Process Flow Design and Trial Production Demo Exercise (FDDx)[1]

1.0 Introduction:

This exercise involves multiple groups (of size 9 or more) performing the same set of activities; further discussion assumes only one group. It is also assumed that the group leader and other members have been selected.

Your group represents a manufacturing company. You have just received intimation from one of your customers that you have been selected to assemble three models of a product called **Beacon**.

The exercise will be performed in three phases: (1) Design the process flow for assembly and testing operations. (2) Demonstrate capability through a trial production demonstration. (3) Prepare a post-production report and present it to the management.

The objective of this exercise is to design an efficient production system, to maximize "net revenue" during trial production run and to recommend future process improvements.

2.0 The Exercise:

Although each member of the group has a different role to play, everyone is expected to read this document thoroughly and understand all aspects of this exercise.

2.1 Phase 1: Process Design

Your group will receive a packet containing a few components to build the product several days before Phase 2. Product specifications for different products and explanatory notes are given in the Appendix B and Appendix C gives product schematics.

During the first group meeting you should select an appropriate name for your company (can even decide on a logo). The group is then divided into a **production team (also called the supplier)**, an **audit team** (three members) and observers, if any. The group leader will be a member of the production team. The group will start discussing the "hardware" (i.e., physical flow of product) design, "software" (i.e., management system) design and rationale for these designs.

[1] See acknowledgements at the end of this report.

Hardware design:

(1) Determine production system (assemble to stock, assemble to order etc,) layout of workstations (straight line, U/L shaped, etc,) and the number of workers assigned to different stations. (A workstation could carry out a single task or a group of tasks). The group could decide to build three products separately.

(2) Draw a process flow diagram. Show tasks and stations, storage points, and number of workers assigned to different stations.

Software design:

(1) Provide a brief description of the management system. Be certain to identify whether your system is make-to-stock, make-to-order, or assemble-to-order. Specify whether you will use "push" system or "pull" system. Determine what information is needed for decision making for all the different operations' tasks.

(2) Draw an information flow diagram.

Rationale: Explain the key competitive priorities and how the design (hardware and software) provides for these priorities.

Usually, multiple group meetings are held. During or after the decisions on hardware and software, number of production team members is finalized[2]. It is possible that there may be some members who do not belong to the audit team or the production team. The production team can practice building the product; the auditors will develop a thorough understanding of their roles.

The group will submit a report (called Report 1: Pre-Production Report) containing the "hardware" (i.e., physical flow of product) design, "software" (i.e., management system) design and rationale for these designs.

Report 1 is due when everyone meets for the trial production demonstration. Additional information about report is provided in Appendix D.

[2] Typically, there are 3 people in the audit team, the production team contains 6 to 8 people and the balance act as observers. If the total group size is only 8, one may be able to do this exercise with 2 auditors and 6 production members.

2.2 Phase 2: Demonstration

When groups gather for the trial production demonstration time, they will be given one or two tables and chairs to set up production process. The exercise coordinator will set up a common store in a central location to supply components to all production teams (from different groups). The coordinator will assign an audit team of one group to audit the production team of a different group[3]. Auditors will represent the customer in this phase.

(A) Pre-demonstration activities (10 to 15 minutes)

i. The production team will set-up the process layout and each production worker will take appropriate position. Activities to be carried out during demonstration include making (and testing) the product, getting material from the stores, delivering finished product to the customer (i.e. auditors), bringing rejected unit from the customer for rework, general coordination and supervision.

ii. The audit team will make initial preparation (see duties of auditors).

iii. Stores will supply a package containing material to produce several units of different products, two wire cutters and a tester.

(B) Activities during demonstration (36 minutes)

Each team is expected to supply 40 units of products to the customer. There are 3 models R, G and Y. These will be needed in the approximate proportion 4:4:2. The exact sequence in which these units are to be delivered will be revealed gradually during the demonstration period.

i. **Warm up period - Time unit 0 to 10 minutes**: After the instructor gives the "start" signal (marking time zero), the production team will start building products from the material supplied in the package (the package will contain material to build a total of 10 units - 4R, 4G and 2Y). The team can build finished product units and/or partially completed units as they desire.

ii. **Order release period - Time unit 10 to 31 minutes**: **The central store will be opened.** Starting at time unit 10, eight customer orders will be released (each order will have 5 units total of different models), one every 3 minutes (the last order will be released at time 31). Deliveries to the customer are of two types:

(a) A customer order in the sequence of order release.

(b) Replacement units for any units rejected by the customer.

A new customer order will be accepted only if there are no pending replacement units to be delivered. When an auditor rejects a unit, the production team must be informed immediately. The rejected unit is taken back to the production area. The production

[3] With two groups X and Y, audit team X will audit production team Y and audit team Y will audit production team X. With three groups X, Y, Z, audit X is assigned to production Y, audit Y is assigned to production Z and audit Z is assigned to production X.

team can supply the replacement unit from stock, build a new one and supply or repair the rejected unit and deliver it again.

A production team representative can make any number of visits to the store to get additional components. While defective raw material can be returned to the store excess material cannot be brought back to the store.

iii. **Closing period - Time unit 31 to 36 minutes: The store will close at time 33**. The production team can work for these five minutes to complete as many orders as possible and deliver them. At the end of this interval, the instructor will give "stop" signal. All production activities must stop immediately. The production team will be allowed to deliver completed orders to the auditor (provided they are in the correct sequence) at this time.

Production team can change the process layout during the demo, if required. If a worker is added, report to the auditor.

(C) Post-demonstration activities (about 10 minutes)

Auditors will come to the production area to count and record excess inventory. This will involve recording and testing of late deliveries. The Production team will clean up production area.

2.3 Phase 3: Debriefing

This involves your group's debriefing and a submission of Report 2 (Post-Production Report). Your submission should be 2-3 pages long describing 1) what, if any thing, you changed for the demonstration relative to your proposed "hardware" and "software" designs, 2) what worked well and what did not work well, 3) what you would improve and how you would improve it, and 4) what you learnt. Each team will be asked to make a short (5 minutes) presentation in the class meeting following the demonstration. Report 2 will be *due* at the beginning of your presentation.

Acknowledgements: This exercise is based on an exercise designed at Harvard Business School (9-64-694).

Appendix A
Duties of Auditors

Work described below may be split among auditors in any convenient manner during the actual exercise. Remember that there is very little work in the beginning but the pace builds up considerably towards the end.

Order Receipt:

1) The exercise coordinator will give you all customer orders (order #1,2,..,8 each containing 5 units of products) at the beginning of demonstration period. When the supplier brings a completed order to you, make sure that it is delivered in the correct sequence.
2) Record the order as received and start testing immediately. If a defective unit is found, call the supplier immediately, explain to them what the defect was (see below) and ask them to replace the defective unit as soon as possible.
3) Suppose, orders numbered 1, 2 and 3 have been received. You found #1 to be defect free, you found a "Y" unit from order #2 to be defective and you have returned the unit to the supplier. At this point, if the supplier brings in order #4, do not accept it. There must not be any pending defective units in the pipeline. On the other hand, suppose you were testing order #2 and there are no defective unit. If the supplier brings order #4, receive the order for testing (even if you have not completed testing of order 2 and 3).

What to test

1) Perform the following.
   a) Insert battery tester positive (red) wire in X23 and negative (black) wire in Y23 to test that the product is functional. For model R, the light should be on continuously. For model G, the light should flicker. For model Y, there should be a buzzer sound in addition to the light.
   b) If any wire appears to be too long, pull it out and measure it.
   c) Make a visual inspection (on a sampling basis, say about 1 unit per order) to see that connections are inserted in the right locations.

   If the product is rejected due to any reason, take the following actions.

   i. Inform the supplier and other auditors in your team immediately.
   ii. Do not test a new order until a replacement unit is submitted and accepted.

Post exercise duties:

1) If any testing is not completed, finish it first.
2) Count inventories and complete Form 2. Suppose that the first 5 order have been accepted at the end of the exercise, 4 units of order 6 are accepted and order 7 is received but not tested. Then all units of first 5 orders will be counted towards profit margin, everything else will be charged to the end of period inventory.
3) Give a copy of completed Forms 1 and 2 to the instructor before leaving the demonstration area. Calculate the net revenue and give that figure to group leader for the final report (Report 2).

Form 1: Sample Product Receipt Form[4]

Order number	✓ mark on order receipt	Circle when a unit is accepted	Tally mark on rejection	✓ mark after accepting order
1	✓	(Y) (Y) (G) (G) (G)	𝍸 /	✓
2	✓	(Y) (Y) G (R) (R)	/ /	
3	✓	Y Y G G R		
4				
●●●				
8				

Final accepted quantity only on the basis of orders accepted:

Plain (R) _____, Power Saver G)_____, Deluxe (Y)_____

Form 2: Cost Information and Revenue calculations

Name of the Production Team _____

1. **Maximum number of team members**: _____
   Labor cost = (**L**) = $7.20 * Maximum number of team members =
2. **Excess Ending Inventory Penalty**: Count the numbers from components, partial assemblies and rejected units due to defects. Example: If you find two breadboards (with chips), one partially completed assembly and four rejected items (including out of sequence); you will count 7 breadboards.

Item	Permissible Stock	Actual stock	Excess units**	Inventory Unit cost ($)	Total Cost for excess units ($)
Breadboards with chips	5			1.00	
Capacitors	5			0.20	
LED (Y, G, R)	5			0.10	
Resistors	15			0.01	
Buzzers	1			0.50	
Total cost for all excess inventory (**I**)					

   ** If actual stock is less than permissible stock, treat excess stock as zero.
3. **Rejection penalty**:
   Rejection penalty = (**J**) = $1.0 x # of units rejected =
4. **Net Revenue:** For each accepted unit of Y and G, the contribution margin (selling price minus material and other costs except labor costs is $5. For Y, it is $6.
   Net Revenue (without notional penalty) = **5 * (R + G) + 6 * Y - L =**
   Net Revenue (with notional penalty) = **5 * (R + G) + 6 * Y - L - I - J =**

[4] These are sample forms. Actual blank forms will be distributed during demonstration. Contents of the actual forms will be slightly different but self-explanatory.

Appendix B
Product Information

Three models of the **Beacon** are: **Plain, Power Saver** and **Deluxe**. However, these are commonly known by the color of the LED used in each model. **Plain Beacon is R (for red), Power Saver Beacon is G (green) and Deluxe Beacon is Y (for yellow).**

Note on LED (Light Emitting Diode) (Figure 1)

It is important that these are inserted with correct orientation (positive and negative). Identification of positive and negative leads is indicated in the diagram below.

Top view of light emitting diode (LED):
Round edge (long wire) - positive
Flat edge (short wire) – negative)

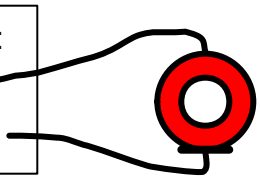

Figure 1: LED Schematic

Note on Resistors

Resistors are differentiated by the their colored stripes. Value 220Ω is read as 220 Ohms. Value 1.0kΩ is read as 1k Ohms or 1000 Ohms.

Here is the color-coding scheme used.

	First two stripes:	Strip 3 (Multiplier)	Strip 4 (Tolerance)
220Ω	Red - Red: 22	Brown: x 10	Gold: 5%
1.0kΩ	Brown - Black: 10	Red: x 100	Gold: 5%
3.0kΩ	Orange - Black: 30	Red: x 100	Gold: 5%

Bend resistors as close to the shape as possible as shown in Figure 2. You need to trim the wire at one end to match two ends for easy insertion.

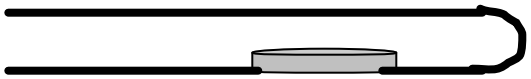

Figure 2: Resistor readied for insertion.

Do not shape resistors as shown in product schematics on the following pages.

Note on Wires

Use all wires of the same color in particular unit built. Splice both ends about 6 mm and insert exposed ends fully inside the holes.

A General Note

All materials except resistors and wires will be recycled and re-used. *Please do not remove timer chip from the breadboard.*

Plain Beacon (R)

No.	Item	Specifications	Comments
1	Breadboard assembly	LM555CN timer chip	Chip inserted in E7-F7: E10-F10
2	Resistor	220 Ω	Insert ends in C8 - C9
3	Resistor	1.0K Ω	Insert ends in J11 - Y11
4	Resistor	3.0K Ω	Insert ends in X8 - A8
5	Capacitor	35V, 500 μF	Insert ends in J8 - Y8
6	Red LED		Insert + in G9, - in G11
7	Wire (22 gauge)**	35 mm max length, ** about 6 mm splicing at both ends	Insert ends in X7 - D7
8	Wire (22 gauge)**		Insert ends in Y7 - G7
9	Wire (22 gauge)**		Insert ends in D9 - G8
10	Wire (22 gauge)**	45 mm max	Insert ends in X10 - G10

Power Saver Beacon (G)

No.	Item	Specifications	Comments
1	Breadboard assembly	LM555CN timer chip	Chip inserted in E7-F7: E10-F10
2	Resistor	220 Ω	Insert ends in C8 - C9
3	Resistor	1.0K Ω	Insert ends in E11 - F11
4	Resistor	3.0K Ω	Insert ends in X8 - A8
5	Capacitor	35V, 500 μF	Insert ends in J8 - Y8
6	Green LED		Insert -in G9, + in G11
7	Wire (22 gauge)**	35 mm max length, ** about 6 mm splicing at both ends	Insert ends in X7 - D7
8	Wire (22 gauge)**		Insert ends in Y7 - G7
9	Wire (22 gauge)**		Insert ends in D9 - G8
10	Wire (22 gauge)**	45 mm max	Insert ends in X10 - G10
11	Wire (22 gauge)**	25 MM MAX	Insert ends in X11 - A11

Deluxe Beacon (Y)

No.	Item	Specifications	Comments
1	Breadboard assembly	LM555CN timer chip	Chip inserted in E7-F7: E10-F10
2	Resistor	220 Ω	Insert ends in C8 - C9
3	Resistor	1.0K Ω	Insert ends in J11 - Y11
4	Resistor	3.0K Ω	Insert ends in X8 - A8
5	Capacitor	35V, 500 μF	Insert ends in J8 - Y8
6	Yellow LED		Insert + in G9, - in G11
7	Wire (22 gauge)**	35 mm max length, ** about 6 mm splicing at both ends	Insert ends in X7 - D7
8	Wire (22 gauge)**		Insert ends in Y7 - G7
9	Wire (22 gauge)**		Insert ends in D9 - G8
10	Wire (22 gauge)**	45 mm max	Insert ends in X10 - G10
11	Wire (22 gauge)**	35 MM MAX	Insert ends in H8 - G2
12	Buzzer		+ pin in I2, - pin in Y2

Appendix C - Product Schematics

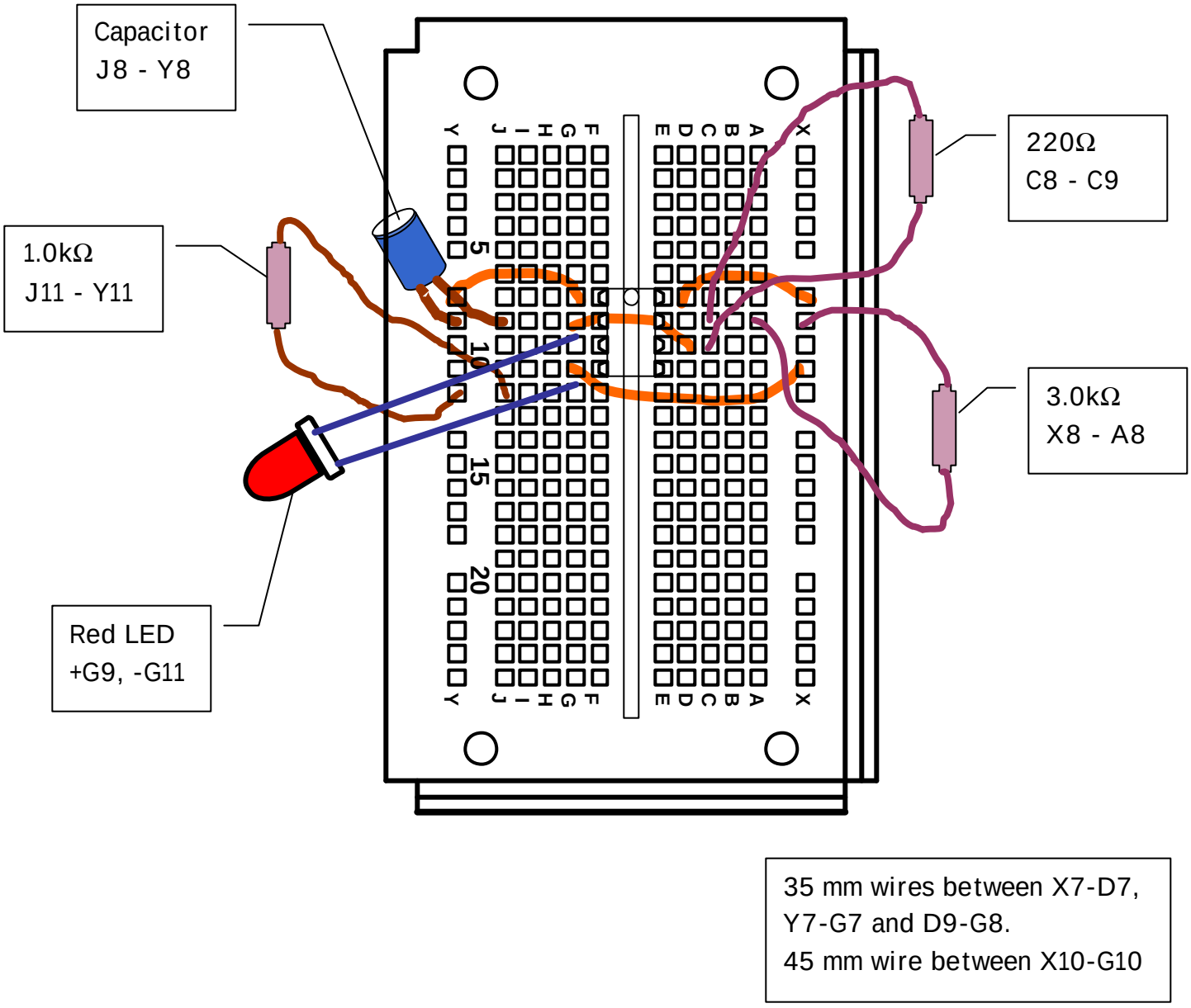

Figure 3: Schematic Diagram for Plain Beacon (R)

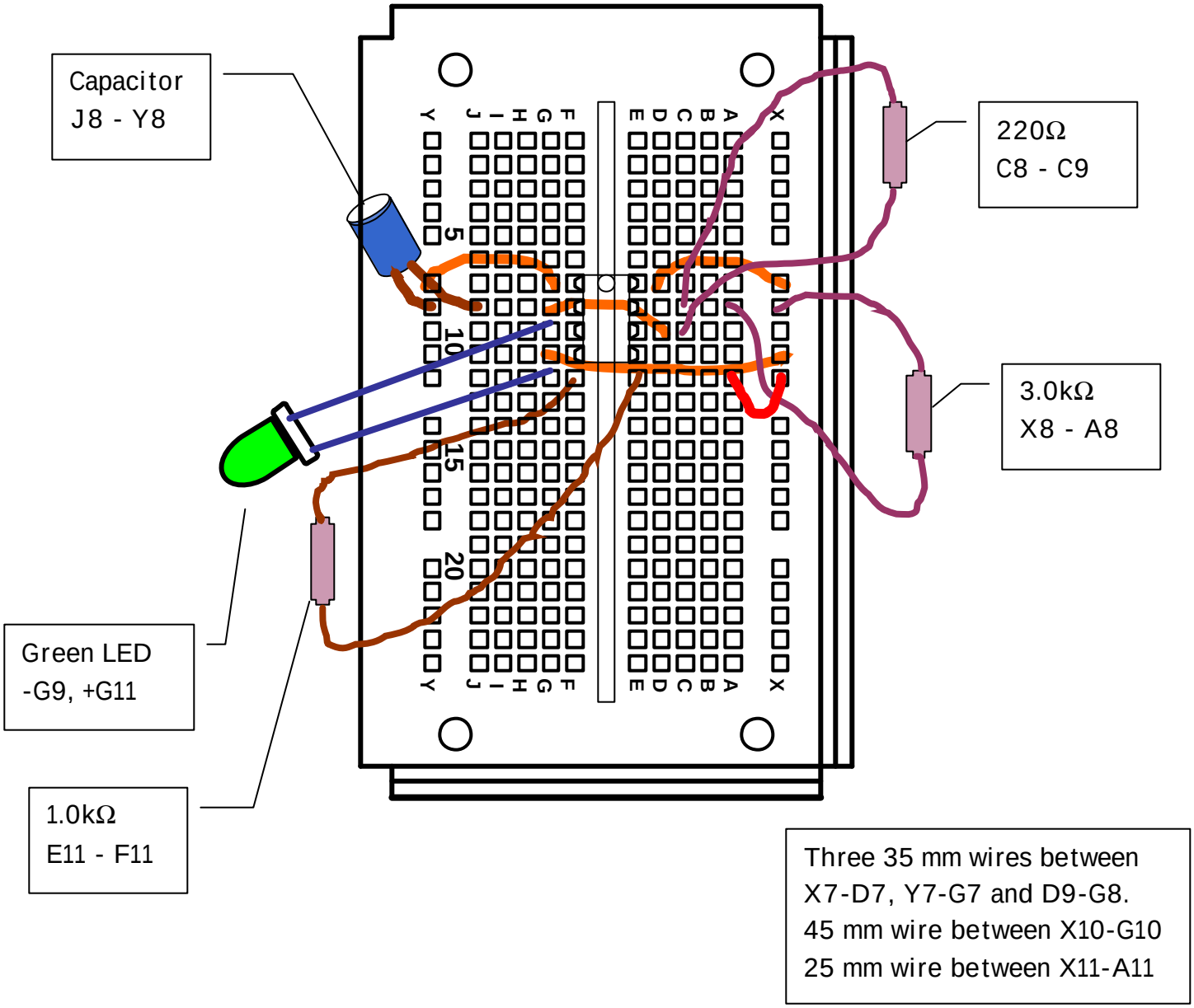

Figure 4: Schematic Diagram for Power Saving Beacon (G)

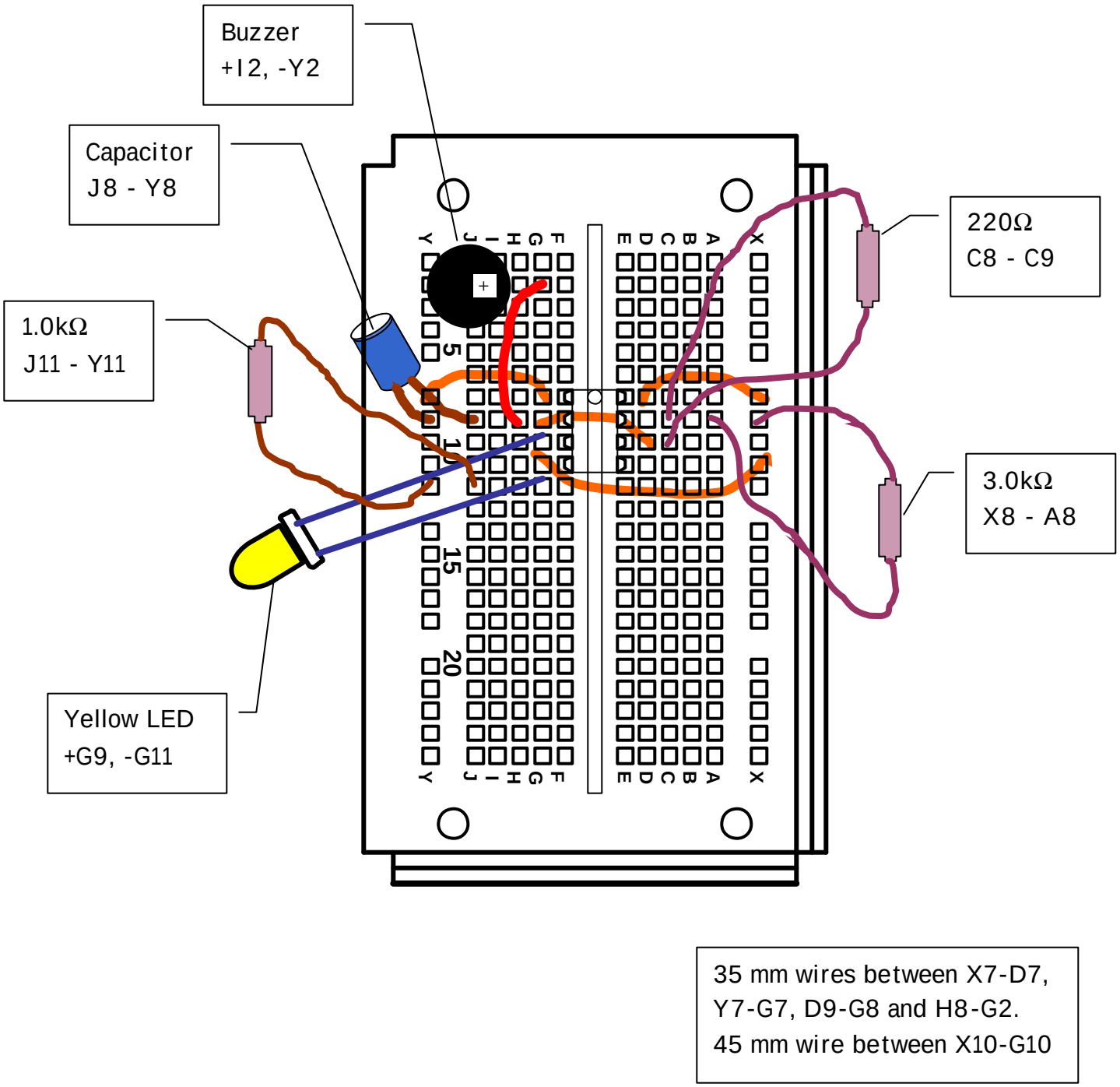

Figure 3: Schematic Diagram for Deluxe Beacon (Y)

Appendix D

Report Covers

Both reports must be typewritten (Figures may be drawn by hand but must be neat, using drawing instruments such as ruler). Put **page numbers**, **staple** all pages and **submit report on time**. **Sample cover page format** is shown below.

Process Design Report for Beacons *
Or (Post Demo Production Report)

Micro Gadgets Inc.**

Jane Foreman (Group Leader)***
Ann Assembler (Production)
Bean Counter (Audit)
Jason Cutter (Production)
Gary Goofer (Observer)
Tom Tester (Production)

Submitted to: Prof. ….

* Use appropriate title for the pre-production and post-production reports.

** Select a suitable name here.

*** Include names of all group members including auditors in **alphabetical order after the Group Leader name**