Overwork	Pivot Bell	Method(s)	Plain Leads Required	Courses Required	Extents Required
Cambridge	2	Fl	1	1	2
	3	Cm/Pr, Bv/Bk, Su/He, Bs/Wa	8	2	
	4	Bo/Hu, Cp/Cq, Ki/Lv	6	2	
	5	Ip/Nf, El/Cr	4	1	
	6	Du, Yo, Bu	3	1	
Norwich	2	No, Wk	2	1	2
	3	Lf/Ro, Wm/St, Be/Me	6	2	
	4	Ne/Ab, Ma/Br, Ta/Hm	6	2	
	5	Bm/Bc, Se/Ha, Ol/Ns, Cb/Sl, Ng/Cw, Wi/Wr	12	3	
	6	Ad, Ws, Fy	3	1	
Carlisle	2	La	1	1	2
	3	Nb/Wh, Fo/MI	4	1	
	4	Nw/Mo, Ak/Ct, Ti/Sh	6	2	
	5	Sa/Wo, Bd/Bf, Te/Ev	6	2	
	6	Mu, Ch, Cl, Gl	4	1	
London	2		0	0	1
	3	Co, Li, Re	3	1	
	4	Ke, Of, Ce, Va, Cd, Sw	6	2	
	5	We, Lo, So	3	1	
	6	Cu, Ca, Av	3	1	
Wilmslow	2	Bl, Do	2	1	2
	3	Fr/Cg, Cj/Nl	4	1	
	4	Wl/Ba, Bg/Fg, Rs/Cs, Kn/Sk, Si/Da, Pb/Hp, Dn/Pe, Bp/Wv	16	4	
	5	C5/Pa	2	1	
	6	Ey	1	1	
Oxford	2	Ox	1	1	2
	3	Es/Cv	2	1	
	4	Cn/Ri, Fi/Nh, Dk/Sd, Cf/Ls, Oc/Ci, Ny/Ks	12	3	
	5	Fu/C4, Rc/Bz	4	1	
	6	Di, Sf, Ms	3	1	
Kent	2	Kt	1	1	2
	3	By/Kh, Pm/Ed, Bh/Os, Bw/Wf	8	2	
	4	Ww/Lu, Cz/Cy, Eh/Rm, Qu/Sn, Tr/Km	10	3	
	5	Dt/Ck, Po/Wt, Al/Hi	6	2	
	6	Wg	1	1	
Peveril	2		0	0	1
	3	Pv, Le, Md, Bt, To, Mi, Cc, Mp	8	2	
	4	Sg, C3, C2	3	1	
	5	Cx, Bn, Hf, Nm, Pn	5	2	
	6	Wd, C1	2	1	

Adding up the numbers in the “Extents Required” column gives a total of 14. Oh dear! Getting all 178 methods in 10 extents looks unlikely! Are there any ways of reducing this?

Looking first at the Wilmslow and Oxford overworks, a lot of the methods in these groups have 4ths place bell as pivot; the path of this bell is the same for both overworks which means 6-lead splices can be applied. So I decided to add to the mix an extent of Wilmslow 3D in which two 6-lead splices were applied to convert 12 of the leads to Duke of Norfolk TB. This meant all the methods with Wilmslow or

Oxford overworks which have 4ths place bell as pivot could be removed from the above table, meaning that the remaining methods for each overwork could now be rung in just one extent each. The extent of spliced Wilmslow 3D and Duke of Norfolk TB was unlikely to be able to provide plain leads of all 28 methods removed from the table, but there were now a couple of spare courses in the Wilmslow and Oxford overwork blocks which could potentially be rung as a method with 4ths place bell as pivot and which could therefore assist with this issue. So I had added an extra extent to the original 14 but had managed to remove 2 so I was now down to a net total of 13.

Next I looked at the Norwich and Kent overworks. Firstly I decided that I could remove Kent TB from the table as long as the composition contained a course of Oxford TB; these 2 methods have an unusual splice in that the leads 23456 of Oxford TB and 24356 of Kent TB contain the same changes, so one or more of the spare leads of Oxford TB could be rung as the corresponding lead(s) of Kent TB instead.

Secondly I looked to see if I could take advantage of the special relationship between the Norwich and Kent overworks. The nature of this relationship is that plain courses of any Norwich-over method and any Kent-over method will contain the same rows when the treble is dodging in 1-2 and 3-4. This means some slightly unusual course splices exist, e.g. Westminster S and Pontefract 3D, Norwich S and Easthampstead 3D, Netherseale S and Wiggshall 3D, Sedlescombe S and Barham 3D. So I decided that instead of including 2 extents of each overwork I would have just one of the Kent overwork and two of the Norwich overwork, with at least 2 of the Norwich-over courses rung as Kent-over methods instead (note that this would mean a rare exception in the composition, i.e. methods with wrong-place backworks being rung in-course rather than out-of-course). By doing this I had now got the number of extents down to 12.

Next I looked at the Cambridge and Carlisle overworks. These two overworks (like Norwich and London) have a special relationship in that a plain course of any Cambridge-over method and the course 54236 of any Carlisle-over method (the counterpart of the plain course as explained earlier) will contain the same rows when the treble is dodging in 3-4; this means that full 5-6 sections can easily be swapped between the Cambridge-over course and its Carlisle-over counterpart, and that for every underwork present in Cambridge-over methods there will be an equivalent Carlisle-over method with the same underwork. I thought I might be able to take advantage of this relationship in some way to reduce the number of extents required.

I had particular concerns about the methods Flamstead S and Langleybury S as I knew that their underworks were unique and that they did not splice directly with any other methods, so each would probably have to be rung as a full course. Also the earlier analysis of part (c) of the methods' 5-6 sections had put these methods in Group 6 which only contains 2 other methods; this meant that if I included courses of Flamstead S and Langleybury S in the composition then I would have to include four courses of either Caithness S or Blunsdon S as well. This was hardly likely to assist in my quest to reduce the number of extents required.

I had previously come up with a fragmented grid splice involving Flamstead S which I thought might help, the grid is as follows:

<u>23456</u> Primrose S	<u>56342</u> Primrose S
35264 Norfolk S	64523 Flamstead S
42635 Primrose S	<u>56342</u>
<u>23456</u>	

Grid splices are not really very friendly for this type of composition because as soon as you ring the grid for one course you have also got to ring it for a further five courses which could be a significant waste. In this instance however it proved not to be the case.

Firstly, the Cambridge/Carlisle backwork relationship means that the grid has a Carlisle-over equivalent meaning some of the grid courses could possibly be rung as Carlisle S, Northumberland S and Langleybury S instead. Secondly, the leads of Primrose S and Carlisle S where the 6 is pivot bell could be rung as Burslem 4D and Glastonbury 4D instead via a 6-lead splice, and the 5-6 sections of 2 of these leads could then be swapped with leads of Berkeley 3D to introduce Surfleet S, Munden S and Berwyn TB. Thirdly, two of the leads of Northumberland S could have their 5-6 sections swapped with leads of Chadkirk TB to bring in Fountains 4D and Francis Genius 3D. Fourthly, the 5-6 sections of four of the remaining leads of Primrose S and Carlisle S could be swapped with leads of Berkeley 3D to introduce further leads of Surfleet S and Munden S and also Barham 3D. Therefore having to include 6 courses of the grid splice might not be too much of an overhead.

So if I decided to include 6 courses of the grid in this composition with some courses rung with Cambridge overwork and the others with Carlisle overwork, what methods would that leave me with after applying the various splices described?

Overwork	Pivot Bell	Method(s)	Plain Leads Required	Courses Required
Cambridge	4	Bo/Hu, Cp/Cq, Ki/Lv	6	2
	5	El/Cr	2	1
	6	Du, Yo, Bu	3	1
Carlisle	4	Nw/Mo, Ak/Ct, Ti/Sh	6	2
	5	Sa/Wo, Bd/Bf, Te/Ev	6	2

On the face of it, it looked like I still needed 8 further courses, but if I could get it down to 6 then that would give me the sought-after 10 extents. Firstly I decided that I could remove Elston 4D and Clarence 4D from this table by ensuring the composition contained 3 courses of Old Oxford 4D which would mean I could apply a 3-lead splice with 2nds and 4ths place bells fixed to give these 2 methods.

Secondly, because it is easy to swap 5-6 sections between Cambridge-over and Carlisle-over courses I decided that I could remove Durham S, York S and Burnaby 4D from this table by borrowing spare leads of their Carlisle-over equivalents. For example, if the composition included the plain course of the Flamstead S grid and also the course 54236 of Alnwick S then the starting leads would be:

<u>42635</u> Cambridge S	<u>54236</u> Alnwick S
35264 Ipswich S	62354 Alnwick S
23456 Cambridge S	43562 Alnwick S
56342 Primrose S	25643 Alnwick S
64523 Flamstead S	36425 Alnwick S
<u>56342</u>	<u>54236</u>

But by swapping various 5-6 sections, these leads can be reformulated as follows:

<u>42635</u> York S	<u>54236</u> Alnwick S
23456 York S	62354 Alnwick S
35264 York S	43562 Carlisle S
56342 Primrose S	36425 Northumberland S
64523 Flamstead S	25643 Carlisle S
<u>56342</u>	<u>54236</u>

So, subject to finding splices to change 2 of the leads of York S to Durham S and Burnaby 4D, I now only needed 6 additional courses to get all the remaining Cambridge-over and Carlisle-over methods, meaning all the Cambridge-over and Carlisle-over methods could be included in just 2 extents. This meant I now had a plan whereby a composition comprising just 10 extents might be possible.

Step 3

As already explained, two of the extents in the composition were effectively pre-assigned, i.e. one of the Flamstead S grid, and one of spliced Wilmslow 3D and Duke of Norfolk TB. For the remaining eight extents (two of Norwich overwork and one each of Carlisle, London, Wilmslow, Oxford, Kent and Peveril overworks) I needed to find a set of 48 courses which between them would contain each row 8 times and which would allow all 178 methods to be included in the composition. This step was really the most tricky of all because there were so many different factors to be taken into consideration, the following list gives an idea of just some of the many things that were going on in my brain during this process!

1	<p>For the Norwich-over courses I needed one course to have 2nds place bell as pivot, two to have 3rds place bell as pivot, two to have 4ths place bell as pivot, three to have 5ths place bell as pivot and one to have 6ths place bell as pivot.</p> <p>Of the remaining three courses, at least two would need to be converted to Kent-over methods via course splices. There was therefore one 'spare' course.</p> <p>Three of the Norwich-over courses needed to be Old Oxford 4D to allow the 3-lead splice to include Elston 4D and Clarence 4D.</p>
2	<p>For the Carlisle-over courses I needed two courses to have 4ths place bell as pivot (some leads of which would be swapped with the Cambridge-over courses to include Cambridge-over methods with 6ths place bell as pivot), and four to have 5ths place bell as pivot (some leads of which would be swapped with the Cambridge-over courses to include Cambridge-over methods with 4ths place bell as pivot).</p>
3	<p>For the London-over courses I needed one course to have 3rds place bell as pivot, two to have 4ths place bell as pivot, one to have 5ths place bell as pivot and one to have 6ths place bell as pivot. There was therefore one 'spare' course.</p>
4	<p>For the Wilmslow-over courses I needed one course to have 2nds place bell as pivot, one to have 3rds place bell as pivot, one to have 5ths place bell as pivot and one to have 6ths place bell as pivot. There were therefore two 'spare' courses.</p>
5	<p>For the Oxford-over courses I needed one course to have 2nds place bell as pivot, one to have 3rds place bell as pivot, one to have 5ths place bell as pivot and one to have 6ths place bell as pivot. There were therefore two 'spare' courses.</p>
6	<p>For the Kent-over courses I needed two courses to have 3rds place bell as pivot, three to have 4ths place bell as pivot, two to have 5ths place bell as pivot and one to have 6ths place bell as pivot; this was 2 courses too many hence the need to ring 2 of the courses as part of the Norwich-over courses instead. There were therefore no 'spare' courses.</p>
7	<p>For the Peveril-over courses I needed two courses to have 3rds place bell as pivot, one to have 4ths place bell as pivot, two to have 5ths place bell as pivot and one to have 6ths place bell as pivot. There were therefore no 'spare' courses.</p>
8	<p>Assuming that in the Flamstead S grid the leads with the 6 ringing 3rds place bell are rung as Burslem 4D rather than Cambridge S, then the two Kent-over courses with 3rds place bell as pivot needed to be rung as Berkeley 3D or Pembroke 3D; swapping of 5-6 sections would then enable Beverley S and Surfleet S to be included in the Cambridge-over courses, Chester S, Munden S and Glastonbury 4D to be included in the Carlisle-over courses, and Barham 3D and Berwyn TB to be included in the Kent-over courses.</p>
9	<p>To include Kirkstall 4D, Tewkesbury 4D and Morning Star TB, one of the courses of Carlisle-over needed to be rung as Tewkesbury 4D or one of the Oxford-over courses needed to be rung as Morning Star TB (or both), unless there were appropriate leads of Sandiacre S and Disley 3D to which 3-lead splices could be applied.</p>

10	To include Caithness S, Blunsdon S and Shelford 3D, either a course of Blunsdon S or Shelford S needed to be included, or there were appropriate leads of Sandiacre S and Disley 3D to which 3-lead splices could be applied.
11	If it proved difficult to include 2 courses of Pontefract 3D (which indeed it did!) then there needed to be appropriate leads of Sandiacre S to which a 3-lead splice could be applied.
12	To include Burnaby 4D, Tintern 4D, Bedford 4D and Southwark 4D then at least 2 courses of any of these methods needed to be included.
13	To include leads of Fountains 4D and Melrose 4D, two courses of Chadkirk TB would be required so that 5-6 sections from these could be swapped with leads of Northumberland S and Whitley S; the swapped-out leads of Chadkirk TB would then become Francis Genius 3D instead.
14	If a course of Norwich S was included but not a course of Warkworth S, then a course of Belvoir 3D would be required which was not the same course used for Norwich S. If a course of Warkworth S was included but not a course of Norwich S, then a course of Dover 3D would be required which was not the same course used for Warkworth S.
15	If a course of Dover 3D was included but not a course of Belvoir 3D, then a course of Warkworth S would be required which was not the same course used for Dover 3D. If a course of Belvoir 3D was included but not a course of Dover 3D, then a course of Norwich S would be required which was not the same course used for Belvoir 3D.
16	To include Bamborough S, Kelso S and Conisborough 3D then at least one course of one of these would be required, or there should be appropriate leads of Old Oxford 4D, Combermere 4D and Duke of Norfolk TB to which a 6-lead splice could be applied.
17	To include Sedlescombe S, Offley S and Finchampstead 3D then at least one course of one of these would be required, or there should be appropriate leads of Old Oxford 4D, Combermere 4D and Duke of Norfolk TB to which a 6-lead splice could be applied.
18	To include Taxal 4D, Marple 4D, Canterbury 4D, Abbeyville 4D, Cheviot TB and Chiltern TB then at least 2 courses of any of these methods needed to be included.
19	To include Netherseale S, Cunecastre S and Stirling 3D then at least one course of any of these methods needed to be included.
20	To include Rochester TB, Fulmer 3D, Cotswold TB and Westmorland 3D then one of the Peveril-over courses needed to be rung as Cotswold TB or Westmorland 3D, and two Oxford-over courses would be required to be rung as either Rochester TB or Fulmer 3D (with the right combination of courses allow appropriate swapping of 5-6 sections). This would use up one of the spare Oxford-over courses.
21	To include Dunedin 3D and Chelsea 3D then at least one course of one of these would be required, or there should be appropriate leads of Wilmslow 3D and Peveril 3D to which a 6-lead splice could be applied.
22	To include British Scholars' Pleasure TB and Mendip TB then at least one course of one of these would be required, or there should be appropriate leads of Wilmslow 3D and Peveril 3D to which a 6-lead splice could be applied.
23	To include Caernarvon 3D, Warwick 3D, Bucknall 3D and Castleton 3D then at least 2 courses of any of these methods needed to be included.
24	To include Trinity Sunday TB, Quantock TB, Pennine TB and Norton-le-Moors TB then at least 2 courses of any of these methods with different underworks needed to be included, or 3 courses of any of these methods with the same underwork needed to be included to which a 3-lead splice could then be applied.
25	To include Easthampstead 3D and Hertfordshire 3D then at least 1 course of either of these

	methods needed to be included.
26	The 48 courses needed to complement each other in terms of their 5-6 section parts (a), (b) and (c) definitions, i.e. each row within these parts needed to occur 8 times.

Finding an appropriate set of 48 courses which met all of the above criteria (and more) was a lengthy task, I would not like to attempt to guess the number of months, days and hours that were involved! Several times I came very close to a solution but couldn't quite get it to fit, and I started to wonder whether what I was attempting was actually possible or not and whether I would have to concede defeat. Would a computer search have helped me at this stage? Maybe, but the thought of writing a program which would take all the required factors into account seemed very daunting and possibly beyond my programming abilities, so I only briefly considered it as an option. However, eventually the breakthrough occurred and I found a solution, you cannot imagine how happy a day that was for me!

Here are some notes on how some of the factors mentioned above were each resolved:

1	The Norwich-over courses included spare courses of Netherseale S and Westminster S, course splicing meant these could be rung as Wiggshall 3D and Pontefract 3D instead. The other spare course was taken up by including courses of both Norwich S and Warkworth S.
2	The Carlisle-over courses were one each of Alnwick S and Tintern 4D, and two each of Tewkesbury 4D and Sandiacre S.
3	The spare London-over course was taken up by including courses of both Wells S and Southwark 4D.
4	One of the spare Wilmslow-over courses had to be rung as Chadkirk TB (see factor 13), the other spare course was rung as Dunedin 3D which helped out with factor 21 and would also help with getting sufficient plain leads out of the extent of spliced Wilmslow 3D and Duke of Norfolk TB.
5	One of the spare Oxford-over courses was taken up by ringing two courses of Rochester TB (see also factor 20), the other was taken up by ringing two courses of Disley 3D (which helped with factors 9 and 10).
6	The requirement to lose two Kent-over courses was satisfied by including courses of Wiggshall 3D and Pontefract 3D in the Norwich-over courses. Only one course with 5ths place bell as pivot was included, however the missing leads of Pontefract 3D were obtained via a 3-lead splice with leads of Sandiacre S (see also note 11 below).
7	The Peveril-over courses were one each of Peveril 3D, Mendip TB, Chiltern TB, Castleton 3D, Hertfordshire 3D and Westmorland 3D.
8	Two courses of Berkeley 3D were included.
9	Two of the Carlisle-over courses were rung as Tewkesbury 4D.
10	Two of the Carlisle-over courses were rung as Sandiacre S and two of the Oxford-over courses were rung as Disley 3D so 3-leads splices could be applied.
11	A combination of appropriate leads of Tewkesbury 4D, Sandiacre S and Disley 3D meant that there were appropriate leads of Sandiacre S to which a 3-lead splice could be applied (see also note 6 above).
12	Courses of Tintern 4D, Bedford 4D and Southwark 4D were included.
13	Two courses of Chadkirk TB were included.
14	Courses of both Norwich S and Warkworth S were included.
15	Courses of Belvoir 3D and Norwich S were included.
16	Appropriate leads of Old Oxford 4D, Combermere 4D and Duke of Norfolk TB were included so

	that a 6-lead splice could be applied.
17	Appropriate leads of Old Oxford 4D, Combermere 4D and Duke of Norfolk TB were included so that a 6-lead splice could be applied.
18	Courses of Taxal 4D, Abbeyville 4D and Chiltern TB were included.
19	A course of Netherseale S was included.
20	Two courses of Rochester TB and one of Westmorland 3D were included.
21	A course of Dunedin 3D was included.
22	A course of Mendip TB was included.
23	Courses of Caernarvon 3D and Castleton 3D were included.
24	Three courses of Trinity Sunday TB were included.
25	A course of Hertfordshire 3D was included.
26	Each of the sets of rows in 5-6 section parts (a), (b) and (c) occurred 8 times.

The following table shows the analysis of the overworks and 5-6 section parts (a), (b) and (c) in the 48 courses proving that each one occurs 8 times. The courses are just referred to by the letters A-F in this table, but in practice they actually relate to the following courses:

	<u>In-course</u>	<u>Out-of-course</u>
D	23456	54236
B	42356	53426
A	34256	52346
C	54326	32456
F	53246	24356
E	52436	43256

The table shows for each selected course which of the different categories the chosen method belongs to, and the totals at the bottom confirm that for each of the different categories each of the six different courses is rung the same number of times, meaning that these 48 courses will contain every row 8 times.

Course	Method	Cambridge-over	Norwich-over	London-over	Carlisle-over	Wilmslow-over	Oxford-over	Kent-over	Peveril-over	(a) Group 101 (Green)	(a) Group 102 (Blue)	(a) Group 103 (Yellow)	(a) Group 104 (Pink)	(a) Group 105 (Orange)	(a) Group 106 (Red)	(b) Group A, C, D	(b) Group F, G, O, Q	(b) Group E, I, N	(b) Group K, L	(b) Group J, M, S	(b) Group B, H, P, R	(c) Group 1 (A, J, K, N)	(c) Group 2 (B, D, F)	(c) Group 3 (C, E, L, S)	(c) Group 4 (G, M, P)	(c) Group 5 (H, I, O)	(c) Group 6 (Q, R)	
A	Tewkesbury 4D				A						A					A						A						
B	Tintern 4D				B						B					B							B					
C	Tewkesbury 4D				C						C					C							C					
D	Alnwick S				D				D												D					D		
E	Sandiacre S				E				E							E							E					
F	Sandiacre S				F				F							F							F					
A	Wearmouth S	A								A						A							A					
B	Westminster S (Pontefract 3D)	B								B						B							B					
C	Warkworth S	C								C						C					C		C					
D	Netherseale S (Wiggenhall 3D)	D								D						D							D					
E	Norwich S	E							E							E						E						
F	Netherseale S	F							F							F							F					
A	Taxal 4D	A									A										A						A	
B	Old Oxford 4D	B									B							B									B	
C	Old Oxford 4D	C									C							C									C	
D	Bedford 4D	D									D							D							D			
E	Old Oxford 4D	E									E							E									E	
F	Westminster S	F								F						F							F					
A	Combermere 4D		A								A							A									A	
B	Combermere 4D		B								B							B									B	
C	Southwark 4D		C								C							C						C				
D	Wells S		D							D						D							D					
E	Lincoln S		E							E						E							E					
F	Abbeyville 4D		F							F						F							F					
A	Disley 3D						A					A							A					A				
B	Rochester TB						B					B							B			B						
C	Disley 3D						C					C							C					C				
D	Evening Star 3D						D					D							D				D					
E	Oxford TB						E					E							E					E				
F	Rochester TB						F					F							F				F					
A	Dunedin 3D					A						A							A					A				
B	Chadkirk TB					B						B							B			B						
C	Ely 3D					C						C							C					C				
D	Belvoir 3D					D						D				D								D				
E	Chadkirk TB					E						E				E					E		E					
F	Cogenhoe 3D					F						F				F					F		F					
A	Berkeley 3D							A								A					A						A	
B	Trinity Sunday TB							B				B							B					B				
C	Caernarvon 3D							C								C							C					
D	Berkeley 3D							D								D					D						D	
E	Trinity Sunday TB							E								E					E					E		
F	Trinity Sunday TB							F								F					F					F		
A	Chiltern TB								A	A														A				
B	Mendip TB								B	B																B		
C	Westmorland 3D								C	C																	C	
D	Castleton 3D								D												D						D	
E	Hertfordshire 3D								E												E						E	
F	Peveril 3D								F												F						F	
A		0	2	1	1	1	1	1	1	1	2	2	1	1	1	2	1	2	1	1	1	1	2	2	1	2	0	
B		0	2	1	1	1	1	1	1	1	2	2	1	1	1	2	1	2	1	1	1	1	2	2	1	2	0	
C		0	2	1	1	1	1	1	1	1	2	2	1	1	1	2	1	2	1	1	1	1	2	2	1	2	0	
D		0	2	1	1	1	1	1	1	1	2	2	1	1	1	2	1	2	1	1	1	1	2	2	1	2	0	
E		0	2	1	1	1	1	1	1	1	2	2	1	1	1	2	1	2	1	1	1	1	2	2	1	2	0	
F		0	2	1	1	1	1	1	1	1	2	2	1	1	1	2	1	2	1	1	1	1	2	2	1	2	0	

Step 4

Before progressing further, I needed to sort out the Cambridge-over and Carlisle-over courses so that they contained the requisite number of leads for each required method. The following table shows the before and after versions of these courses once various swaps of 5-6 sections had been applied:

BEFORE

<u>64523</u>	Fl	<u>63542</u>	Fl	<u>62534</u>	Fl	<u>63254</u>	Fl	<u>62453</u>	Fl	<u>64352</u>	Fl
56342	Bs	56234	Bs	56423	Bs	26435	Bs	46325	Bs	36245	Bs
42635	Cm	34625	Cm	23645	Cm	35642	Cm	25634	Cm	45623	Cm
35264	lp	25463	lp	45362	lp	42563	lp	34562	lp	23564	lp
23456	Cm	42356	Cm	34256	Cm	54326	Cm	53246	Cm	52436	Cm
<u>56342</u>		<u>56234</u>		<u>56423</u>		<u>26435</u>		<u>46325</u>		<u>36245</u>	
<u>54236</u>	Ak	<u>53426</u>	Ti	<u>52346</u>	Te	<u>32456</u>	Te	<u>24356</u>	Sa	<u>43256</u>	Sa
62354	Ak	64253	Ti	35624	Te	43625	Te	32645	Sa	24635	Sa
43562	Ak	32564	Ti	63452	Te	64532	Te	63524	Sa	62543	Sa
25643	Ak	45632	Ti	46235	Te	56243	Te	56432	Sa	56324	Sa
36425	Ak	26345	Ti	24563	Te	25364	Te	45263	Sa	35462	Sa
<u>54236</u>		<u>53426</u>		<u>52346</u>		<u>32456</u>		<u>24356</u>		<u>43256</u>	

AFTER

<u>42635</u>	Yo	<u>25463</u>	Nf	<u>34256</u>	Lv	<u>63254</u>	Fl	<u>34562</u>	Hu	<u>63425</u>	Fl
23456	Yo	34625	Pr	56423	Lv	26435	Bs	62453	Fl	46532	Bo
35264	Yo	42356	Cm	23645	Lv	35642	Cm	46325	Hu	25346	Pr
56342	Wa	56234	Wa	45362	Lv	42563	lp	25634	Pr	54263	Bo
64523	Fl	63542	Fl	62534	Lv	54326	Cm	53246	Pr	32654	Cm
<u>56342</u>		<u>56234</u>		<u>34256</u>		<u>26435</u>		<u>34562</u>		<u>54263</u>	
<u>25643</u>	Cl	<u>53426</u>	Ti	<u>63452</u>	La	<u>32456</u>	Ev	<u>56432</u>	Nb	<u>43256</u>	Gl
54236	Ct	64253	Ti	46235	Nb	64532	Te	32645	Sa	35462	Wo
36425	Wh	32564	Ti	35624	Cl	56243	Te	63524	Wo	24635	Wo
62354	Ak	45632	Ti	52346	Gl	25364	Ev	45263	Sa	56324	Wh
43562	Cl	26345	Ti	24563	Cl	43625	Te	24356	Gl	62543	Wo
<u>36425</u>		<u>53426</u>		<u>46235</u>		<u>64532</u>		<u>45263</u>		<u>35462</u>	

The required methods not included in the “after” courses could be derived as follows:

Durham S	Swap middle 2 rows of a lead of York S with a lead of Castleton 3D
Burnaby 4D	Swap 5-6 section of a lead of York S with a lead of Southwark 4D
Surfleet S, Hexham S, Beverley S, Berwick S	The 5-6 sections from 2 spare leads of Primrose S and a spare lead each of Cambridge S and Burslem 4D can be swapped with leads of Berkeley 3D
Caithness S, Cranford S	There are two spare leads of Hull S and one of Kirkstall 4D which, with the assistance of the courses of Disley 3D, can be converted to Cranford S via 3-lead splices
Newcastle S, Morpeth S	There are two spare leads of Tintern 4D where 5-6 sections can be swapped with leads of Wearmouth S and Wells S
Munden S, Chester S	The 5-6 sections from a spare lead of Carlisle S and a spare lead of Glastonbury 4D can be swapped with leads of Berkeley 3D
Blunsdon S, Brentford S	There are two spare leads of Sandiacre S and one of Tewkesbury 4D which, with the assistance of the courses of Disley 3D, can be converted to Blunsdon S via 3-lead splices
Fountains 4D, Melrose 4D	There are two spare leads of Northumberland S where 5-6 sections can be swapped with leads of Chadkirk TB
Pontefract 3D	There are two further spare leads of Sandiacre S and one more of Tewkesbury 4D which, with the assistance of the courses of Disley 3D, can be converted to Pontefract 3D via a 3-lead splice

Step 5

I now had a set of 60 courses containing each row 10 times, but a number of splices still needed to be applied to obtain all 178 methods. The 60 original courses are shown in full in the table below along with an indication of the additional splices.

42635	Yo	Du	2		25463	Nf			34256	Lv			63254	Fl			34562	Hu			63425	Fl			
23456	Yo	Bu	1		34625	Pr			56423	Lv			26435	Bs	Su	5	62453	Fl			46532	Bo	Cp	A	
35264	Yo				42356	Cm	Su	3	23645	Lv			35642	Cm			46325	Hu	Cq	B	25346	Pr	He	7	
56342	Wa				56234	Wa		a	45362	Lv	Hu>Cq	4Ab	42563	lp			25634	Pr	He	6	54263	Bo			
64523	Fl				63542	Fl			62534	Lv		c	54326	Cm			53246	Pr			32654	Cm			
56342					56234				34256				26435				34562				54263				
25643	Cl				53426	Ti			63452	La			32456	Ev			56432	Nb	Fo	13	43256	Gl	Mu	14	
54236	Ct				64253	Ti	Nw	8n	46235	Nb	Fo	10e	64532	Te	Sa>Po	12C	32645	Sa			35462	Wo			
36425	Wh			d	32564	Ti		m	35624	Cl	Mu	11	56243	Te			63524	Wo	Wt	C	24635	Wo	Bf	D	
62354	Ak				45632	Ti			52346	Gl			25364	Ev			45263	Sa	Bd	A	56324	Wh			
43562	Cl				26345	Ti	Nw	9	24563	CL			43625	Te			24356	Gl			62543	Wo	Wt	Ck	
36425					53426				46235				64532				45263				35462				
23456	Wg				42356	Po		f	34256	Wm			54326	Wk		+	53246	Ws			52436	No	Wk	17	
35264	Wg				34625	Po			56423	Wm	Lf	15	35642	Wk		+	34562	Ws			45623	No			
56342	Wg				63542	Po			23645	Wm	Ro	16	63254	Wk		+	46325	Ws			64352	No			
64523	Wg				56234	Po			45362	Wm			26435	Wk		+	62453	Ws			36245	No			
42635	Wg				25463	Po		g	62534	Wm	Be	8	42563	Wk		+	25634	Ws			23564	No			
23456					42356				34256				54326				53246				52436				
23456	Be				42356	OI		f	34256	Ta			54326	Ns		+	53246	Ab			52436	OI	Se	F	
56342	Be				34625	OI	EI	E	62534	Ta			63254	Ns		+	46325	Ab		h	45623	OI			
42635	Be				63542	OI			45362	Ta		j	42563	Ns	Bc	G+	25634	Ab	Br	19	64352	OI	EI	E	
35264	Be				56234	OI			23645	Ta			35642	Ns	Cr	E+	34562	Ab	Hm>Br	20,21	36245	OI			
64523	Be				25463	OI		g	56423	Ta	Ma	18	26435	Ns	Ha	F+	62453	Ab			23564	OI	Bm	G	
23456					42356				34256				54326				53246				52436				
54236	We	So	9		53426	Ce			52346	Ce	Of	F	32456	So			24356	Av	Cu	19	43256	Li			
25643	We	Lo	18		64253	Ce			63452	Ce			43625	So			45263	Av			56324	Li			
62354	We				32564	Ce			24563	Ce			64532	So			56432	Av			24635	Li			
36425	We				45632	Ce	Ke	G	35624	Ce	Ke	G	56243	So			63524	Av	Ca	22	35462	Li			
43562	We				26345	Ce	Of	F	46235	Ce			25364	So	Lo	1	32645	Av	Ca	21	62543	Li			
54236					53426				52346				32456				24356				43256				
23456	Es				42356	Rc	Fu	23	34256	Di			54326	Di	Sf	B	53246	Rc	Fu	24	52436	Ox			
56342	Es				34625	Rc			45362	Di	Sf	B	42563	Di	Ms	4	25634	Rc		p	45623	Ox			
42635	Es				63542	Rc			56423	Di	Ms	12	26435	Di	Sf	D	62453	Rc			64352	Ox			
35264	Es				56234	Rc			62534	Di	Sf	D	63254	Di			46325	Rc			36245	Ox	Kt	#	
64523	Es				25463	Rc			23645	Di			35642	Di			34562	Rc		o	23564	Ox			
23456					42356				34256				54326				53246				52436				
23456	Bl			+	42356	Cj			34256	Dn	Bp	25i	54326	Ey			53246	C5			52436	Cj			
42635	Bl			+	56234	Cj	Fr	13a	62534	Dn		c	42563	Ey			25634	C5		p	36245	Cj	Fr	10	
64523	Bl			+	34625	Cj			45362	Dn		b	26435	Ey			62453	C5			45623	Cj			
56342	Bl	Do	17+		25463	Cj			23645	Dn			63254	Ey			46325	C5			23564	Cj			
35264	Bl			+	63542	Cj			56423	Dn			35642	Ey			34562	C5		o	64352	Cj			
23456					42356				34256				54326				53246				52436				
23456	Ba			+	42356	Sd	Nh	F	34256	Ba		i	54326	Dk			53246	WI			52436	WI	Bp	27	
56342	Sd			+	56234	Ba			56423	Ba			63254	WI			62453	WI			64352	Dk	Fi	F	
42635	Sd			+	34625	Sd	Ri	G	23645	Sd			42563	WI		Bp	26	34562	WI			23564	WI		
35264	Ba			+	25463	Ba			45362	Sd		j	35642	Dk	Cn	G	25634	Dk			45623	Dk			
64523	Ba			+	63542	Ba			62534	Ba			26435	WI			46325	Dk		h	36245	WI			
23456					42356				34256				54326				53246				52436				
54236	By	Bh	11		53426	Km	Rm	29	52346	Kh	Os	3	32456	Cz	Ww	22	24356	Tr	Eh	32	43256	Km			
36425	By	Bw	5d		26345	Km	Lu	28	24563	Kh			64532	Cz			63524	Tr			56324	Km			
25643	By	Bh	7		45632	Km			46235	Kh	Wf	14e	25364	Cz			45263	Tr			24635	Km	Sn	H	
43562	By				32564	Km		m	63452	Kh			43625	Cz	Ww	30	32645	Tr			35462	Km			
62354	By				64253	Km		n	35624	Kh	Os	6	56243	Cz	Eh	31	56432	Tr	Qu	H	62543	Km	Cy	33	
54236					53426				52346				32456				24356				43256				
54236	Cx	Pn>Nm	28H		53426	Mp			52346	C2	C3	16	32456	Wd			24356	Pv			43256	Hf			
25643	Cx				26345	Mp			63452	C2			25364	Wd	C1	24	56432	Pv			24635	Hf	Pn	32	
62354	Cx	Bn>Pn	2,33		45632	Mp	Pv	26	24563	C2	Sg	20	56243	Wd			32645	Pv			62543	Hf	Pn	29k	
36425	Cx				32564	Mp	Cc	25	35624	C2	C3	15	64532	Wd			45263	Pv			56324	Hf	Bn	31	
43562	Cx	Bn	30		64253	Mp	Pv	27	46235	C2			43625	Wd	C1	23	63524	Pv			35462	Hf			
54236					53426				52346				32456				24356				43256				

The additional splices are detailed below. Firstly there are a number of swaps of 5-6 sections:

1	23456 York S with 25364 Southwark 4D, giving Burnaby 4D and London S.
3	42356 Cambridge S with 52346 Berkeley 3D, giving Surfleet S and Barham 3D.
4	45362 Kirkstall 4D with 42563 Disley 3D, giving Bourne S and Morning Star TB.
5	26435 Burslem 4D with 36425 Berkeley 3D, giving Surfleet S and Berwyn TB.
6	25634 Primrose S with 35624 Berkeley 3D, giving Hexham S and Barham 3D.
7	45623 Primrose S with 25643 Berkeley 3D, giving Hexham S and Barham 3D.
8	64253 Tintern 4D with 62534 Wearmouth S, giving Newcastle S and Bedford 4D.
9	26345 Tintern 4D with 54236 Wells S, giving Newcastle S and Southwark 4D.
10	46235 Northumberland S with 36245 Chadkirk TB, giving Fountains 4D and Francis Genius 3D.
11	35624 Carlisle S with 54236 Berkeley 3D, giving Munden S and Barham 3D.
12	64532 Tewkesbury 4D with 56423 Disley 3D, giving Sandiacre S and Morning Star TB.
13	56432 Northumberland S with 56234 Chadkirk TB, giving Fountains 4D and Francis Genius 3D.
14	43256 Glastonbury 4D with 46235 Berkeley 3D, giving Munden S and Berwyn TB.
17	52436 Norwich S with 56342 Belvoir 3D, giving Warkworth S and Dover 3D.
19	25634 Netherseale S with 24356 Abbeyville 4D, giving Marple 4D and Cunecastre S.
20	34562 Netherseale S with 24563 Chiltern TB, giving Taxal 4D and Stirling 3D.
23	42356 Rochester TB with 43625 Westmorland 3D, giving Fulmer 3D and Cotswold TB.
24	53246 Rochester TB with 25364 Westmorland 3D, giving Fulmer 3D and Cotswold TB.
25	34256 Dunedin 3D with 32564 Mendip TB, giving British Scholars' Pleasure TB and Chelsea 3D.
26	42563 Wilmslow 3D with 45632 Mendip TB, giving British Scholars' Pleasure TB and Peveril 3D.
27	52436 Wilmslow 3D with 64253 Mendip TB, giving British Scholars' Pleasure TB and Peveril 3D.
28	26345 Trinity Sunday TB with 54236 Castleton 3D, giving Warwick 3D and Pennine TB.
29	53426 Trinity Sunday TB with 62543 Hertfordshire 3D, giving Easthampstead 3D and Pennine TB.
31	56243 Caernarvon 3D with 56324 Hertfordshire 3D, giving Easthampstead 3D and Bucknall 3D.
32	24356 Trinity Sunday TB with 24635 Hertfordshire 3D, giving Easthampstead 3D and Pennine TB.
33	62543 Trinity Sunday TB with 62354 Bucknall 3D, giving Caernarvon 3D and Pennine TB.

Next there are a number of swaps of the middle 2 changes of leads:

2	42635 York S with 62354 Castleton 3D, giving Durham S and Bucknall 3D.
15	56423 Wearmouth S with 35624 Chiltern TB, giving Lightfoot S and Cheviot TB.
16	23645 Wearmouth S with 52346 Chiltern TB, giving Lightfoot S and Cheviot TB.
18	56423 Taxal 4D with 25643 Wells S, giving Marple 4D and London S.
21	34562 Taxal 4D with 32645 Abbeyville 4D, giving Marple 4D and Canterbury 4D.
22	63524 Abbeyville 4D with 32456 Caernarvon 3D, giving Canterbury 4D and Warwick 3D.
30	43625 Caernarvon 3D with 43562 Castleton 3D, giving Warwick 3D and Bucknall 3D.

Next there are a number of cross-extent 3-lead and 6-lead splices:

A	Leads 45362 of Bourne S, 23564 of Hull S and 45263 of Wooler S have a 3-lead splice applied (bells 2 and 4 fixed) to give Caithness S, Cranford S and Brentford S.
B	Leads 46325 of Hull S, and leads 45362 and 54326 of Disley 3D have a 3-lead splice applied (bells 4 and 5 fixed) to give Cranford S and Shelford 3D.
C	Leads 64532, 63524 and 62543 of Sandiacre S have a 3-lead spliced applied (bells 5 and 6 fixed) to give Pontefract 3D.
D	Bells 24635 of Sandiacre S, and leads 62534 and 26435 of Disley 3D have a 3-lead splice applied (bells 2 and 6 fixed) to give Blunsdon S and Shelford 3D.
E	Leads 34625, 35642 and 64352 of Old Oxford 4D have a 3-lead splice applied (bells 3 and 6 fixed) to give Elston 4D.
F	Leads 26435 and 52436 of Old Oxford 4D, and leads 26345 and 52346 of Combermere 4D, and leads 42356 and 64352 of Duke of Norfolk TB have a 6-lead splice applied (bell 3 fixed) to give

	Sedlescombe S, Offley S and Finchampstead 3D.
G	Leads 42563 and 23564 of Old Oxford 4D, and leads 45632 and 35624 of Combermere 4D, and leads 35642 and 34625 of Duke of Norfolk TB have a 6-lead splice applied (bell 6 fixed) to give Bamborough S, Kelso S and Conisborough 3D.

Additionally the following splice is applied:

#	Lead 36245 of Oxford TB is rung instead as lead 32645 of Kent TB (these 2 leads contain the same rows).
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This gives us enough leads of every method in the 178 (subject to altering some leads to their 2nds or 6ths place equivalent), but to ensure there are enough plain leads of every method, two pairs of courses are deconstructed and rebuilt as three courses, one of four leads and two each of three leads, so that a plain lead of every method in the original courses is included. So the following two courses:

<u>54326</u> Warkworth S	<u>54326</u> Neasden 4D
35642 Warkworth S	63254 Neasden 4D
63254 Warkworth S	42563 Bacup S
26435 Warkworth S	35642 Clarence 4D
42563 Warkworth S	26435 Hathern S
<u>54326</u>	<u>54326</u>

become:

<u>53462</u> Warkworth S	<u>36524</u> Neasden 4D	<u>42563</u> Bacup S
45236 Warkworth S	45236 Hathern S	35642 Clarence 4D
24653 Neasden 4D	62345 Warkworth S	26435 Warkworth S
36524 Warkworth S	<u>36524</u>	<u>42563</u>
<u>53462</u>		

And the following two courses:

<u>23456</u> Belvoir 3D	<u>23456</u> Balmoral 3D
42635 Belvoir 3D	56342 Sandal TB
64523 Belvoir 3D	42635 Sandal TB
56342 Dover 3D	35264 Balmoral 3D
35264 Belvoir 3D	64523 Balmoral 3D
<u>23456</u>	<u>23456</u>

become:

<u>42635</u> Belvoir 3D	<u>53624</u> Dover 3D	<u>56342</u> Sandal TB
64523 Balmoral 3D	65432 Balmoral 3D	42635 Sandal TB
23456 Belvoir 3D	32546 Belvoir 3D	35264 Balmoral 3D
<u>42635</u>	<u>53624</u>	64523 Belvoir 3D
		<u>56342</u>

Some leads also have to be swapped with the same lead in a different course to allow 2nds and/or 6ths place variants to be rung, e.g. lead 56234 Waltham 4D is swapped with lead 56234 Francis Genius 3D giving leads of Cambridge 3D and Burslem 4D instead. These swaps are denoted in the table by lower case letters a-k.

Step 6

The final step was then to join all the courses together in such a way that plain leads of every method were included, i.e. any bobbed or singled leads needed to have an equivalent plain lead somewhere else in the composition. My personal preference is not to have any repetitions of lead-end and lead-head rows between calls so this imposed a further constraint. To make the composition more practical to ring I tried to mix up overworks as little as possible, but inevitably the composition ended up with 90+ changes of overwork which I felt could not be much improved on. This step was another lengthy one but I eventually managed to produce a composition which met all the required criteria.

The final challenge of course was to ring the composition, and this was achieved at the first attempt at Wadenhoe on February 1st 2014.

APPENDIX A – ALPHABETICAL LIST OF METHODS

Av	Abbeyville 4D	Do	Dover 3D	No	Norwich S
Al	Alderbourne 3D	Dk	Duke of Norfolk TB	Oc	Ockley TB
Ad	Allendale S	Dn	Dunedin 3D	Of	Offley S
Ak	Alnwick S	Du	Durham S	Ol	Old Oxford 4D
Ab	Annable's London S	Eh	Easthampstead 3D	Os	Oswald 3D
Bc	Bacup S	Ed	Edinburgh 3D	Ox	Oxford TB
Ba	Balmoral 3D	El	Elston 4D	Pa	Pattishall 3D
Bm	Bamborough S	Ey	Ely 3D	Pb	Pebmarsh 3D
Bh	Barham 3D	Es	Evening Star 3D	Pm	Pembroke 3D
Be	Bedford 4D	Ev	Evesham 4D	Pn	Pennine TB
Bt	Beeston 3D	Fi	Finchampstead 3D	Pe	Pevensey 3D
Bl	Belvoir 3D	Fl	Flamstead S	Pv	Peveril 3D
By	Berkeley 3D	Fg	Fotheringay 3D	Po	Pontefract 3D
Bk	Berwick S	Fo	Fountains 4D	Pr	Primrose S
Bw	Berwyn TB	Fr	Francis Genius 3D	Qu	Quantock TB
Bv	Beverley S	Fy	Fryerning S	Re	Redbourn S
Bd	Blunsdon S	Fu	Fulmer 3D	Ri	Richborough 3D
Bg	Bogedone 3D	Gl	Glastonbury 4D	Rm	Richmond 3D
Bo	Bourne S	Ha	Hathern S	Rc	Rochester TB
Br	Braintree 4D	Hp	Hatherop 3D	Ro	Rosendale S
Bf	Brentford S	Hf	Hertfordshire 3D	Rs	Rostherne 3D
Bp	British Scholars' Pleasure TB	He	Hexham S	Sd	Sandal TB
Bn	Bucknall 3D	Hi	Hitcham 3D	Sa	Sandiacre S
Bu	Burnaby 4D	Hu	Hull S	Se	Sedlescombe S
Bs	Burslem 4D	Hm	Humber 4D	Sf	Shelford 3D
Bz	Burton TB	Ip	Ipswich S	Sh	Sherborne 4D
C4	Cadoxton 3D	Ke	Kelso S	Sk	Skipton 3D
Cz	Caernarvon 3D	Kt	Kent TB	Sn	Snowdon TB
Cp	Caithness S	Kh	Kentish 3D	So	Southwark 4D
Cg	Cambridge 3D	Km	Killamarsh TB	Sl	St Albans 4D
Cm	Cambridge S	Ks	Kingston TB	Sw	St Werburgh 4D
Ca	Canterbury 4D	Ki	Kirkstall 4D	St	Stamford S
Ct	Canterbury S	Kn	Knutsford 3D	Sg	Stirling 3D
Ci	Capel TB	La	Langleybury S	Si	Stisted 3D
Ck	Carisbrooke 3D	Le	Leasowe 3D	Su	Surfleet S
Cl	Carlisle S	Lf	Lightfoot S	Ta	Taxal 4D
Cx	Castleton 3D	Li	Lincoln S	Te	Tewkesbury 4D
Cj	Chadkirk TB	Lo	London S	Ti	Tintern 4D
Cw	Charlwood 4D	Ls	London Scholars' Pleasure TB	To	Tollesbury 3D
Cc	Chelsea 3D	Lv	London Victory 4D	Tr	Trinity Sunday TB
Cs	Chepstow 3D	Lu	Ludlow 3D	Va	Vale Royal 4D
Ch	Chester S	Ma	Marple 4D	Wa	Waltham 4D
C3	Cheviot TB	Md	Melandra 3D	Wk	Warkworth S
C2	Chiltern TB	Ml	Melrose 4D	Ww	Warwick 3D
Cr	Clarence 4D	Mp	Mendip TB	Wf	Waterford TB
C5	Cogenhoe 3D	Me	Merton 4D	Wt	Wath 3D
Co	Coldstream S	Mi	Middlesex 3D	Wm	Wearmouth S
Cb	College Bob IV 4D	Ms	Morning Star TB	We	Wells S
Cf	College Exercise TB	Mo	Morpeth S	Ws	Westminster S
Ce	Combermere 4D	Mu	Munden S	Wd	Westmorland 3D
Cn	Conisborough 3D	Ns	Neasden 4D	Wh	Whitley S
Cy	Conway 3D	Nh	Neath 3D	Wg	Wiggenhall 3D
C1	Cotswold TB	Nl	Nelson TB	Wi	Willesden 4D
Cv	Coventry 3D	Ne	Netherseale S	Wl	Wilmslow 3D
Cq	Cranford S	Nw	Newcastle S	Wv	Woodcock's Victory TB
Cd	Crowland 4D	Ng	Newdigate 4D	Wo	Wooler S
Cu	Cunecastre S	Ny	Norbury TB	Wr	Wragby 4D
Da	Danbury 3D	Nf	Norfolk S	Yo	York S
Di	Disley 3D	Nb	Northumberland S		
Dt	Donottar 3D	Nm	Norton-le-Moors TB		