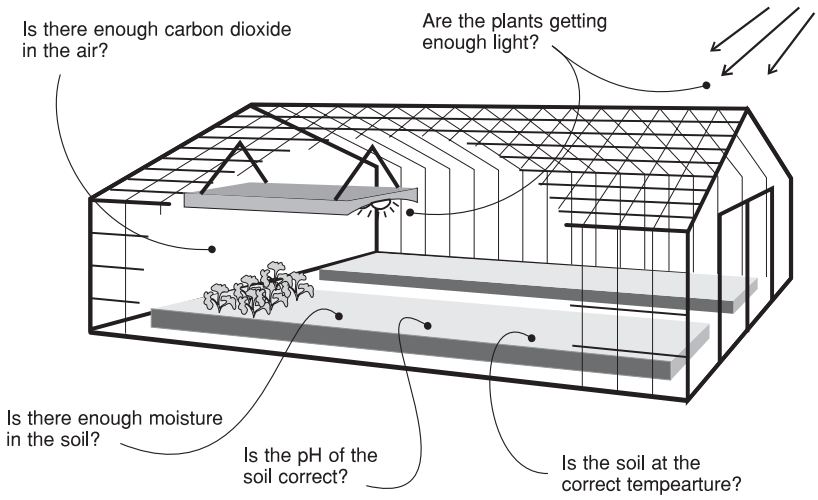
DESIGN BRIEFS: ENVIRONMENTAL MONITORING AND CONTROL IN A COMMERCIAL GREENHOUSE

Greenhouses provide an environment that allow plants to grow quickly and successfully.
This is important for commercial growers.

To maintain these conditions normally means that someone has to check them regularly. They have to take action if something needs to be changed. This requires a lot of time and labour. The conditions could be monitored and controlled automatically.



WHAT ARE THE BEST CONDITIONS?

These will be different for different plants but will always involve:

- Temperature.
- Light level.
- Moisture level in the growing medium (this could be soil but often a specially made up mixture is used).

It might also involve the pH of the growing medium and the carbon dioxide levels in the atmosphere.

To design your system, you need to find out more about these conditions.

There are two ways to do this:

1. Carry out some scientific investigations.
2. Visit a market garden, garden centre or commercial grower.

You should try to do both of these.

A SCIENCE INVESTIGATION

There are several pieces of computer software you can use to identify the optimum conditions for growing plants:

- Super Seed (CUP).
- Seed Germination (Garland).
- Photosynthesis (Garland).

They allow you to 'investigate' by controlling and changing variables and 'making measurements'.

Whichever programmes you use:

- Make some predictions.
- Plan a strategy to check your predictions - this means working out which variables to keep constant and which to change and what measurements you take.
- Collect data.
- Display the data.
- Use the data to check your predictions.
- Write a report.

VISIT A MARKET GARDEN, GARDEN CENTRE OR COMMERCIAL GROWER.

Visits need careful planning.
Before you go you should think about:

- What do you need to find out?
- What questions could you ask?
- Who will you ask?
- Will you write down the answers or use a tape recorder?
- Do you need photographs (or a video)? Make sure that you have permission.
- Do you need to make some sketches?

Before you make your visit, make a careful plan. You might find it useful to prepare a sheet to record the information you collect.
See Technology Study File 6.

DESIGN PROPOSALS

From your visit and discussions with the staff, you should be able to identify some problems to do with growing plants in greenhouses. Here are some examples to help you.

- Frost protection.
- Moisture levels.
- Light levels.

You can:

- Work on one of these.
- Work as a team to cover several or all the aspects that need to be monitored and/or controlled.
- Work on an idea of your own.

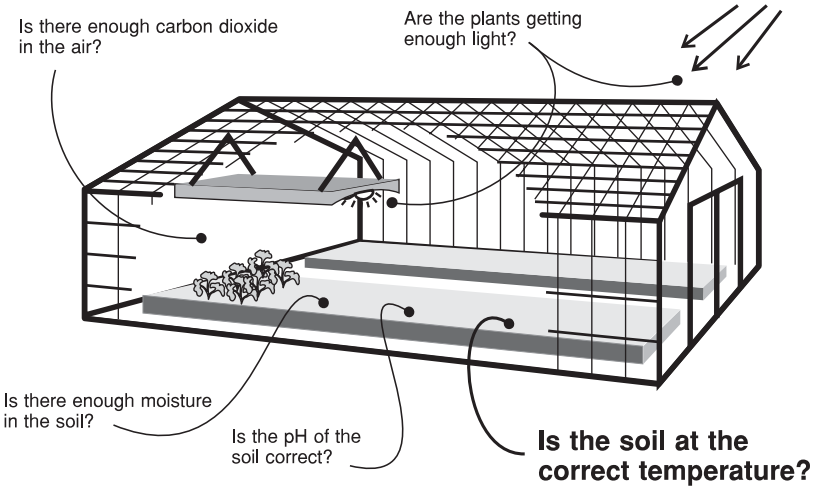
Whichever of these you do, you need to:

- Analyse the situation fully.
- Produce a specification.
- Produce a design proposal.
- Prototype the design to test it.

FROST PROTECTION

During spring, night time frosts occur quite often. These can damage young seedlings and plants. This could be avoided by:

- Giving a warning to the grower if the temperature becomes too low. This could be the temperature of the air or of the growing medium.



- Monitoring and controlling the temperature using a heater.

The first of these would still mean someone getting up to turn on a heater. What would happen if the temperature outside then went up?

The control of the heater seems to be the better solution, but it might be more expensive.

ANALYSING THE PROBLEM

- What temperature do you need in the greenhouse?
- What are the minimum and the maximum temperatures?
- Do you need to be able to change the settings?
- Will the heater be used all the time or only at night?
- Do you need an alarm in case the system or the heater fails?
- Do you need to protect the system from the hostile conditions of temperature and humidity in a greenhouse?

Open loop control	**with no feedback.**
Closed loop control	**with feedback.**
Digital control	**switching the output ON and OFF.**
Analogue control	**continuously changing the level of the output.**
Continuous control	**inputs and outputs are constantly monitored and controlled.**
Sequential control	**a sequence of actions are performed one after the other.**

Does your system need feedback?

If so, what information needs to be fed back?

Do you need to control the temperature continuously or just switch the system on and off?

INPUT - PROCESS - OUTPUT

INPUT - *What sensor will you use?*

PROCESS - *How will you control the temperature?*

OUTPUT - *What heater will you use?*
- *Do you need to use a relay?*

PRODUCING A SPECIFICATION

Now you must produce a specification for your design.
It should describe fully what the system must do.
It should include all of the answers to the questions above.

PRODUCING A DESIGN

Design a system to meet the specification.

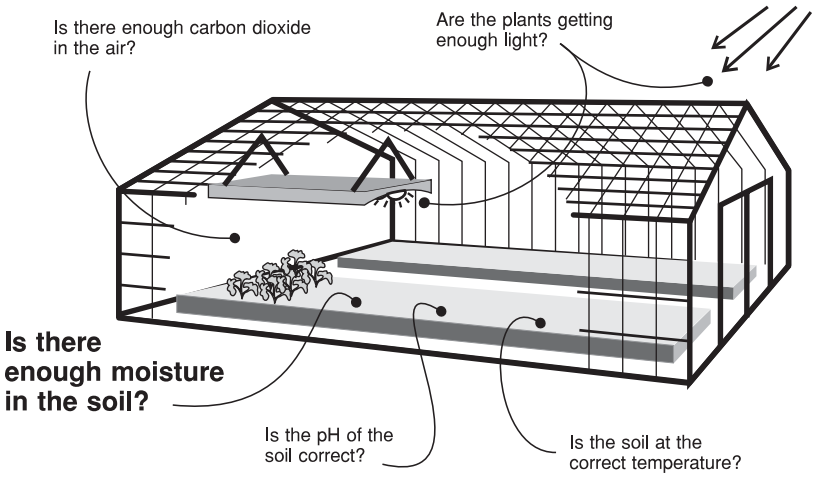
TESTING THE DESIGN

You can model your design using kits.
Make sure that your design meets the specification.
Make a list of questions or a check list to help you.

This should include questions such as:

- Did the system switch ON and OFF at the correct temperature?
- Did it work each time you tried it?

MOISTURE LEVELS IN THE GROWING MEDIUM



During the early growth of plants, they are affected by the moisture level in the growing medium. The moisture level must not be allowed to become too low. Mature plants also require regular watering. This could be achieved by:

- Warning the grower if the moisture level becomes too low.
- Monitoring and controlling the moisture level automatically.

The first of these would still mean someone watering the plants.

The automatic control seems to be a better solution.
But it might be more expensive.

ANALYSING THE PROBLEM

- What moisture level do you need?
- Are there minimum and the maximum levels?
- Do you need to be able to change the settings?
- Will the system be used all the time or only during the day?
- Do you need an alarm in case the system fails?
- Do you need to protect the system from the hostile conditions in a greenhouse?

INPUT - PROCESS - OUTPUT

INPUT - *What sensor will you use?*

PROCESS - *How will you control the moisture level? You may need to use an electric pump. This will be run using an electric motor.*

OUTPUT - *What pump will you use?*
- *Do you need to use a relay?*

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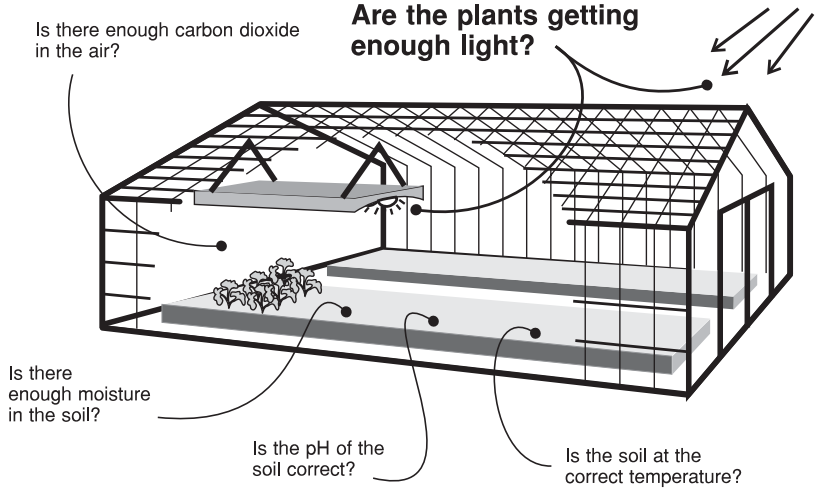
LIGHT LEVELS

The growth of plants is affected by the amount of light they receive. It is possible to provide artificial lighting to encourage the growth of plants. The light level will then need to be monitored and controlled automatically. This is because the external light levels will change during the day.



ANALYSING THE PROBLEM

- What light level do you need?
- Are there minimum and maximum levels?
- Do you need to be able to change the settings?
- Will the system be used all the time or only during the day or during the night?
- Do you need an alarm in case the system fails?
- Do you need to protect the system from the hostile conditions in a greenhouse?

INPUT - PROCESS - OUTPUT

INPUT - *What sensor will you use?*

PROCESS - *How will you control the light level?*

OUTPUT - *What light source will you use?*

- *Do you need to use a relay?*

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