**UNIT 3 EAN Bar Codes**  Lesson Plan 1

### 1 Introduction

T: What codes can you think of that are used in everyday life?
T: What codes do supermarkets use all the time?  (*Bar codes*)
T: Why do they use them?  (*Speedy reading of prices at check-outs, stock control, etc.*)
T: In fact, bar codes not only speed up checkout times but also mean that the price of each product can be quickly altered, special offers (3 for the price of 2, etc.) can be automatically applied and stock control is immediate.
T: When might this system break down?  (*Power cuts, computer problems*)
T: Where would it be ineffective with stock control?  (*Stolen items*)

**8 mins**

### 2 Checking check digits

T: What does the computer do with items at the checkout?  (*Reads bar codes*)
T: What happens if it reads a code incorrectly?  (*It alerts the checkout operator with a warning sound*)
T: How does the computer know if it has read the bar code correctly?

T: Consider the number

\[
0 \ 0 \ 3 \ 6 \ 8 \ 1 \ 2 \ 4
\]

\[\uparrow\]

check digit

The final number is the check digit. The computer works out:

\[
3 \times (1st + 3rd + 5th + 7th) + (2nd + 4th + 6th + check \ digit)
\]

which must be divisible by 10.

T: Who would like to check this with our bar code?

P (at board):

\[
3 \times (0 + 3 + 8 + 2) + (0 + 6 + 1 + 4)
\]

\[= 3 \times 13 + 11\]
\[= 39 + 11\]
\[= 50\]

\[\text{Is this number divisible by 10?} \quad (\text{Yes})\]

T: So will the computer accept this as a correct bar code?  (*Yes*)
T: Well done.
UNIT 3  EAN Bar Codes  Lesson Plan 1

8-Digit EAN

Notes
Individual work; allow 4 or 5 minutes with T monitoring and checking Ps' work.

Volunteer P at board, carefully monitored, and helped if necessary.

Give praise when deserved.

Activity 2 (continued)

Now try the questions in Exercise 2.

T: Let's look at (a). Is the check digit correct?  (Yes)
T: Good. Now (b).  (Yes)
T: What about (c)?
Ps: It's not correct.
T: Who would like to volunteer to show us how to find the correct check digit here?
P (while writing on board):

\[
\begin{align*}
3 \times (5 + 1 + 8 + 2) + (0 + 6 + 6 + 2) \\
= 3 \times 16 + 14 \\
= 48 + 14 \\
= 62
\end{align*}
\]

As this number has to be divisible by 10, it is too great by 2. The final number should have been 0.
T: Well done!

Finding check digit

T: We can also calculate a missing check digit.

For example, (writes on board, Exercise 1, part (a)):

\[
\begin{array}{c}
0 \\
0 \\
0 \\
8 \\
6 \\
3 \\
x
\end{array}
\]

where \(x\) is the unknown check digit.

T: How should I do this?  (Use the method)
T: Who would like to work this out?
P (at board):

\[
\begin{align*}
3 \times (0 + 0 + 6 + 9) + (0 + 8 + 3 + x) \\
= 3 \times 15 + 11 + x \\
= 45 + 11 + x \\
= 56 + x
\end{align*}
\]

T: What value of \(x\) makes this divisible by 10?
Ps: 4
T: Good. So the check digit is 4.

T: Now you can try Exercise 1, problems (b) and (c).

Solutions

(b) \[3 \times (5 + 2 + 4 + 1) + (0 + 1 + 2 + x)\]
\[= 3 \times 12 + 3 + x\]
\[= 36 + 3 + x\]
\[= 39 + x\]

To make this divisible by 10, \(x\) must be 1.

(continued)
UNIT 3  EAN Bar Codes  Lesson Plan 1

8-Digit EAN

(c) \(3 \times (0 + 4 + 6 + 5) + (0 + 2 + 5 + x)\)

\[= 3 \times 15 + 7 + x\]

\[= 45 + 7 + x\]

\[= 52 + x\]

To make this divisible by 10, \(x\) must be 8.

---

4  Error correction  (Activity 2a)

T: We know how to detect one error in a bar code number but if the number is incorrectly read, can it be corrected?

T: Try this number

\[5 0 2 6 \ 8 0 2 0\]

First show that it is not correct and then try to find what the number could have been

It might not be the check digit that is wrong.

T: Who has some answers?

T: What can we conclude?

Ps: It is not possible to correct errors, so the computer needs to read the number again.

T: Well done.

---

Homework

Find several examples of bar codes on products. Look at the actual design of the code and see what you can conclude about it.

Bring some examples of bar codes to the next lesson.
## UNIT 3 EAN Bar Codes  Lesson Plan 2

### Design

T: What have you noticed about your bar codes?  
(Various answers)

T: How many numbers are there on a bar code?  
(8 or 13; 7 on M & S products)

T: We'll start with the 8-digit bar codes.  
You should be able to see (writes on board):

- left hand guard rails (2 extended black lines)
- 4 numbers coded on the left
- centre guard (2 extended black lines)
- 4 numbers coded on the right
- right hand guard rails (2 extended black lines)

T: What else have you noticed?  
Ps: Each number is coded by two lines.
T: Yes – what can you say about these lines?  
Ps: They are of different widths/thicknesses.  
T: Good; how many different widths/thicknesses are there?  
Ps: Three?  
T: No, look again.  
Ps: Four.  
T: Yes – you could refer to them as  
*very thin, thin, thick, very thick*  
We'll see how to actually design the left hand numbers.  
8 mins

### Left hand codes

T: You will not know this, but the code for each digit is constructed from a *seven* module system. Here is the code for 5 – of course, you cannot see the construction lines.

T: To design each number we put either 0 (white) or 1 (black) into code of the same width but with these rules

T: Can anyone show me another possible code for a number?

T: Now that we have 2 (3) examples you can work in pairs to find all the possible solutions.

T: How many solutions have you found?  
(7, 8 or 9)

T: How many do we need?  
(10)

T: Who wants to show a solution?

(continued)

### Notes

Ps should have brought several examples of bar codes from products. (T should have some ready in case they are needed.)

Ps will need to have 2 or 3 8-digit codes in front of them.

Use **OS 3.1** to illustrate.

This should be very interactive with Ps responding to the answers given. Reluctant Ps should be chosen to give answers whenever possible.

Praising.

Use **OS 3.2**.

Use **OS 3.3** here.

Either use the right hand side of **OS 3.2** or wait to see if Ps volunteer answers.

If T has the facilities the bar code design program can be used at this stage, or at the review stage after Ps have had 5-10 minutes to find solutions.

If any P has more than 10 solutions T will need to review the errors with the whole class.

Volunteer Ps gives solutions; other Ps agree/disagree.
<table>
<thead>
<tr>
<th>Activity 2 (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T: Well done!</td>
</tr>
</tbody>
</table>

### Codes and Ciphers

#### UNIT 3 EAN Bar Codes Lesson Plan 2

#### 3 Right hand codes

T: The full set of LH codes for 8-digit EANs is given on your sheet. The digits 0 to 9 are each arbitrarily given one of the 10 possible solutions.

T: Now what about right hand codes? What do you notice? (Similar system; 8 black bars, etc.)

T: Why is a different system needed for RH codes? (So that the light pen/scanner can detect whether it is reading from left to right or from right to left)

T: That’s right; a different but related design is used for RH numbers as you can see on your sheet.

T: Which number set is used for the LH code? (A)

T: Number set C is used for RH codes, but how is it related to number set A? (Each 0 becomes 1 and vice versa)

T: We call C the dual of A.

T: We have not yet used number set B, but can you see how it is obtained from C? (Reflection)

T: Could you now design another number set? (The dual of B)

T: We will see in the next lesson how number set B is used with 13-digit EANs.

---

**Homework**

Show that the check digit for the 13-digit EAN

\[ 4 9 0 2 5 8 0 4 2 3 9 1 9 \]

is correct, using a method similar to that used for 8-digit EANs.

---

**Design of 8-Digit EAN**

---

**Notes**

T shows OS 3.3 or computer program to check answers. Continue until all 10 have been found; T gives praise, particularly to anyone has all the solutions.

Review of systematic strategies for finding all solutions, e.g. for five 1s, move the right hand ‘0’ along to the left.

So there are just four possible configurations using five 1s.

---

Each P is given a copy of OS 3.4.

Ps use their wrappers, etc. but restrict this to 8-digit EANs.

T gives each pair of Ps a copy of OS 3.5.

T gives Ps a few minutes to discuss this in pairs.

Interactive discussion, preparing for next lesson.
### Codes and Ciphers

<table>
<thead>
<tr>
<th>Activity</th>
<th>Checking homework</th>
</tr>
</thead>
<tbody>
<tr>
<td>T: Who could verify the check digit? &lt;br&gt; Come and show us on the board.</td>
<td>3 \times (9 + 2 + 8 + 4 + 3 + 1) + (4 + 0 + 5 + 0 + 2 + 9 + 9) &lt;br&gt; [= 3 \times 27 + 29] &lt;br&gt; [= 81 + 28] &lt;br&gt; [= 110] &lt;br&gt;This is divisible by 10. &lt;br&gt;T: Good.</td>
</tr>
</tbody>
</table>

| 2 Practice |
| T: What is the check digit for the number \[500043678467x\] ? | T: Who has the answer? (8) <br>T: Who would like to show us their working? |

| Design of Code |
| T: There is an added complication with the design of the 13-digit EAN. Has anyone spotted it? <br> (There is an odd number to code) | T will need to give the rules here but the more that Ps can understand from their examples the better. <br>**OS 3.5** can also be used to identify the number sets used if you look very carefully. |
| T: What else do you notice from your examples? <br>(The first number is outside the bar!) | This is not easy to describe as it involves essentially stating the rules; T must make sure that Ps have understood. |
| T: Yes – the code shows the last 12 digits, 6 on each side of the guards; the first digit is found by the computer according to what number sets have been used for the LH numbers. <br>What number set is used for the last 6 digits? (Number set C) <br>What could be used for the other 6 digits? (A or B) | T allows at least 5 minutes for Ps to work in pairs on this activity. |
| T: In fact, if you use only number set A for all 6 of these digits, this means that the first (uncoded) digit is 0. <br>For the other 9 possibilities the left hand six numbers are coded using a combination of number set A or B. <br>How many ways can you make using 3 As or 3 Bs? <br>Here is one example: <br>A A A B B B | T checks that all answers are just 3 As and 3 Bs. Praising. |
| Now find all other possibilities but be systematic in your search. | |
| T: How many solutions have you found? (7, 8, 9 ?) | |
| T: Show your solutions to the class. | |

(continued)
<table>
<thead>
<tr>
<th>Codes and Ciphers</th>
<th>UNIT 3  EAN Bar Codes  Lesson Plan 3</th>
<th>Design of 13-Digit EAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity 3</strong> (continued)</td>
<td>T: In the same way as with the bar code design, these solutions are arbitrarily assigned to a digit, as shown on one side. T: The computer first has to determine the number set used for the six LH digits; this gives the first digit. Now the computer checks the check digit for the 13-digit EAN!</td>
<td><strong>Notes</strong> Use OS 3.6 here.</td>
</tr>
<tr>
<td></td>
<td>30 mins</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong> Practice</td>
<td>T: Using the template on OS 3.7, illustrate the bar code for</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 7 7 0 0 4 9 3 9 2 0 7 7</td>
</tr>
<tr>
<td></td>
<td>Also verify that the check digit is correct.</td>
<td>Each pupil is given a copy of OS 3.7, OS 3.6 and OS 3.5.</td>
</tr>
<tr>
<td></td>
<td>45 mins</td>
<td></td>
</tr>
<tr>
<td><strong>Homework:</strong> Activity 6</td>
<td>How could you design a bar code system that codes letters and digits?</td>
<td></td>
</tr>
</tbody>
</table>